Scalding and Its Significance in Livestock Slaughter and Wholesome Meat Production

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Abstract

Scalding is the process of treating carcass with hot water or steam for efficient removal of the bristles or feathers by the dehairer/defeatherer. The selection of time and temperature is very important during scalding, because it must reflect the microbial load, level of muscle degeneration, colour of carcass, temperature of carcass, cooking characteristics and appearance of skin. During Scalding process, carcasses are come in contact with each other and pathogenic and non-pathogenic microorganisms introduce from one to another. Salmonella and Campylobacter are the most common pathogenic microorganisms identified from the carcasses but Staphylococcus aureus, coliforms, aerobic bacteria and Enterobacteriaceae, Pseudomonas spp, etc. are also isolated from the scalding tank and contaminated carcasses. Excessive application of technical processing aids and/or antimicrobial agents for enhancing the scalding process are also act as potential risk factors.

Keywords: Scalding, Pig, Poultry slaughter, wholesome meat production

Introduction

Scalding is the process of treating carcasses with hot water or steam to loosen the hair or feather in the follicle to aid their removal (Warriss, 2000). Pork and poultry carcasses are both subjected to a scalding operation during processing. The time and temperature of the heat treatment are primarily determined by the need for efficient removal of the bristles or feathers by the dehairer/defeatherer (Bolton, 2004). Too low a temperature and the hair/feathers will not be loosened; too high a temperature and the skin will be cooked and the hair/feathers will be difficult to remove and there is also a risk of denaturation and shortening of the outermost layer of muscle. The simplest equipment consists of a tank into which the carcass is lowered by a hoist. The water is heated by oil, gas, electricity or an open steam-pipe. Alternatively vertical cabinets utilizing hot-water sprays or steam can be used. Temperatures between 58 and 62 °C are normally used for 5–6 min for pig carcasses (Gracey et al, 1999), while temperatures of 50–51 °C for 3.5 min are employed for ‘soft’ scalded chicken carcasses destined for chilling, or 56–58 °C for 2–2.5 min for ‘hard’ scalded carcasses destined for freezing (Mountney, 2001).
Scalding in pig slaughter

When the pigs are not skinned, the hair must be removed from the carcasses. Scalding is the first of the dehairing operations. Scalding the pigs facilitates hair removal by denaturing the proteins in the hair follicles. The time–temperature combination applied is important, as under scalding would not facilitate hair removal and over scalding would cause the skin at the base of the bristles to contract, thus holding them tighter. While a typical time–temperature regime may vary from 5 to 10 min at 60 to 70 °C, the exact combination applied will depend on the amount of hair and its ease of removal (Bolton, 2004).

Methods of Scalding

1. Horizontal water scalding in a paddle wheel tank or scalding tank: - Traditionally this was achieved by immersing the carcasses in hot water in a scald tank. Factors considered during this process are hourly rate of slaughter, size of pigs to be handled, ease of operation of the machines, efficiency of cleansing, etc. Food safety is also a consideration during scalding as each carcass brings a quantity of dirt, faeces and ingesta to the scald tank and as a result the water quickly becomes polluted and may act as a vehicle for carcass cross-contamination. Despite this, if the temperature is sufficiently high, enteric bacteria such as Salmonella, Escherichia coli and Campylobacter will be destroyed and studies have found that $1.0 \times 10^6 - 1.9 \times 10^6$ Campylobacter per ml may be reduced to less than 10 organisms per ml after 1–1.25 min in scald tank water at 56 °C. Similar reductions have been observed for Salmonella and Yersinia strains at 60 °C after 1.7–2.2 min and 2.5 min, respectively. (Bolton et al., 2003)

![Scalding Tank](http://ebeyfarm.blogspot.in/2012/08/scalding-pigs.html)

Potential Risk Factors:-

a. Unhygienic circumstances associated with the typical scalding tank,

b. Salmonella sp may present in the sludge and water of scalding tank.

c. Microorganisms, parasites such as Ascaris suum, whip worm, etc , Balantidium coli and moulds such as Aspergillus, Mucor, etc, may transfer from one carcass to other.

d. Many of these organisms can gain entrance to the lung and to blood vessels in the stab wound.

