Food Safety Practices and Technologies Used by U.S. Poultry Slaughter Plants: Results of a National Mail Survey

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1. Introduction

Practices and technologies implemented by poultry (chicken and turkey) slaughter plants for controlling foodborne pathogens and other hazards may subsequently help reduce the risk of salmonellosis and other foodborne illnesses in the United States. Plants may implement these procedures to meet U.S. Department of Agriculture/Food Safety and Inspection Service (USDA/FSIS) microbiological performance criteria or as part of their sanitation standard operating procedures (SSOPs) or Hazard Analysis and Critical Control Point (HACCP) plan. To characterize the use of food safety practices and technologies in the poultry slaughter industry, we conducted a nationally representative mail survey of poultry slaughter plants.

2. Purpose

The purpose of the survey was to obtain uniform information on practices and technologies used to control pathogens and promote food safety in the poultry slaughter industry. The survey findings can be used to establish baseline measures of current food safety practices and technologies for regulated establishments. Additionally, FSIS can use the survey data to guide regulatory policy making and conduct required economic analyses.

3. Study Design

Sample Design

We used FSIS's Enhanced Facilities Database (EFD) as the sampling frame. We stratified the sample by inspection status (federal versus state) and HACCP size (very small [<10 employees or < $2.5 million in annual sales], small [10–499 employees], and large [500+ employees. Because of the relatively small number of plants, we selected all plants (i.e., took a census).

Survey Administration

We conducted the survey in fall 2004. To enhance cooperation and maximize the response rate, we used a multimodal survey approach. We contacted plants by telephone to screen for eligibility and to identify the target respondent for the survey, mailed a self-administered questionnaire to target respondents, and made a series of telephone calls to nonrespondents to encourage participation.

Survey Response

We received 219 completed surveys. The overall weighted response rate was 78%. Response rates were higher for federally-inspected plants (80%) than for state-inspected plants (45%). Also, for federally-inspected plants, response rates were higher for small plants (80%) and large plants (85%) compared with very small plants (56%).

Data Analysis

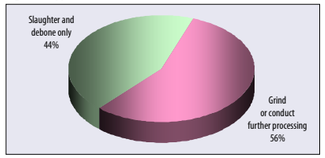
We weighted the survey data to reflect the selection probabilities of sampled establishments and to compensate for differential nonresponse. We performed a chi-square test for the relationship between the variable of interest and HACCP plant size (large versus very small and small versus very small).

4. Results

A. Plant Characteristics

- The poultry slaughter industry is characterized by large plants, accounting for most of the industry's production volume and sales revenue. About 23% of poultry slaughter plants are very small and account for less than 1% of total revenue, 29% are small and account for 11% of total revenue, and 48% are large and account for 89% of total revenue.
- The mean plant age (or years since most recent renovation) is 19 years (standard error = 1.2), the mean plant size is 111,586 square feet (standard error = 7,918), and the mean number of employees is 645 (standard error = 39).
- More than half of plants grind poultry or conduct other further processing activities. Of these, 24% produce ready-to-eat (RTE) products, 87% produce not-ready-to-eat (NRTE) products, and 61% produce inputs to further processing by another plant.

Figure 1. Types of Activities Conducted



B. Use of Food Safety Technologies and Practices for Poultry Slaughter and Deboning

Table 1. Use of Food Safety Technologies for Slaughter and Deboning Operations (% of plants)

	Very Small	Small	Large	All Plants
Bioluminescent testing system	0.0	20.3+++	37.5***	25.8
Conveyor belts made from materials designed to prevent bacterial growth	3.7	34.4+++	33.6***	28.4
Use of some type of carcass decontamination intervention	33.3	95.3+++	98.4***	85.7
Inside-outside bird washers	29.6	95.3+++	98.4***	85.1
Organic acid rinse	3.7	21.9++	28.1***	21.9
Metal detection equipment	3.7	42.2+++	85.9***	58.6
Automatic bird transfer (from kill line to evisceration line)	0.0	23.4+++	61.7***	39.7

+++ = Difference between small and very small plants is statistically significant at 0.01 level.
++ = Difference between small and very small plants is statistically significant at 0.05 level.
+ = Difference between small and very small plants is statistically significant at 0.10 level.
*** = Difference between large and very small plants is statistically significant at 0.01 level.
** = Difference between large and very small plants is statistically significant at 0.05 level.
* = Difference between large and very small plants is statistically significant at 0.10 level.

