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Cross-contamination by cooked-meat slicing machines and cleaning cloths

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In recent years two large food-borne outbreaks of salmonella infection have stressed the importance of cooked-meat slicing machines, among other things, in the spread of salmonellas from contaminated meat products to other meats. Since many different cold meats may be sliced during the day on one machine, a contaminated product can constantly recontaminate the machine, thereby increasing the spread of the organism to other meats. Such an accident was likely in the Aberdeen typhoid outbreak (Report, 1964), in which a history of eating various cold meats from the infected shop was given by 373 patients who remembered the association out of the 507 recorded cases (Walker, 1965). The second outbreak occurred in Washington, U.S.A., in May–June 1965, in which there were 356 known cases of salmonellosis due to *Salmonella meleagridis*, all related to one combined caterer–delicatessen–restaurant (Kaufmann, Hayman, Heath & Grant, 1968). The same serotype was isolated from many of the patients, from 64 of 115 employees, from 17 of 29 different types of ready-to-eat foods examined including several cold meats (e.g. corned beef, roast beef, tongue and salami), and from the environment; as might be expected, the slicing machines concerned were found to be contaminated with *S. meleagridis*—one by repeat sampling after what was thought to be an adequate cleaning and disinfection programme. The purpose of this paper is to provide laboratory evidence of the obvious—that a contaminated slicing machine will easily cross-contaminate other products passed through it.

MATERIALS AND METHODS

Sealed cans of corned beef (2·7 kg.), chopped pork (1·8 kg.) and brisket of beef (1·8 kg.) were opened aseptically when required. To facilitate slicing, these canned products were stored for 3 days at 4° C. before opening. The salami (0·9 kg.) used was in the form of a sealed sausage.

Cross-contamination experiments

A central core of meat (6 cm. long, 2 cm. diam.) was removed from one end of half the contents of a can of chopped pork using a sterile cork-borer. The core was inoculated in several parts with a total of 6×10^9 coagulase-positive staphylococci using a syringe with a wide-bore needle, replaced in the hole on the chopped pork and pressed gently down. The chopped pork was then sliced on a cooked-meat

slicing machine (Asco G.2 gravity-feed slicer), cutting the inoculated piece of chopped pork first. The same machine was then used for cutting 20 slices of chopped pork from the uninoculated half of the can, 10 slices of corned beef, 10 slices of brisket of beef and 10 slices of salami. After homogenizing some of the slices of each meat in separate Atomix beakers, approximately 2–3 g. samples of each were inoculated into five bottles of cooked-meat medium containing 10% (w/v) sodium chloride for enrichment of staphylococci. Total viable and staphylococcal counts were made by spreading 0·5 ml. samples of dilutions of the homogenized meat in quarter-strength Ringer's solution on the surface of duplicate plates of blood agar and phenolphthalein diphosphate agar with polymyxin (Hobbs, Kendall & Gilbert, 1968); plates were incubated for 48 hr. at 35° C.

The slicing machine was then cleaned using the method given by Gilbert & Maurer (1968). To avoid the risk of spoiling further experiments, the cleaning procedure was repeated twice.

The experiments were repeated using half the contents of a can of corned beef inoculated with 3×10^9 *Salmonella oranienburg* in a central core. After slicing the corned beef, the same machine was then used for cutting 20 slices of corned beef from the uninoculated half of the can and a freshly opened can, 10 slices of chopped pork and 10 slices of brisket of beef. After homogenizing some of the slices, 25 g. samples were incubated in 100 ml. volumes of selenite broth at 35° C. Subcultures on Wilson and Blair bismuth sulphite agar and deoxycholate citrate sucrose agar were made after 24 and 72 hr. and the plates incubated for 48 hr. Total viable counts were made on blood agar as previously described.

Experiments were then made with the cotton cloths normally used by shops and restaurants for wiping down surfaces and equipment and for washing-up. One piece of sterile cloth (10 × 10 cm) was dampened with warm water, wiped over the gravity feed and knife centre disk of the slicing machine used previously for cutting meat infected with *S. oranienburg*, and then placed in 100 ml. of selenite broth. One larger piece of sterile cloth (30 × 10 cm) was dampened with warm water, wiped over the upper and lower surfaces of the cutting blade and then cut into three pieces (approximately 10 × 10 cm). On piece was placed directly in selenite broth, one piece was quickly rinsed (10 sec.) in warm water at 50° C. before addition to selenite broth and one piece was soaked in warm water containing 0·75% (w/v) of detergent/disinfectant for 10 min. and rinsed in water before addition to selenite broth. Subcultures on Wilson and Blair agar and deoxycholate citrate sucrose agar were made after 24 and 72 hr. and the plates incubated for 48 hr.

RESULTS

Samples of the three freshly opened canned products gave no growth from enrichment cultures and they were assumed to be sterile. The viable counts on salami were $3{\cdot}4–4{\cdot}3 \times 10^6$/g.

Table 1 shows the effect of cutting cold meats on a slicing machine contaminated with coagulase-positive staphylococci from a previously sliced product. Coagulase-positive staphylococci were found up to the 41st slice of meat cut on the machine.