2. Vertical water scalding process: - During the circulation process in a closed and well insulated scalding tunnel water with a temperature of approx. 60 - 62°C is sprayed out of special spray nozzles to the free hanging carcasses. Here the contamination from one carcass to other is limited and more hygienic than the vertical scalding tank (Gracey et al., 1999).
3. **Vertical condensation scalding process:** In this process involves the use of a double-walled tunnel in which steam, generated from a water bath in its bottom, is blown over the carcass and through a ventilator located over the condenser. The temperature in the tunnel is controlled by a thermostat at 61 to 64°C. The cooling water from the condenser in the tunnel is used to flush the pig carcass during the dehairing process. Before entry into the tunnel, the carcass should hang for 3 minutes and lie on its side for 2 minutes. The pig carcass are then transposed to the tunnel on a raising rail so that the head is lower than the other parts of the body during the whole scalding process, which last 6 minutes (Gracey et al., 1999).

**Advantages of vertical scalding:**

a. Improved bacteriological standard of the pig meat.
b. Production of pig meat with minimum muscular degeneration and bacteria free lung.
c. Reduced incidence of PSE (Pale, Soft, Exudative muscle) - this is due to the fact that vertical scalding does not produce a rise in body temperature to above 41°C as in normal scalding operations.
d. Dehairing is also better with this method.
e. In large slaughter houses, the operation cost also to be reduced.

Condensation systems using steam are becoming more popular and are currently used in Poland, Spain, France, Switzerland, Japan and China. Factors such as pig breed and seasonal influences should be taken into account. In the United States, for example, there is an easy hair season (February to March) when a scalding combination of 58 °C for 4.5 min is typically used, and a hard-hair season (September to November) when 60 °C for 4.5 min is applied. Throughout the rest of the year, a typical scalding time–temperature combination of 4.5 min at 59 °C is the normal (Sikorski, 2004).

Dehairing is usually performed using a single dehairing machine. This removes the hairs mechanically by rotating the carcasses using the action of rotating flails while cold or hot water is sprayed over the carcasses. A perforated tray under the machine screens hair and other detritus from the water. The dehairing machine is an important source of *Salmonella, E.coli, Campylobacter, Yersinia* and *Listeria* on pork carcasses. Prevention or reduction of contamination is dependent on effective cleaning of the equipment.

**Scalding in poultry slaughter**

Scalding is the process of immersing the birds in warm water to loosen the feathers. In a small plant, scalding can be performed manually (i.e., placing the carcasses in and removing them from a scalding tank), but in large plants it is done in a continuous manner whereby the birds are dipped in a single or multistage scalding bath while suspended from a moving shackle line.
There are various scalding schemes selection of one over another depends on the degree of difficulty in removing the feathers, the chilling method that is to follow (water, air), and the age of the bird. Higher scalding temperatures are better for loosening feathers from their follicles, but hard scalding is also the harshest on the skin (the outer layer of the skin, epidermis, becomes loose and is later removed during the plucking operation). The removal of the epidermis can result in discoloration of the skin if it is dehydrated during subsequent air chilling. However, hard scalding is the only satisfactory way to release the feathers of waterfowl. Generally speaking, hard scalding does not cause as much discoloration in the thick skin of waterfowl as it does in young poultry (usually 7 weeks of age). Soft scalding/semi-scalding is commonly used for young broilers and turkeys since it does not damage much of the epidermis, but still allows for relatively easy feather removal. Adequate agitation of the scald water and uniform temperature are essential to ensure good feather removal. (Barbut, 2002).

The carcasses are submersed in a bath of hot water which serves to denature the protein structures holding the feathers in place and loosens the feathers without causing appreciable damage to the outer skin layers, the stratum corneum or “cuticle”. Because it leaves this waxy, yellow-pigmented layer of the skin intact, soft scalding is the preferred scalding method for producing fresh poultry with a yellow skin exposed. Such skin color is highly desired in some parts of the world as indicating a healthy bird.