Table 2. Use of Food Safety and Sanitation Practices for Slaughter and Deboning Operations (% of plants)

	Very Small	Small	Large	All Plants
Sanitizes hands or gloves that contact raw product in slaughter area on a specified frequency	63.0	79.7+	85.2***	79.6
Sanitizes hands or gloves that contact raw product in deboning area on a specified frequency	48.1	78.0++	85.6***	76.5
Rotates sanitizing chemicals on annual or more frequent basis	29.6	62.5+++	61.7***	56.1
Uses chemical sanitizers for food contact hand tools during operations	59.3	62.5	80.5**	71.5
Uses sterilizer pots for heat sterilization of hand tools during operations	14.8	39.1++	43.8***	37.2
Requires and documents that bird growers use stipulated practices for pathogen control	37.0	57.8*	70.3***	60.7
Requires and documents that bird growers use stipulated practices for controlling chemical residues	44.4	71.9++	91.4***	77.3
Conducts fat pad sampling on a regular schedule	3.7	46.9+++	89.8***	62.0
Identifies and tracks products—backward	55.6	79.7++	85.9***	78.7
Identifies and tracks products—forward	51.9	79.7+++	94.5***	82.6
Has written polices and procedures for product recalls	44.4	90.6+++	100.0***	87.3
Has written polices and procedures to protect against bioterrorism	18.5	51.6+++	90.6***	66.5
Conducts audits of slaughter and deboning operations	22.2	78.1+++	96.1***	77.6
Has food safety manager on staff	44.4	68.8++	85.9***	73.5

Poultry slaughter plants may implement technologies and practices to control *Salmonella*, *Campylobacter*, and other pathogens during slaughter and deboning operations. For example, plants may wash carcasses with one or more in-line inside-outside bird washers to help meet zero fecal tolerance regulations; this practice has also been shown to reduce the incidence of *Campylobacter* on poultry carcasses (Smith, Northcutt, Musgrove, 2004).

- The most frequently used food safety technology is some type of carcass decontamination intervention (86% of plants). Most plants use inside-outside bird washers (85%).
- Nearly 60% of plants use metal detection equipment to help detect physical hazards in incoming birds.
- Few plants use the other technologies listed in Table 1. Large and small plants are more likely to use most of these technologies compared with very small plants ($p < 0.01$).
- With the exception of sterilizer pots, the majority of poultry plants have adopted the sanitation practices listed in Table 2, such as rotating sanitizing chemicals annually.
- Many plants require and document that their bird growers use stipulated practices for controlling pathogens (61%) and for controlling chemical residues (77%).
- About 80% of plants have procedures in place to identify and track products one step forward and one step backward; and 87% have written polices and procedures for product recalls.
- About 67% of plants have written policies and procedures to protect against bioterrorism.
- Nearly 80% of plants have their slaughter and deboning operations audited either by an independent third party or by its customers, and 74% of plants have a food safety manager on staff.
- Large and small plants are more likely to use most of the practices listed in Table 2 compared with very small plants ($p < 0.01$).

C. Use of Food Safety Technologies and Practices for Poultry Processing

Table 3. Use of Food Safety Technologies for Further Processing (% of plants)

	Very Small	Small	Large	All Plants
Conveyor belts made from materials designed to prevent bacterial growth	0.0	26.9++	30.7***	25.5
Metal detection equipment	8.3	61.5+++	96.6***	76.8
Use of some type of decontamination intervention during processing operations	41.7	46.2	53.4	50.2
Application of antimicrobial chemicals	41.7	46.2	48.9	47.3
Irradiation	0.0	0.0	0.0	0.0
High-pressure processing	8.3	0.0	9.1	7.1
Infrared technology	0.0	3.8	6.8	5.2
Other types of pasteurization	8.3	7.7	4.5	5.7

