APPLIED MICROBIOLOGY, May 1970, p. 795-799
Vol. 19, No. 5

Salmonella Contamination in a Poultry-Processing Plant

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Received for publication 23 January 1970

Bacteriological examination of 1,427 samples from a poultry-processing plant over a 2-year period yielded 202 (14.2%) cultures positive for salmonellae. The results indicate that contamination is reduced by washing procedures within the plant but that recontamination of the carcasses occurred in at least two different stages of processing, i.e., during evisceration and chilling. There was evidence of spread of salmonellae from flock to flock during the serial processing of flocks, but the spread was usually not extensive. The serotypes of salmonellae isolated in this study were similar to those of chicken origin reported from other areas of the country.

Salmonella contamination of poultry has been the subject of many investigations and numerous reports (9). Since poultry is a major food source, its contamination with salmonellae may result in the development of human illness. This study of the *Salmonella* contamination of chickens in a single poultry-processing plant was conducted to determine whether the *Salmonella* contamination in a plant was consistent or varied with the flocks being processed, to determine whether spread of *Salmonella* from one flock to another during serial processing of poultry flocks existed and to determine the stages of processing in which contamination or decontamination of the carcasses occurred. A total of 1,427 samples, collected from the plant over a 2-year period from February 1966 to February 1968, were examined for salmonellae.

MATERIALS AND METHODS

The poultry-processing plant studied processed broilers from a vertically integrated poultry operation and was federally inspected. The plant consisted of five separate rooms as follows: entrance and hanging area, killing area, scalding and picking area, eviscerating and chilling area, and packing area (Fig. 1). Sampling consisted of collecting swab samples from the chicken carcasses, viscera, and materials and equipment used during processing operations, such as tables, tubs, conveyers, knives, saws, and gutter water. Prior to swabbing dry surfaces the cotton-tipped swab was dipped in saline solution. An untreated dry swab was used to swab wet surfaces. Carcasses were examined by rapidly swabbing the external surface for approximately 30 sec. Feces of entering chickens were examined by rotating a swab in newly passed excreta in the chicken crates on the delivery truck.

Bacterial analyses were conducted by inserting the swabs immediately after collection into a plastic screw-cap tube containing 10 ml of tetrathionate broth (Difco). The cotton-wrapped end of the swab was snapped off and dropped into the tube. A 1:100,000 dilution of Brilliant Green was added to tetrathionate broth in this study. The tubes were returned to the laboratory, usually within 4 hr after collection. The broth cultures were incubated for 48 hr at 37 C, and then a large loopful of the broth culture was streaked on plating medium. Brilliant Green agar (Difco) containing 80 mg of sodium sulfadiazine per liter of agar was used as the plating medium. At least three suspect colonies were picked from each positive plate, and each of these was inoculated into a Triple Sugar Iron agar tube (Difco). After 24 hr of incubation, tubes that showed typical reactions for *Salmonella* were subjected to serological (and where indicated, biochemical) tests. Details of the procedures followed the techniques suggested by Galton, Morris, and Martin (4). The O and H serological grouping, as described by Edwards (1), was followed by definitive serological typing (2). The nomenclature used in this report is based upon the three-species concept (5).

RESULTS AND DISCUSSION

Salmonella isolations from the chicken fecal matter of 10 flocks collected at the plant entrance were compared with those from carcasses, viscera, and equipment during processing in various areas of the plant (Table 1). Salmonellae were isolated with similar frequency from feces at the plant entrance, from carcasses before evisceration, from carcasses after evisceration, from edible viscera (gizzards and livers), and from environmental samples within the plant. The various serotypes of salmonellae isolated from the feces of the

