Neck skin is more significant risk in ground poultry contamination

Neck skin is a more significant risk in ground poultry contamination than internalized Salmonella, though bones and spleens may also pose a risk in turkey.

BY WALID ALALI, DIEZHANG WU, YUE CUI, CAGATAY CELIK AND CHARLES L. HOFACRE

What is the Salmonella presence externally versus internally in poultry carcasses and how might this affect ground product contamination?

Foodborne salmonellosis outbreaks have been linked to the consumption of ground poultry (turkey and chicken) in the U.S., according to data from the Centers for Disease Control. Although the overall Salmonella prevalence on turkey and chicken carcasses has been low (2 percent and 4 percent, respectively), the overall prevalence in ground turkey and chicken has been several-fold higher (11 percent and 24 percent, respectively), according to data from the USDA Food Safety and Inspection Service.

In ground poultry production (mechanically and non-mechanically separated products), skin-on, skinless, bone-in, and boneless parts are typically used. External contamination of carcasses (i.e., skin contamination) can contribute to Salmonella presence in ground products; whereas internalization of Salmonella in inner organs and parts of birds such as spleen, liver, kidneys, and bones is currently under investigation as a potential source of Salmonella in ground products.

Neck skin poses potential food safety issues

Neck skin, parts of it, and/or other skin parts are used as a source of fat in ground poultry production. Salmonella can attach to the skin of carcasses and could be entrapped inside the skin feather follicles. These follicles open up when carcasses enter the hot-water scalding tank to ease feather removal during picking. Salmonella cells could then enter the feather follicles of the skin. As the carcass temperature decreases further down in the process, these follicles would shrink leading to Salmonella entrapment.

This is a food safety issue for the poultry industry as the entrapped Salmonella are hard to inactivate or remove via washing or other chemical interventions at the processing plants. Contaminated skin can be a source of Salmonella in ground poultry.

Neck skin is usually more contaminated compared to the skin of other parts. This is because poultry carcasses are hung upside down during processing resulting in wash fluids dripping through the neck skin. Furthermore, according to a study conducted by Cox et al. (2010), Salmonella prevalence in neck skin alone was representative of the whole carcass rinsate.
FOOD SAFETY RESEARCH

Salmonella in internal organs of poultry

Even though researchers have reported the presence of Salmonella in internal organs such as spleen, liver and kidney of naturally infected birds, there is little data available in the scientific literature about internalization of this organism in bones/bone marrow. Bones can break during further processing and de-boning which may result in the marrow oozing and contaminating the meat utilized in ground production.

Knowledge gaps and research objectives relayed to Salmonella

Currently there is a lack of available information on the following:

» The potential contribution of Salmonella internalization versus external contamination to pathogen levels in ground products

» The presence and numbers of Salmonella in internal parts such as bones in relation to ground poultry production

» The relationship between Salmonella levels in internal organs such as spleen and ground product contamination

Salmonella in poultry bones, neck skin, spleens

The authors at the University of Georgia conducted three research studies in collaboration with the poultry industry to investigate the following:

» Salmonella prevalence and serotype distribution in drumstick bones and neck skin of post-chilled chicken carcasses

» Salmonella levels (presence and numbers) in broiler spleens as predictor for contamination levels in ground chicken

» Salmonella levels (prevalence and numbers) in turkey drumstick bone, spleen, and neck skin samples in relation to Salmonella-status in the ground turkey product

Following are the findings of these three research studies conducted at University of Georgia.

Study 1: Salmonella prevalence in chicken bones, skin

In the first study, 300 neck skin and 299 drumstick bone samples collected from post-chilled chicken carcasses were tested for the presence of Salmonella. The neck skins were rinsed and then stomached before testing for Salmonella. Bones were extracted from the drumstick meat, sterilized via boiling water and ethanol, and then crushed prior to pathogen analysis.

Salmonella prevalence on chicken neck skin and drumstick bone samples is presented in Table 1.

