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An evaluation of various working practices in shops selling raw and cooked meats

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SUMMARY

Three groups of premises (butchers' shops, supermarkets and general dealers) which sell raw and cooked meats were compared. Salmonellas were not detected, but *Escherichia coli*, and to a lesser degree *Staphylococcus aureus* and *Streptococcus faecalis*, were widely distributed in all three groups of premises. Contamination of hands, towels and nail brushes was related to poor working practices. The presence of *E. coli* or *Str. faecalis* on slicing machines was associated with contamination of meat samples. A number of wiping cloths were heavily contaminated with *E. coli*, and many also contained *Clostridium perfringens*. Few premises provided written cleaning plans, and in many cases staff did not receive an adequate training in food hygiene. The use of disinfectants as part of the cleaning process did not necessarily reduce the level of bacterial contamination. In general there was poor correlation between microbiological results and a visual inspection made by an environmental health officer. The possible reasons for this finding are discussed.

INTRODUCTION

Sliced cooked meats are important vehicles of bacterial food poisoning. Contamination of these foods may be associated with inadequate processing, or they may be contaminated after cooking from a source such as raw meat, the hands of personnel, or dirty equipment and work surfaces. One important vehicle appears to be the blades of food-slicing machines, which can spread bacteria from one slice of meat to the next (Gilbert, 1969; Bassett, Kurtz & Moore, 1978). Wiping cloths are also important reservoirs of bacteria for contamination of hands equipment and surfaces (Davis, Blake & Woodall, 1968; Tebbutt, 1984).

In large establishments separate areas and personnel can be allocated to the preparation of raw and cooked meats. In small shops, unless an effective code of practice is used, frequent transfer by staff between raw and cooked food areas increases the risk of cross-contamination. Recently, Tebbutt (1984) studied

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working practices in commercial kitchens and found that codes of practice were almost non-existent, and that education in food hygiene was often inadequate.

The aim of this investigation was to study bacterial contamination of the hands of personnel and of various items of equipment in shops selling sliced cooked meats, and to determine whether microbiological results correlated with visual inspections and hygiene assessments made by environmental health officers.

MATERIALS AND METHODS

Sampling programme

Where possible one environmental health officer from each of the five authorities taking part was designated as sampling officer. He was asked to sample towels, nail brushes, tongs, and blades of food-slicing machines and wiping cloths, to obtain two types of sliced meat, and to collect finger-rinse samples from two food handlers. He was asked to enquire whether staff had received any training in food hygiene. Staff who had attended an approved course of instruction were regarded as formally trained, and staff who had received some training in hygiene during the course of their work, but had not attended an approved course, were regarded as informally trained. In each shop the officer looked for a written cleaning plan, and reported if there was evidence of a lack of routine cleaning. He tried to assess the risks of cross-contamination between raw and cooked meats, and checked the storage temperature of cooked meats. A questionnaire about cleaning and disinfection practices was completed for each shop visited.

Diluents

All diluents contained quarter-strength Ringer solution with 0·1 % peptone. For finger-rinse specimens Tween 80 was added to give a final concentration of 0·1 %. For towels, nail brushes, tongs and slicing-machine blades the diluent (designated PTT) contained Tween 80 (1 %) and sodium thiosulphate (0·2 %).

Collection of specimens

Finger-rinse specimens, cloths and samples from towels and nail brushes were collected as previously described (Tebbutt, 1984).

Tongs. The surface was sampled with a swab previously moistened in PTT diluent. The swab stick was broken off into 10 ml of the diluent.

Slicing-machine blade. An area measuring about 100 cm^2 was sampled with a swab moistened in PTT diluent and the swab stick was broken off into 10 ml of the diluent.

Sliced meats. A sample was submitted in a plastic bag in addition to the wrapping provided by the retailer.

After collection samples were kept in cool-boxes and transferred to the laboratory as soon as possible.

Microbiological examination

Finger-rinse specimens and swab samples were examined as previously described (Tebbutt, 1984).