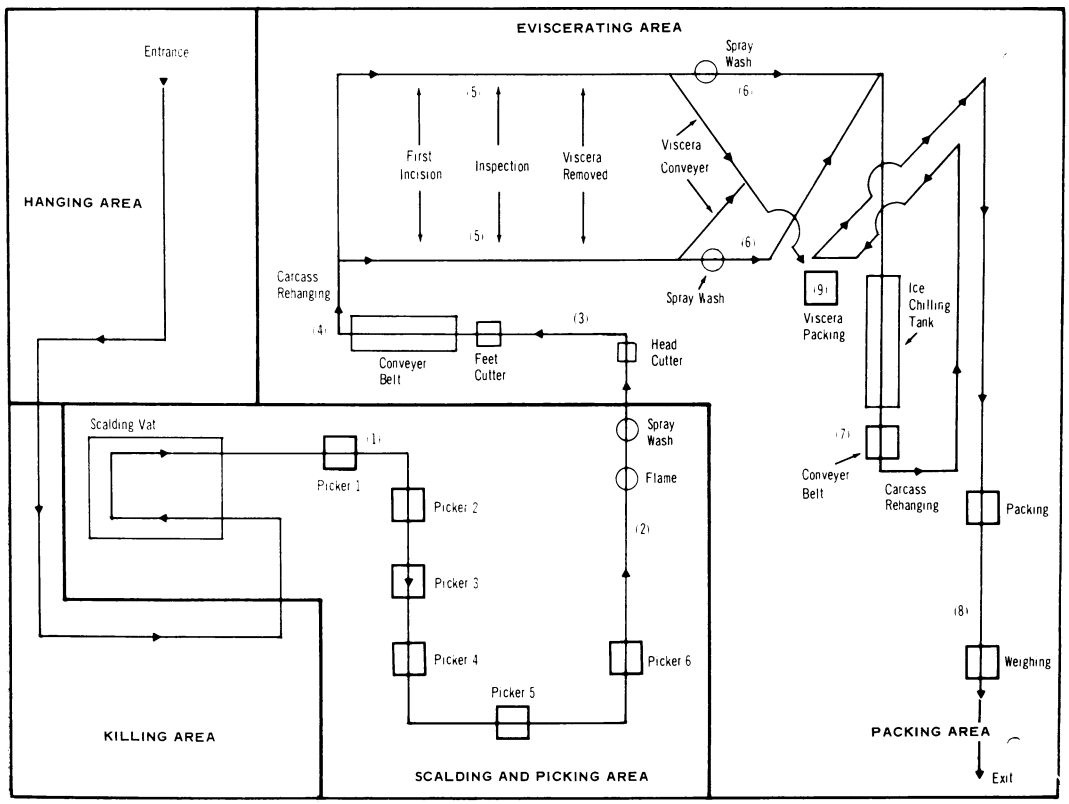

FIG. 1. *Diagram of poultry-processing plant. Numbers in parentheses indicate stations at which poultry carcasses were sampled.*

TABLE 1. *Salmonella isolated from samples of entering-chicken feces as compared with samples collected at various stages of processing of 10 poultry flocks*

Source	No. of positive samples/total no. of samples	Per cent positive
Feces at plant entrance	12/59	20.3
Carcasses before evisceration	48/203	23.6
Carcasses during and after evisceration	38/212	17.9
Edible viscera	26/108	24.1
Plant environment[a]	28/100	28.0

[a] Tables, tubs, conveyers, knives, saws, and gutter water.

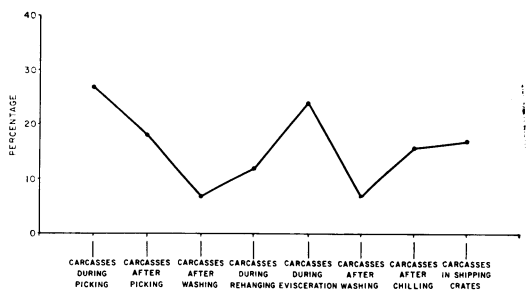

FIG. 2. *Salmonellae on poultry carcasses at various stages of processing. Sampling stations are indicated on Fig. 1.*

entering chickens were similar to those serotypes isolated from the various areas of the plant (Table 2). The four serotypes that were not isolated from the feces were isolated infrequently from within the plant.