Total viable counts and counts of coagulase-positive staphylococci from the sliced chopped pork, corned beef and brisket of beef were similar: coagulase tests showed that all colonies tested were coagulase-positive staphylococci. Only the first slice of the salami gave any positive results on enrichment culture for coagulase-positive

Table 1. *Effect of cutting cold meats on a slicing machine contaminated with coagulase-positive staphylococci*

Product sliced	Slice no.	Total viable count/g.	Count of coagulase-positive staphylococci/g.	Enrichment cultures (5) positive for coagulase-positive staphylococci
Chopped pork	1	970	1100	5
	2	520	580	5
	3	370	390	5
	4	260	290	5
	5	170	350	5
	10	190	210	5
	15	60	110	5
	20	110	80	5
Corned beef	21	120	110	5
	22	40	40	5
	25	60	60	5
	30	< 20	< 20	5
Brisket of beef	31	50	60	5
	32	< 20	20	5
	35	< 20	< 20	1
	40	< 20	< 20	4
Salami	41	$6{\cdot}9 \times 10^6$	< 20	1
	42	$1{\cdot}4 \times 10^7$	< 20	0
	45	$4{\cdot}0 \times 10^6$	< 20	0
	50	$3{\cdot}6 \times 10^6$	< 20	0

Table 2. *Effect of cutting cold meats on a slicing machine contaminated with* Salmonella oranienburg

Product sliced	Slice no.	Total viable count/g.	Enrichment culture for *Salmonella oranienburg*
Corned beef	1	210	+
	2	80	+
	3	120	+
	4	50	+
	5	50	+
	10	20	+
	15	30	+
	20	< 20	+
Chopped pork	21	< 20	+
	22	50	+
	25	< 20	+
	30	20	+
Brisket of beef	31	< 20	+
	32	< 20	−
	35	< 20	−
	40	< 20	−

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staphylococci. This may have been due to the small number of staphylococci left on the slicing machine or to overgrowth on enrichment of any staphylococci by the background flora of the salami.

Table 2 shows the effect of cutting cold meats on a slicing machine contaminated with *S. oranienburg*. This serotype was isolated up to the 31st slice of meat cut on the machine. Numerous colonies from the total viable counts were serotyped and all were shown to be *S. oranienburg*.

Table 3 shows the results of experiments on the cloth used for cleaning the slicing machine contaminated with *S. oranienburg*. This serotype was isolated from a piece of cloth wiped over the gravity feed and knife centre disk and from the pieces of cloth wiped over the upper and lower surfaces of the cutting blade both before and after rinsing the cloth in warm water for 10 sec. However, a piece of cloth wiped over the contaminated blade and then soaked in warm water containing detergent/disinfectant for 10 min., followed by rinsing, was negative for salmonellas on enrichment culture.

Table 3. *Experiments on cloths used for cleaning slicing machines*

Area wiped with cloth	Treatment of cloth after wiping	Enrichment culture for *Salmonella oranienburg*
Gravity feed and knife centre disk	None	+
Upper and lower surfaces of cutting blade	None	+
	Rinsed in warm water (10 sec.)	+
	Soaked in warm water with detergent/disinfectant (10 min.) and rinsed	−

DISCUSSION

The results confirm the part played by slicing machines in the cross-contamination of various sliced meats. The results show also that cleaning cloths contaminated with pathogens could readily contaminate other equipment and utensils. In at least three recent outbreaks of food poisoning due to *Salmonella reading* and *S. tennessee* (Cruickshank, 1965; Burnett & Davies, 1967) and *S. meleagridis* (Kaufmann *et al.* 1968), the organisms have been isolated from slicing machines.

The dangers associated with dirty dish-cloths and tea-towels have been stressed recently by Davis, Blake & Woodall (1968). Similar dangers are associated with cotton meat cloths used for wrapping raw meats which may be contaminated with salmonellas from animal hosts. Such cloths are widely used in kitchens, shops and restaurants and every effort should be made to educate the public in the hygienic value of disposable paper. In the meantime it is necessary to emphasize that all dish and cleaning cloths should be washed and disinfected daily, either by boiling, or by soaking overnight in freshly made up detergent/disinfectant solution, or washed out in detergent and soaked in disinfectant solution overnight.

Although the 32nd, 35th and 40th slices of meat cut on the machine were negative on enrichment for *S. oranienburg* (Table 2), and also presumably the intervening slices which were not examined, experiments with the cloths (Table 3) showed that the slicing machine used for cutting this meat was still contaminated. Positive cultures from an area of low contamination are much more likely to be obtained by wiping a large surface area with a piece of cloth or a large swab than a small area with a normal swab.

Recommendations concerning the slicing and storage of cold meats and the cleaning of slicing machines and associated equipment, namely carving knives and can-openers, have been given recently by Gilbert & Maurer (1968), who recommend that such equipment be cleaned at least twice daily. Where possible it is also desirable that a whole can of meat be sliced at one time and the equipment cleaned again before re-use. It is only necessary here to re-emphasize the importance of efficient and regular cleaning by responsible persons using hot water containing detergent/disinfectant or detergent followed by disinfectant applied with clean cloths or preferably disposable paper.

SUMMARY

In view of recent food-borne outbreaks of salmonella infection in which cooked-meat slicing machines have been implicated in the spread of organisms from contaminated meat products to other meats, experiments have been made to provide laboratory evidence that a contaminated slicing machine will easily cross-contaminate other products passing through it. Chopped pork inoculated with coagulase-positive staphylococci was cut on a slicing machine; staphylococci were isolated up to the 41st slice of various cooked meats cut on the same machine. The experiments were repeated with *Salmonella oranienburg*; this serotype was isolated up to the 31st slice of various cooked meats cut on the same machine, and from pieces of damp cloth wiped over the gravity feed, knife centre disk and cutting blade.

The importance of efficient and regular cleaning of slicing machines with hot water containing detergent/disinfectant, or detergent followed by disinfectant, applied with clean cloths or preferably disposable paper, is stressed.

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