Cooked meat samples. At least 10 g of sample was weighed, sufficient quarter-strength Ringer solution added to form a 1/10 dilution, and the sample homoge-

nized using a Colworth Stomacher 400. Five hundred microlitres were placed on to MacConkey Agar (MA) and incubated at 44 °C overnight. Colonies on MA which resembled coliform bacilli, which produced indole from tryptophan at 44 °C, and which grew and formed gas in Brilliant Green Bile Broth at 44 °C were identified as *Escherichia coli* type I. The colonial appearance on MA and the ability to hydrolyse aesculin were used to identify *Streptococcus faecalis*. Five hundred microlitres of the food suspension was added to Cooked Meat Medium (Oxoid) and the broth incubated at 37 °C overnight. A loopful of the culture was placed on a kanamycin–blood agar plate and incubated overnight anaerobically at 37 °C. A Nagler test was used to demonstrate colonies of *Clostridium perfringens*. An equal volume of double-strength nutrient broth containing 10% (v/v) horse serum (Wellcome number 3) was added to the remainder of the food suspension. After overnight incubation at 37 °C, a loopful of the broth was inoculated on to Kranep Agar (KA), Desoxycholate Citrate Agar (DCA) and MA. KA was incubated for 72 h at 37 °C, DCA at 37 °C overnight, and MA at 44 °C overnight. Suspect colonies of *Staphylococcus aureus*, *E. coli*, *Str. faecalis* and *Salmonella* sp. were identified as previously described.

Cloths. Twenty millilitres of quarter-strength Ringer solution were added to the plastic bag containing the cloth and the contents mixed thoroughly. The fluid was poured off and examined for *E. coli*, *Str. faecalis*, *S. aureus*, *Cl. perfringens* and *Salmonella sp.* as described for cooked-meat suspensions.

Statistical analysis

Premises were included in the statistical analysis if samples were received from slicing machines, wiping cloths, finger tips and cooked meats. The detection of one or more indicator bacteria in a sample after enrichment was scored as one unit, and two units were given whenever a direct count was obtained. Student's *t* test was used to compare the microbiological results obtained from (i) shops which provided formal training for their staff and those which provided none, (ii) shops which used a written cleaning plan and those which did not, and (iii) shops in which there was evidence of a lack of routine cleaning and those which were visibly clean.

RESULTS

Of the 160 premises visited, 75 were butchers' shops, 55 were in supermarkets and 30 were general dealers. Occasional samples from some items of equipment were not received and the results from some specimens could not be analysed because the relevant part of the questionnaire had not been completed.

Salmonellas were not isolated from finger-tip samples. Fig. 1 shows the detection of *E. coli*, *S. aureus* and *Str. faecalis* on finger tips. In most cases the counts were low, and more than 200 cfu of *E. coli* were detected in only 8 samples and more than 5×10^3 cfu of *S. aureus* in only 4 samples. Information about hand-washing procedures was obtained in 144 premises. In 54 (38%) of these, staff do not routinely wash their hands after touching raw meats. Staff in butchers' shops were less likely to wash their hands (38/70, 54%) than those in supermarkets (11/46, 24%) and in general dealers (5/28, 18%). Of the 301 cooked meats submitted, 48