The most frequent isolates from the neck skins were S. Liverpool (37.9 percent), S. Kentucky (27.6 percent), and S. Typhimurium (27.6 percent). The two isolates from the bones were S. Kentucky. Salmonella prevalence of stomached neck skin samples was significantly higher than that for rinsed skin samples. This is probably due to the fact that Salmonella can be firmly attached to skin and/or entrapped inside the feather follicles. Based on the findings from this study, Salmonella in neck skin can be a more significant source of ground chicken contamination compared to internalized Salmonella in bone.

Table 1. Salmonella prevalence on chicken skin and drumstick bone samples

<table>
<thead>
<tr>
<th>Sample type</th>
<th>No. of samples</th>
<th>No. of Salmonella-positive samples</th>
<th>Salmonella prevalence (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necker skin(^{a})</td>
<td>299</td>
<td>64</td>
<td>21.4 (16.7-26.1)</td>
</tr>
<tr>
<td>Rinsed neck skin</td>
<td>299</td>
<td>7</td>
<td>2.3 (0.6-4.0)</td>
</tr>
<tr>
<td>Stomached neck skin</td>
<td>299</td>
<td>62</td>
<td>20.7 (16.1-25.4)</td>
</tr>
<tr>
<td>Bone</td>
<td>300</td>
<td>2</td>
<td>0.7 (0-1.6)</td>
</tr>
</tbody>
</table>

\(^{a}\)Skin samples were considered positive if Salmonella was detected in either rinsed or stomached neck skin samples.

» Salmonella in neck skin appears to be a more significant source of ground chicken contamination compared to internalized Salmonella in bone.
FOOD SAFETY RESEARCH

Study 2: Salmonella in chicken spleens

In the second study, we hypothesized that the presence and numbers of *Salmonella* in spleen may indicate highly contaminated flocks and consequently higher levels of ground chicken contamination.

A total of 260 composite spleen and 260 ground chicken samples were collected from 16 flocks during processing.

The overall *Salmonella* prevalence levels in spleen and ground chicken samples were 7 percent and 15 percent, respectively; whereas the mean *Salmonella* numbers were 0.9 log for both.

At the flock level, *Salmonella* internalization in the spleen was not a significant predictor for *Salmonella* in ground chicken.

Study 3: Salmonella in turkey skin, spleen, bones

In the third study, a total of 210 samples of turkey neck skin, spleen, and drumstick bones representing 14 flocks were collected and tested. Samples were collected post-FSIS inspection at a turkey processing plant.

*Salmonella* prevalence and numbers of these turkey parts is presented in Table 2.

*Salmonella* was internalized in spleen and bones of turkeys at low percentages. However, the contamination was at higher levels in neck skin which may pose higher risk in ground turkey products.

At the flock level, when *Salmonella* was present at quantifiable levels (via enumeration) in spleen and/or bone, this organism was present in ground turkey at quantifiable levels as well.

Salmonella risk may be different in chicken and turkey

What do the data in these three studies reveal? *Salmonella* was present in chicken bones at a very low level; however in turkey bones, the pathogen was present at a relatively higher level. This can be a source of contamination in ground turkey.

There might be a correlation between *Salmonella* numbers in turkey spleen and ground turkey at the flock level, but not in chicken spleen and ground chicken.

Neck skin (and possibly poultry skin, in general) appears to be a more significant risk factor to ground poultry contamination than internalized *Salmonella*.

<table>
<thead>
<tr>
<th>Sample type</th>
<th>No. of samples</th>
<th>Prevalence</th>
<th>Mean log numbers/sample (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck skin</td>
<td>210</td>
<td>51 percent</td>
<td>2.0 (1.8-2.2)</td>
</tr>
<tr>
<td>Spleen</td>
<td>210</td>
<td>5 percent</td>
<td>1.6 (0.7-2.4)</td>
</tr>
<tr>
<td>Bone</td>
<td>210</td>
<td>5 percent</td>
<td>1.4 (1.2-1.6)</td>
</tr>
<tr>
<td>Ground turkey</td>
<td>92</td>
<td>17 percent</td>
<td>1.9 (1.1-2.6)</td>
</tr>
</tbody>
</table>

» Salmonella contamination was at higher levels in turkey neck skin which may pose higher risk in ground turkey products.

» Turkey drumstick prior to meat removal and bone extraction

» Turkey spleen ready to be dipped in boiling water to sterilize the outside surface

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