![Diagram of skin layers. (Adapted from Suderman, D. R. and Cunningham, F. E., J. Food Sci. 45 (3), 444, 1981.)](image_url)

**Methods of Scalding**

1. **Soft scalding/semiscallding** entails scalding for 60 to 180 s in water at 50 to 53°C. This method leaves the epidermal layer intact, which is why it is commonly used for young broilers and turkeys but still allows for relatively easy feather removal (Fletcher, 1999). Birds slaughtered for display should be
scalded in this way to improve the appearance of the carcass, since water that is too hot will cause the outer layer of skin to loosen or be lost. Such loss also results in the loss of some yellow pigment from the skin.

2. **Subscalding/medium scalding** is used for mature birds, and involves using water at 54 to 58°C for 60 to 120 s. The epidermal layer is broken down by this time–temperature combination, and the feathers are usually much easier to remove.

3. **Hard scalding/full scalding** requires a water temperature above 60°C for 45 to 90 s. This method is faster and eliminates pinfeathers, but the birds tend to dry out and have a less desirable appearance (*Mountney, 1989*). It is easier to remove the feathers from carcasses scalded at this temperature than from those scalded at lower temperature, but the flesh of such poultry is “doughy” and lifeless and the skin becomes discolored soon after processing. As a result, the carcass must be kept covered with a packaging material or moist with ice or water. Waterfowl may be scalded at this temperature because it is the only satisfactory way to release feathers, while the skin of waterfowl does not discolor as readily as do other species of poultry (*Barbut, 2004*).

Careful equipment design is required for meat hygiene. Since 1 g of soil material (e.g., dirt, faecal material) attached to the feathers can contain $10^8–10^9$ microorganisms, it is important to minimize cross-contamination in this common bath (*Mulder and Dorresteijn, 1977*). Maintaining and controlling the temperature is one of the key features to keep bacterial load under control. Another means is the use of a counter flow design (clean water introduced at the exit end of the tank, and water flow towards the entrance where the more contaminated birds are introduced).

Installing a multistage scalding tank system can further reduce contamination problems; this would consist of 2–4 water tanks, where the carcasses are moved from the initial, more contaminated bath, to the cleanest bath at the end. Lillard (1973) reported that when scald water contaminants enter the broiler’s respiratory system during immersion scalding, they can be spread to the circulatory system and to the internal organs, and possibly throughout the entire carcass.

### Common Scalding Times and Temperature for Various Classes of Poultry

<table>
<thead>
<tr>
<th>Class</th>
<th>Scalding Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broilers (hard scald)</td>
<td>90-120 seconds</td>
<td>56-58°C</td>
</tr>
<tr>
<td>Broilers (soft scald)</td>
<td>180-220 seconds</td>
<td>50-51°C</td>
</tr>
<tr>
<td>Turkeys</td>
<td>50-125 seconds</td>
<td>59-63°C</td>
</tr>
<tr>
<td>Quail</td>
<td>30 seconds</td>
<td>53°C</td>
</tr>
<tr>
<td>Waterfowl</td>
<td>30-60 seconds</td>
<td>68-82°C</td>
</tr>
</tbody>
</table>

*(Barbut, 2002)*

Variables requiring consideration during the scald process step are mechanical, physical, and chemical. Mechanical variables include counter-current flows and agitation to produce a washing effect. Counter-
current systems move water counter to the direction of poultry carcasses at all points. Water enters the system at the point where poultry carcasses exit, and water exits at the point where poultry carcasses enter, producing a dirty-to-clean gradient that continually moves poultry carcasses into cleaner water. Cleaner water is a relative condition as the amount of dry matter and microorganisms in the scald water increase over time. Physical variables are time and temperature, which influence washing and antimicrobial effects. The chemical variable is pH, which also influences the antimicrobial effect.