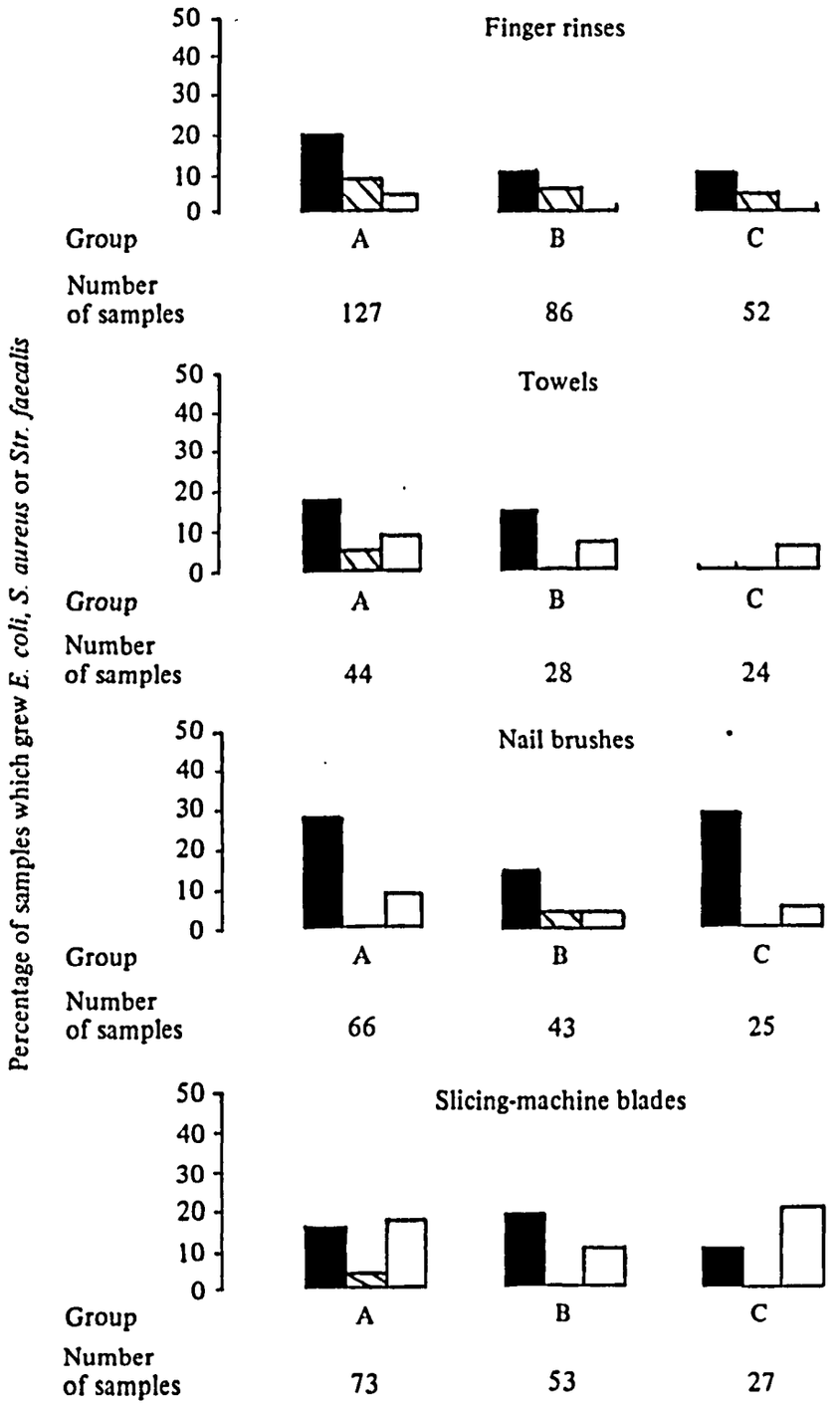

Fig. 1. Isolation of *E. coli* (■), *S. aureus* (▨) and *Str. faecalis* (□) from finger rinses, towels, nail brushes and slicing machines from butchers' shops (group A), supermarkets (group B) and general dealers (group C).

(16%) were touched by hands. This practice was more common in butchers' shops (19/68, 28%) than in supermarkets (2/53, 4%) or general dealers (3/30, 10%).

Of the 151 premises from which information about hand drying was obtained, 53 (35%) provided disposable paper. Hot-air dryers were available in two butchers' shops. Communal towels were used for hand drying in 45% of butchers' shops (33/74) and in 62% of general dealers (18/29). Twenty-one supermarkets (44%) used a continuous roller-towel system. Fig. 1 shows the percentage isolations of *E. coli*, *S. aureus* and *Str. faecalis* from towels. Twenty-one per cent of communal towels (12/58) and 20% of roller-towel systems were contaminated with one or more of the indicator bacteria.

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Table 1. *Comparison of cleaning methods for blades of food-slicing machines with the isolation of* E. coli, S. aureus *and* Str. faecalis

Method	No. positive*/ no. in group† using method A	B	C	No. positive (% of total using method)
Hot water	0/2	0/1	0/0	0
Detergent	15/42	9/26	3/20	27 (31)
Disinfectant	1/1	2/3	1/2	4 (67)
Detergent and disinfectant solution	3/12	0/1	2/5	5 (28)
Detergent then disinfectant	1/7	0/1	0/1	1 (11)
Combined agent (sanitizer)	1/7	3/20	0/0	4 (15)

* Indicates that *E. coli*, *S. aureus* or *Str. faecalis* was present.