Table 4. Use of Food Safety and Sanitation Practices for Further Processing Operations (% of plants)

	Very Small	Small	Large	All Plants
Sanitizes hands or gloves that contact raw product in further processing area on a specified frequency	41.7	80.8++	89.8***	81.0
Sanitizes hands or gloves that contact RTE product in further processing area on a specified frequency	—[a]	—[a]	—[a]	90.1
Treats drains with sanitizers for pathogen control	58.3	80.8	55.7	61.2
Uses chemical sanitizers for hand tools during operations	66.7	57.7	68.2	65.8
Rotates sanitizing chemicals on an annual or more frequent basis	50.0	73.1	68.2	66.6
Treats food contact equipment to remove biomatter during operations	58.3	50.0	70.5	64.5
Uses antimicrobial treatment for food contact equipment during operations	50.0	53.8	58.0	56.0
Requires and documents that raw poultry suppliers use stipulated practices for pathogen control	37.5	50.0	57.5	53.8
Requires and documents that raw poultry suppliers use stipulated practices for controlling chemical residues	25.0	50.0	66.2**	58.5
Conducts audits of further processing operations	16.7	76.9+++	97.7***	81.9

[a]Results suppressed because of small number of respondents.

The interim final rule on the control of *Listeria monocytogenes* in RTE meat and poultry products (9 CFR 430) provides incentives for producers of RTE products to use postlethality treatments, antimicrobial ingredients at formulation, and other intervention technologies to reduce the presence or growth of *Listeria* on these products (Bricher, 2005). Additionally, plants may implement technologies and practices to control *Salmonella* and other pathogens during processing operations for RTE and NRTE products.

- One-half of plants use a decontamination intervention during processing operations; application of antimicrobial chemicals is used most often. Few plants use the other interventions listed in Table 3.
- Nearly 80% of plants use metal detection equipment to help detect physical hazards in processed product. Large and small plants are more likely to use this equipment compared with very small plants ($p < 0.01$).
- The majority of plants use the sanitation procedures listed in Table 4, such as treating drains with sanitizers for pathogen control.
- More than half of plants require and document that raw poultry suppliers use stipulated practices for controlling pathogens and chemical residues.
- About 82% of plants have their processing operations audited. Large and small plants are more likely to have their operations audited compared with very small plants ($p < 0.01$).
- For most practices listed in Table 4, differences in practices were not observed between small and very small plants and between large and very small plants.

D. Employee Food Safety Training

Table 5. Food Safety Training for Employees (% of plants)

	Very Small	Small	Large	All Plants
Newly hired employees[a]				
Formal coursework	7.4	20.8+++	56.6***	28.1++
On the job	81.5	70.3	81.2	78.2
Written materials	11.1	73.4+++	84.4***	68.0
No training	11.1	1.6++	0.0***	2.5
Continuing training[a]				
Formal coursework	7.4	34.4+++	49.2***	37.4
On the job	77.8	82.8	85.2	83.2
Written materials	3.7	31.2+++	53.1***	37.9
No training	18.5	1.6+++	1.6***	4.6
HACCP training				
One or more production employees has completed formal HACCP training	85.2	93.8	96.1**	93.4

[a]Respondents could select multiple responses.

Plants may conduct food safety training with new employees and with current employees on a continuing basis. The training may be formal training conducted by plant personnel or professional trainers, informal on-the-job training, or written materials.

- Nearly all plants provide food safety training for new employees. Most plants conduct on-the-job training (78%).
- Nearly all plants provide continuing food safety training for their employees. Most plants conduct on-the-job training (83%).
- Very small plants are less likely to conduct food safety training for new and current employees compared with small and large plants ($p < 0.01$ for most comparisons).
- Most plants have one or more employees that have completed formal HACCP training (93%). Large plants are more likely to have HACCP-trained employees compared with very small plants ($p < 0.05$).