**Immersion scalding** is the most common scald technology in use and is best described as dragging carcasses through a tank of hot water (*Barbut, 2002*). Immersion systems come in single- and multi-stage configurations, incorporating mechanical and physical variables. Single-stage systems provide less washing effect than multi-stage systems. U.S. Poultry processors in the United States prefer a “hard scald” combining shorter scald times and higher scald temperatures. A “hard scald” facilitates removal of the epidermis, which enhances the adhesion of coatings commonly used with fried foods. European poultry processors prefer a “soft scald,” combining longer scald times and lower scald temperatures. A “soft scald” retains much of the epidermis and natural skin color.

**Steam-spray scalding** is a less popular alternative. *Klose et al. (1971) and Dickens (1989)* found that a mixture of steam and air at 50 to 60°C and 137.9 kPa pressure applied for approximately two minutes provided a uniform scald of either dry or damp broilers, facilitated feather removal, and yielded carcasses microbiologically equivalent to immersion systems. Some religious dietary laws prohibit scalding and soak poultry carcasses in cold water.

(Potential Risk Factors

a. Pathogenic and non-pathogenic microorganisms introduced during the scald process. These microorganisms are present on the internal and external surfaces of the carcass as well as in the scald water.)
b. *Salmonella* and *Campylobacter* are the most common pathogenic microorganisms identified with the scalding process step. (Berrang et al. 2007)

c. *Staphylococcus aureus, coliforms, aerobic bacteria and Enterobacteriaceae, Pseudomonas* spp, etc. are also isolated from the scalding tank and contaminated carcasses. (Cason et al. 1999)

d. Chemical potential risk factors include residues introduced during the scald process through the excessive application of technical processing aids and/or antimicrobial agents. Technical processing aids enhance the scalding process and include surfactants, denuding agents, and emollients. Surfactants reduce surface tension, improve wetting agent function, and inhibit foam. Alkaline denuding agents loosen the keratinized outer layer of the epidermis. Emollients retain moisture and prevent excessive drying of the denuded dermis. When a processing aid produces the same technical effect at lower scald water temperatures, a greater number of microorganisms can survive the scald process.

e. Failure to maintain a proper time/temperature combination diminishes the desired technical effect of preparing feathers for removal and detracts from sanitary dressing.

f. Increasing scald water temperature to increase the death rate of bacteria may not be a management option, however, because higher temperatures also affect the skin’s appearance, color, and cooking characteristics (Jones and Grey, 1989). Any unnecessary heating of scald water also has an economic cost (Cason et al., 2001). High scald temperature can cause the carcass to become oily, which favors the retention of microorganisms on the carcass surface. (Cox et al. 1974)

**Controls**

a. In counter current systems, sufficient water replacement with post-scald carcass rinse is considered good manufacturing practices for efficient immersion scalding. (Waldroup et al. 1993).

b. Waldroup et al. (1993) found that counter current scalding reduced aerobic bacteria, coliform, and *E. coli* 0.64 log₁₀, 0.76 log₁₀, and 0.72 log₁₀ CFU/ml, respectively, and *Salmonella* prevalence by 10 percent in scald water.

c. Multi-tank immersion systems further improve the microbiological quality of the scald water (Cason et al. 2000).

d. Increasing scald water pH from 7 to 9, reduces microbial levels in the water, (Humphrey and Lanning 1984).

**Conclusion**

Scalding is one of the major process employed during poultry and pig slaughter for removing feather and hair from the skin respectively. Careful equipment design and processing conditions are required for scalding of livestock, because during this process carcasses are come in contact each other and act as a chance of contamination. Since very small quantity of soil material (eg:- dirt, faecal material) attached to the carcasses can contain 10⁸ to 10⁹ microorganisms, it is important to minimize cross contamination in
this common scalding tank. Maintaining and controlling the temperature is one of key feature to keep bacterial load under control and also important for maintaining the level of muscle degeneration, colour of carcass, temperature of carcass, cooking characteristics and appearance of skin. For quality pork and poultry meat production, method of scalding and temperature selection is needed to be studied.

References


Fletcher, DL 1999. Recent advance in poultry slaughter technology. Poultry sciences (78): 277