† Group A consisted of butchers' shops, group B consisted of supermarkets and group C consisted of general dealers.

Twenty-five (16 %) of the premises did not provide nail brushes for staff during hand washing. Sixty brushes (44 %) had wooden handles. The detection of *E. coli*, *S. aureus* and *Str. faecalis* on nail brushes is shown in Fig. 1. Thirty-eight per cent of wooden brushes and 21 % of nylon brushes were contaminated with one, or more of these bacteria. No salmonella was isolated from nail brushes.

Swab samples from the blades of food-slicing machines were obtained from 153 premises. Fig. 1 shows the percentage of isolations of *E. coli*, *S. aureus* and *Str. faecalis* from these samples. In most butchers' shops (55/69, 80 %) cooked meats were sliced as required, whereas in 75 % of supermarkets meats were cut in advance and kept refrigerated until required. In general the blade of food-slicing machines was not cleaned between slicing different types of cooked meats. Table 1 compares the isolation of *E. coli*, *S. aureus* and *Str. faecalis* with the cleaning method for blades of slicing machines. A detergent applied with a cloth was often used (88/151, 58 %). For chemical disinfection hypochorites were generally chosen in butchers' shops and general dealers and quaternary ammonium compounds, as part of a combined agent, were used in supermarkets (Table 2).

Of 301 cooked meat samples, 129 (43 %) grew one or more of the indicator bacteria. No salmonella was isolated. In general, meats purchased in supermarkets were less likely to be contaminated (33 % positive) than those obtained from butchers' shops or general dealers (49 % and 48 % positive). Although samples of corned beef were less often contaminated than other meats, the difference was small. Fig. 2 shows the isolations of *E. coli* and *Str. faecalis* from cooked meats. *E. coli* was isolated from 62 samples, and of these 11 contained 100 or more bacteria per gram. Sixty-seven samples grew *Str. faecalis*, and of these six contained 100 or more bacteria per gram. After enrichment, *S. aureus* was isolated from eight samples, and one meat sample grew *Cl. perfringens*. Most premises (144/151, 95 %) kept cooked meats in refrigerated displays cabinets. No information about storage conditions was obtained from nine premises. The air temperature was measured in 96 cabinets, and was less than 5 °C in 69 (72 %) of them. In seven

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Table 2. *Types of chemical disinfectants used for cleaning food-slicing machines, wiping cloths and work surfaces*

Type	Area of use: Blade	Cloth	Work surface
Hypochlorites			
A*	19	57	21
B	4	22	5
C	6	23	7
QACs†			
A	5	4	5
B	21	17	22
C	0	0	0
Other‡			
A	2	0	3
B	1	1	1
C	2	1	1

* A–C are groups of premises (see Table 1).

† QACs = Quaternary ammonium compounds.

‡ Dettol was used for cleaning blade, cloths and work surfaces in one supermarket, pine disinfectant was used for cloths in one general dealers. The type of disinfectant was not stated in the remainder.