Salmonellae isolated at various stages of processing during nine visits to the plant (Table 3) revealed that salmonellae were more frequently isolated from environmental specimens than from the chicken carcasses, but the environmental samples were from items that came in frequent contact with many chicken carcasses and parts. When viscera were sampled during evisceration, salmonellae were isolated with about the same frequency as from the carcass (16.1% versus 17.0%), but 30.9% of the swabs were positive at the visera-packing station where the edible viscera

were being repacked into the chicken carcasses (station 9 in Table 3, and Fig. 1).

Carcass contamination was reduced by the washing procedures [Table 3, stations 3 (4.5%) and 6 (4.0%)], but carcasses were subsequently recontaminated in an area of extensive handling [Table 3, station 5 (17.0%)] and in an area in which there was extensive contact among car-

TABLE 2. *Salmonella serotypes isolated from 10 flocks at various stages of processing*

S. enteriditis serotype	Feces at plant entrance	Carcasses during processing before first incision	Carcasses during and after evisceration	Edible viscera	Plant environment[a]
Group I[b]					
blockley	1	2	4	1	3
bredeney	4	26	6	5	0
heidelberg	3	17	3	4	2
litchfield	1	0	9	1	2
montevideo	1	6	9	9	8
thompson	1	3	6	5	13
typhimurium	1	0	2	1	2
Group II[c]					
eimsbuettel	0	0	1	0	0
lexington	0	1	0	0	0
schwarzengrund	0	1	0	0	0
Group B, non-motile	0	0	0	1	0

[a] *See* Table 1.
[b] Isolated from feces of chickens entering plant.
[c] Not isolated from feces of chickens entering plant.

TABLE 3. *Salmonellae isolated from poultry carcasses at various stages of processing on 9 separate days*

Sampling station[a]	Sample source	Determination[b] on day									Total	Per cent
		1	2	3	4	5	6	7	8	9		
1	Carcasses during picking	2/2	3/6	12/17	4/18	1/15	0/34	0/18	2/18	2/13	26/141	18.4
2	Carcasses after picking	0/5	1/5	10/17	2/16	3/18	2/34	0/18	0/18	1/13	19/144	13.2
3	Carcasses after washing		0/3	2/17	2/18	1/17	0/32	0/18	0/18	1/10	6/133	4.5
4	Carcasses during rehanging			2/6	3/18	4/17	0/30	0/18	1/18	0/13	10/120	8.3
5	Carcasses during evisceration		0/2	7/18	4/16	2/16	0/28	0/18	5/18	5/19	23/135	17.0
6	Carcasses after evisceration	0/11			1/16	2/18	0/28	0/18	2/18	0/17	5/126	4.0
7	Carcasses after chilling	0/6	1/5	4/17	4/16	1/18	0/26	0/18	6/18	0/22	16/146	11.0
8	Carcasses in shipping crates	0/5	5/11	1/15	4/18	2/18	0/28	0/20	7/18	1/22	20/155	12.9
5a	Viscera during evisceration	0/5	0/3	4/18	4/18	2/18					10/62	16.1
9	Viscera during packing	0/5	5/5	2/10	1/16	9/18				0/1	17/55	30.9
	Environmentals[c]	0/24	13/21	3/13	4/19	8/27	0/5	0/3		10/39	38/151	25.2

[a] *See* Fig. 1.
[b] Number of positive samples/total samples examined.
[c] Swab samples of tables, tubs, conveyers, knives, and saws, and 10-ml water samples from drain troughs.

TABLE 4. *Salmonella serotypes isolated from a chicken-processing plant during serial processing of flocks*