E. Microbiological Testing Practices

Table 6. Microbiological Testing Practices (% of plants)

	Very Small	Small	Large	All Plants
Conducts voluntary microbiological testing	44.4	92.2+++	95.3***	85.2
Has company-owned lab for microbiological testing	3.7	65.6+++	94.5***	69.9
Tests carcasses prior to deboning[a]	66.7	78.0	93.4***	86.2
Tests raw poultry after deboning (before processing)[a]	50.0	45.8	73.8*	62.9
Tests RTE finished products (for plants producing RTE product)[a]	—[b]	—[b]	—[b]	95.1
Tests NRTE finished product (for plants producing NRTE product)[a]	62.5	78.0	81.6	79.0
Conducts environmental sampling	22.2	84.4+++	88.3***	75.2

[a]Results are for plants that conduct microbiological testing.
[b]Results suppressed because of small number of respondents.

Poultry slaughter plants are required by FSIS to conduct generic *E. coli* testing of carcasses. Plants may voluntarily conduct other testing of raw product, finished product, equipment, and food contact surfaces.

- About 85% of plants conduct voluntary microbiological testing for generic *E. coli*, *Salmonella* species, and other pathogens. The majority of plants use traditional cultural methods. Large and small plants are more likely to conduct voluntary microbiological testing compared with very small plants ($p < 0.01$).
- For plants that conduct microbiological testing, 86% test carcasses prior to deboning; plants most often test for *Salmonella* species (90%) and generic *E. coli* (76%), in addition to mandatory testing.
- For plants that conduct microbiological testing, 63% test raw poultry after deboning. The majority test for total coliforms and generic *E. coli* and conduct aerobic plate count (APC) and total plate count (TPC) testing.
- For plants that conduct microbiological testing and produce RTE finished product, 95% test finished product. The majority test for total coliforms, *Salmonella* species, generic *E. coli*, *Staphylococcus aureus*, *Listeria* species, and *Listeria monocytogenes* and conduct APC and TPC testing.
- For plants that conduct microbiological testing and produce NRTE finished product, 79% test finished product. The majority test for total coliforms, *Salmonella* species, and generic *E. coli* and conduct APC and TPC testing.
- About 75% of plants conduct environmental sampling. Large and small plants are more likely to conduct environmental sampling compared with very small plants ($p < 0.01$).

5. Discussion

We conducted a national survey of poultry slaughter plants to collect uniform information on practices and technologies to control pathogens and promote food safety in the poultry slaughter industry. The majority of plants have adopted many of the food safety technologies and practices asked about in the survey. In particular, most plants use some type of carcass decontamination intervention and about half use some type of decontamination intervention for processed product. Most plants conduct voluntary microbiological testing and environmental sampling. Most plants provide food safety training for new employees and also provide food safety training on an ongoing basis. Some plants expect to increase use of these technologies and practices in the next few years.

We found that large and small plants are more likely than very small plants to use many of the food safety technologies and practices asked about in the survey, to conduct microbiological testing and environmental sampling, and to conduct food safety training for its employees. However, we do not have data indicating that large and small plants produce a safer product. Similarly, a 2001 survey conducted by USDA's Economic Research Service found that large plants typically relied on sophisticated equipment and testing, while smaller plants tended to focus more on SSOPs and plant operations to make changes to comply with the PR/HACCP rule (Ollinger, Moore, Chandran, 2004). To increase use of food safety technologies among small and very small plants, FSIS funded cooperative agreements in 2004 to identify feasible technologies and to foster their adoption. Also, FSIS recently announced initiatives aimed at providing assistance necessary for small and very small plant owners to further improve their establishments' food safety programs.

Our survey findings can be used to establish a baseline of current practices in the poultry slaughter industry. FSIS anticipates conducting the survey on a recurring basis to track changes in plants' food safety risk management practices.

References

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For More Information

RTI International. 2005. *Survey of Meat and Poultry Slaughter and Processing Plants*. Prepared for the U.S. Department of Agriculture/Food Safety and Inspection Service. Research Triangle Park, NC: RTI International.

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