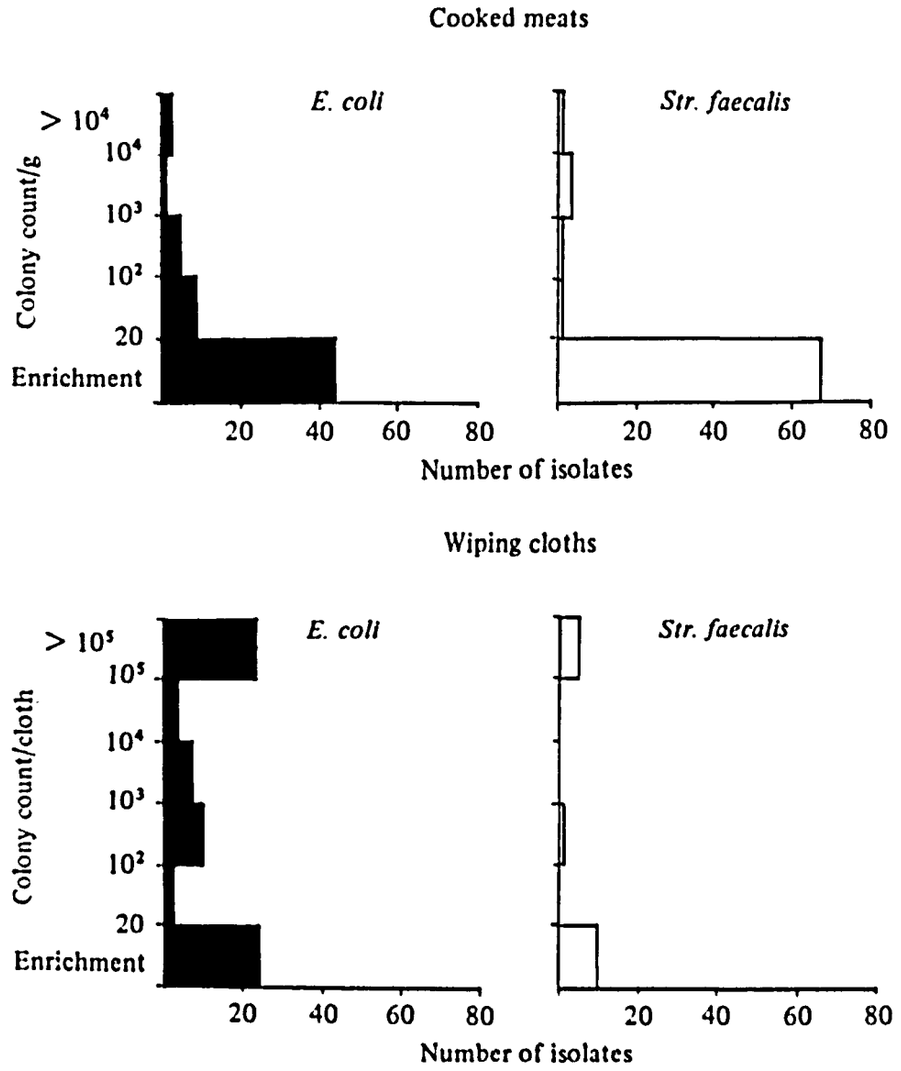

Fig. 2. Isolation of *E. coli* and *Str. faecalis* from sliced cooked meats and from wiping cloths. A total of 301 meat samples and 131 cloths were examined.

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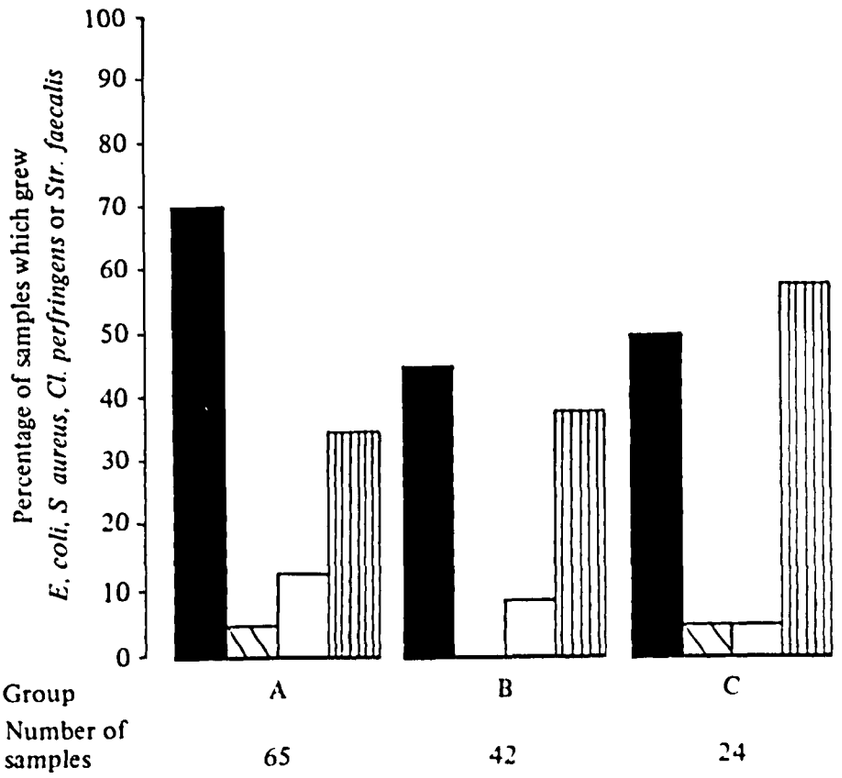