S. enteriditis serotype	No. isolated on day														
	3			4			5			8			9		
	1st (A)	2nd (B[b])	3rd[a] (A)	1st (C)	2nd (D[b])	3rd (E)	1st (F)	2nd (G[b])	3rd (H)	1st (I)	2nd (J[b])	3rd (K)	1st (L)	2nd (M[b])	3rd (N[b])
anatum	—	—	—	—	—	—	—	—	—	—	—	—	2	4	3
blockley	7	2	1	—	—	—	—	—	1	—	—	—	—	—	—
bredeney	10	3	23	—	6*	—	—	—	—	—	—	—	—	—*	—
derby	—	—	—	—	—*	—	—	—	—	—	—	—	—	—	—
eimsbuettel	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
heidelberg	2	—*	—	3	8*	2	—	3	2	—	—	—	—	1	—
infantis	—	—	—	—	1	—	—	—	—	—	17*	6	1	2*	5*
litchfield	—	—	—	11	2	—	—	—	—	—	—	—	—	—	—
montevideo	6	1	2	—	—	—	—	15*	10	—	—	—	—	—	—
schwarzengrund	—	—	—	—	—*	—	—	—	—	—	—	—	—	—	—
typhimurium	—	1	—	3	1	—	—	—	—	—	—	—	1	3*	2*
typhimurium var. copenhagen	—	—	—	—	—	—	—	—	—	—	—	—	1	—*	—
Group B, nonmotile	—	—	—	—	—	—	5	1	—	—	—	—	—	—	—
Total serotypes	25	7	26	17	19	2	5	19	13	0	17	6	5	10	10
Total positive samples	19	7	25	17	17	2	5	19	13	0	17	6	4	9	7
Total number of samples	57	52	55	71	72	64	36	96	80	48	48	48	37	70	62
Per cent positive samples	33	13	45	24	24	3	14	20	16	0	35	13	11	13	11

[a] Represents 1st, 2nd, and 3rd flock processed; capital letters are flock designations.

[b] Swab samples of feces, equipment, and housing of these flocks at the farm were bacteriologically examined, and the asterisks indicate the serotypes isolated.

TABLE 5. *Salmonella serotypes isolated from the poultry plant during the 2-year study*

Order of frequency	*S. enteriditis* serotype	No. isolated
1	*bredeney*	42
2	*montevideo*[a]	34
3	*infantis*[a]	32
4	*heidelberg*[a]	30
5	*thompson*[a]	27
6	*litchfield*	13
7	*typhimurium*[a]	12
8	*blockley*[a]	11
9	*anatum*[a]	9
10	Group B, nonmotile	6

[a] These 7 serotypes were also listed among the 10 most common serotypes from chicken origin reported to the National Communicable Disease Center during 1968.

casses, i.e., the chilling tanks where the carcasses are rotated in an ice slush [Table 3, station 7 (11.0%)]. This recontamination is depicted clearly in Fig. 2. Flocks yielding no salmonellae were excluded from the data in Fig. 2; hence, the percentages are higher than those shown in Table 3.

Results of the examination of three consecutive flocks in each of five visits to the plant (Table 4) indicated that the frequency with which salmonellae were isolated varied from flock to flock. The results from the third visit show that flock B was less contaminated with salmonellae than flock A, which was processed before and after flock B. There was evidence of spread of contamination in flocks A, C, F, G, J, and M to the flocks processed next, but this spread was not extensive. Minimal spread of contamination was indicated by the fact that only 3% of the samples from flock E were positive, whereas 24% of the samples collected from the two preceding flocks yielded salmonellae. There were indications that salmonellae spread extensively from flock G to H and from J to K. However, the histories of the latter flocks (H and K) were not determined; therefore, it is possible (but not likely) that these birds were already contaminated with the same serotypes when they arrived at the plant.

The 10 most commonly isolated *Salmonella* serotypes in this study (Table 5) were compared

to those serotypes from chicken sources reported to the National Communicable Disease Center during 1968 (6).

During this study, 1,427 samples collected from this processing plant were examined for salmonellae, and 202 (14.2%) were positive. However, 400 of these samples were collected from flocks selected for examination in the processing plant because they had been shown to be contaminated when examined on the farm. Therefore, 1,027 samples were collected in the processing plant from flocks with unknown history, and 126 (12.3%) were positive. Of the latter flocks, 113 were samples of carcasses in shipping crates, ready for distribution to retailers, and 14 (12.4%) were positive. The level of contamination in this plant is similar to that reported in other studies (3, 7, 8), but levels of contamination as high as 50% have been reported for market broilers (8).

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