Fig. 3. Isolation of *E. coli* (■), *S. aureus* (▨), *Str. faecalis* (□) and *Cl. perfringens* (▥) from wiping cloths in butchers' shops (group A), supermarkets (group B) or general dealers (group C).

premises, five of which were butchers' shops, cooked meats were kept at room temperature before sale.

Sixteen per cent of meat samples were touched by hand. The remainder were served either with tongs or with a plastic sheet to cover the hand. Although available, tongs were sometimes not used to serve sliced meats. Swab samples were received from 104 tongs and 26 (25%) of these grew one or more of the indicator bacteria.

Cloth samples and information about the use of wiping cloths were obtained from 131 premises. In three supermarkets disposable paper was provided for cleaning food surfaces. Sixty-six per cent of cloths were used for cleaning in both raw or cooked food areas. No salmonella was isolated from wiping cloths. Fig. 3 shows the percentage isolations of *E. coli*, *S. aureus*, *Str. faecalis* and *Cl. perfringens* from cloths. Overall 74% of the cloths were contaminated with one or more of these bacteria. *E. coli* was isolated from 74 cloths (56%), and of these 25 contained more than 10^5 cfu (Fig. 2). Fourteen cloths grew *Str. faecalis* and four of these contained more than 10^5 cfu. *Cl. perfringens* was isolated after enrichment from 52 cloths (40%).

Wiping cloths were discarded at the end of the working day in five premises. These cloths all contained one or more of the indicator bacteria. Other cloths were cleaned at least daily, but none of the methods appeared to be satisfactory (Table 3). Hypochlorites were generally chosen for chemical disinfection of cloths in butchers' shops and general dealers, but quaternary ammonium compounds, usually as part of a combined process, were as likely to be used in supermarkets (Table 2).

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Table 3. *Comparison of cleaning methods for wiping cloths with the isolation of* E. coli, S. aureus, Str. faecalis *and* Cl. perfringens

Method*	No. positive†/ no. in group‡ using method A	B	C	No. positive (% of total using method)
None (discard daily)	1/1	2/2	1/1	4(100)
Wash in detergent	8/10	5/9	3/4	16(70)
Soak in disinfectant	20/33	10/15	5/13	35(57)
Soak in detergent plus disinfectant	14/15	2/6	9/10	25(81)
Wash in detergent then soak in disinfectant	5/8	0/3	0/0	5(45)
Soak in combined agent (sanitizer)	2/6	10/16	0/0	12(55)

* Usually water from hot water supply system was used, but sometimes boiling water was chosen. The contamination rates were not related to water temperature

† Indicates that *E. coli*, *S. aureus*, *Str. faecalis* or *Cl. perfringens* was isolated.

‡ A–C are groups of premises (see Table 1).

Formal training in food hygiene was provided in only nine premises, eight of which were supermarkets. Staff in 34% of butchers' shops, in 38% of general dealers and in 12% of supermarkets received no training whatsoever in food hygiene. Comparison of the microbiological results obtained from premises which provided formal training with those that did not, however, showed no significant difference between these two groups (mean scores 2·3 and 3·5, $P > 0{\cdot}1$). Information about written cleaning plans was obtained from 159 premises. Of these, only 19 (12%) had written plans. These were more likely to be available in supermarkets (15/55, 27%) than in butchers' shops (1/74) and general dealers (3/30, 10%). The microbiological results obtained from premises with written plans, however, were not significantly better than those without them (mean scores 3·1 and 3·7, $P > 0{\cdot}1$). Overall, environmental health officers reported a lack of routine cleaning in 11% of premises, but the microbiological results obtained from these were not significantly worse than the results from premises which were visibly clean (mean scores 4·4 and 3·6, $P > 0{\cdot}1$).

DISCUSSION

The value of microbiological sampling in the prevention of food-borne disease associated with catering premises is uncertain. It is generally accepted that random food sampling is not worthwhile. A programme which concentrates on specific aspects of hygiene and on cleaning procedures may help to establish and monitor a good code of working practice. It is not clear, however, which sites should be sampled, and whether or not total bacterial counts or specific bacteria should be looked for. This study has shown that *E. coli*, and to a lesser degree *S. aureus* and *Str. faecalis*, are widely distributed in premises selling raw and cooked meats. Other workers have reported that processed foods, including sliced meats, are frequently contaminated with *E. coli* (Shooter *et al.* 1971; Pinegar & Cooke, 1985). In view of this widespread distribution the significance of

small numbers of these bacteria is open to question, and quantitative assessment may be needed to indicate a potential hazard.

It is worrying that so many staff in butchers' shops handled sliced cooked meats, particularly as most of them do not wash their hands after touching raw foods. At the very least a no-touch technique should be introduced into premises selling unwrapped cooked meats. Undoubtedly poor siting of wash-hand basins contributes to infrequent hand washing. However, hand washing may not always be practical in between serving raw and cooked meats, and the use of disposable alcohol-impregnated wipes might be considered to supplement existing washing facilities. These wipes, however, have yet to be evaluated fully under working conditions.

Although bulk slicing of meats and cold storage until needed is strongly recommended (Gilbert & Maurer, 1968), we were unable to demonstrate a difference in the isolation of *E. coli*, *S. aureus* or *Str. faecalis* from meats cut as required and those sliced in bulk. The presence of *E. coli* or *Str. faecalis* on slicing-machine blades, however, was associated with contamination of meat samples. These results confirm the part played by slicing machines in the cross-contamination of sliced meats (Gilbert, 1969; Bassett, Kurtz & Moore, 1978). Although slicing machines cleaned by a combination of detergent and disinfectant were less often contaminated than those cleaned by a detergent or disinfectant alone, the difference was small, and other factors such as the efficiency of cleaning and the use of contaminated wiping cloths must be important. We found, as did Davis, Blake & Woodall (1968), that wiping cloths were frequently heavily contaminated with *E. coli*. The risks of cross-contamination would be considerably reduced by the use of disposable paper for cleaning surfaces and equipment.

The risks of cross-contamination appear to be greatest in small premises in which separate areas and personnel cannot be provided for the preparation of raw and cooked meats. Hands, towels and nail brushes were more often contaminated in butchers' shops than in supermarkets in which separate facilities were provided. Contamination of cloths and slicing machines occurred to similar extents in all three types of premises. There is little point in providing separate surfaces for different preparations if all surfaces are cleaned with the same contaminated cloth. New combined agents (sanitizers), particularly those containing quaternary ammonium compounds, are increasingly used by larger retailers. Although convenient, there is little evidence to show that these agents are more effective than cleaning with detergent alone. We consider that disinfectants are usually unnecessary, and if used are no substitute for regular and efficient cleaning and drying of surfaces between uses.

It is disappointing to have found no clear relationship between the microbiological results and a visual inspection made by an environmental health officer. Bassett, Kurtz & Moore (1978) also reported poor correlation between total bacterial counts and hygienic assessments. Several reasons could explain why this finding occurred. First, repeat visits and sampling in shops are probably needed to obtain a clear understanding of working practices and to determine the level of bacterial contamination. Secondly, we did not define the points which environmental health officers should look for in their inspection, and a more critical examination of hygienic practices and cleaning schedules to determine their

effectiveness and whether or not they are actually used is probably necessary. It is unlikely, however, that officers would have had sufficient time to carry out such a detailed inspection of so many premises. During an inspection greater emphasis should be placed on assessing day-to-day working practices as well as judging the structure of premises. It is possible that selective microbiological sampling might be helpful to environmental health officers in making this assessment. To investigate this possibility a further study is planned in which repeat visits and microbiological sampling will be carried out in premises in which high-risk foods are manufactured.

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