

EVALUATION OF CARCASS WASHERS

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Primary Audience: Poultry Processing Plant Managers, Eviscerating Room Supervisors, Picking Room Supervisors, Directors of Quality Control, Quality Assurance Personnel, Processing Equipment Manufacturers, Research Scientists

SUMMARY

Two broiler carcass washers were designed, constructed, and installed in the poultry processing lab at the Richard B. Russell Research Center in Athens, GA. One washer (W₁) was installed on the processing line between the scalding and the picker, and the second washer (W₂) was installed after the picker. Hot water (approx. 57°C, ~135°F) was supplied to W₁ through an adjustable steam mixing valve; tap water (approx. 16°C, ~60°F) was used in W₂; water line pressure to each washer was maintained at approx. 275.8 kPa (40 psi) for all trials. Processing line speed was adjusted to allow approx. 4.5 s of washing action from the spray nozzles on each carcass. Immediately after administration of treatments, carcasses were removed from the picking line shackles and were subjected to the whole bird rinse procedure for microbiological analysis. No significant difference was found ($P > .05$) in microbial counts between carcasses washed before defeathering and those not washed before defeathering. The process of defeathering appears to equalize microbial populations among the carcasses as they pass through the picking machine.

Key words: Broiler processing, carcass rinsing, carcass washers, most probable number, pre-pick washing, post-pick washing, *Salmonella*

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DESCRIPTION OF PROBLEM

The broiler processing industry has been criticized for not marketing a raw product that is free of contamination. Many scientific research reports and popular press articles have focused on the presence of pathogenic microorganisms such as *Salmonella*, *Campylobacter*, and *Listeria*, creating alarm in the general public. Given present production and processing conditions, it is difficult to produce raw meat products for retail sale that are sterile and yet

acceptable, both organoleptically and visually, to the consumer.

Researchers and poultry industry personnel are constantly analyzing production systems, processing methods, and equipment to identify areas that could improve the microbiological quality of processed carcasses. For example, it has been reported that a significant reduction in microbial counts of scald water in the last stage of a three-stage scalding could be

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accomplished by setting up the scalding in separate sections and operating the units as a counter-flow system [1]. The model system was analyzed mathematically by a computer program and tested in a laboratory situation using a series of tanks and a mixture of fecal material that was pumped from one tank to a second tank to the final tank. The cleaner the carcasses were before entering the picking machine, the fewer the organisms available for spreading from one carcass to another carcass during the defeathering operation [2].

Studies have shown that cross-contamination occurs in the scalding and in the pickers. When the carcasses were inoculated with marker organisms and processed in a commercial plant, the contaminants were spread widely among carcasses [3].

It has been theorized that the skin surface of carcasses, after scalding and picking, retains a film of processing water which contains insoluble and soluble organic matter plus large numbers of bacteria. This film of water is initially derived from the scald tank and water sprayed on the carcasses in the pickers. The quality of the water depends largely on the contamination level of birds entering the processing plant; the bacterial flora will reflect that which is carried on the feathers and feet and released from the intestines [4].

The use of spray washers to reduce the presence of pathogenic organisms on eviscerated carcasses has also been reported by Whitehead *et al.* [5]. Results of their study showed only a slight reduction in bacterial contamination on carcasses that were sampled before and after passing through the washer. They found no significant difference in bacterial counts between a water usage of "0.26 gal/carcass and 0.64 gal/carcass", and thus recommended that "0.26 gal/carcass" be used in final carcass washers.

Another study [6] reported a significant reduction in the microbial counts of eviscerated carcasses spray washed with 71.1°C water compared to those sprayed with 21.1°C water. Water temperatures of 65.6°C and above reduced the mean microbiological count about 1.0 log. Carcasses washed with hot water at a temperature greater than 65.6°C had a shelf-life about a one day longer than did those washed with 21.1°C water.

A carcass cleaning machine has been designed and tested under commercial condi-

tions [7]. When this machine was placed on the line prior to the scalding, a significant reduction in solids content of scald water was noted compared to a processing line without the machine. The results of cleaning the carcass prior to scalding demonstrates an attempt to improve the microbiological quality of processed poultry. The present study complements the study of the carcass cleaner [7].

The objective of this research is to develop a method to provide carcasses free of dirt and fecal material on the feathers, skin, and feet to the picking machines. Washing carcasses after scalding and picking offers the potential of producing cleaner processed carcasses.

MATERIALS AND METHODS

Four experimental trials were conducted in the pilot plant poultry processing room at the research center. The facility is equipped with a stunner, restraining (bleeding) cones, a one-section scalding, and a five-bank Gordon Johnson disk picker. A variable speed overhead conveyor with removable shackles was used to convey the carcasses through the scalding and picker.

Market age broilers used in the trials were purchased from a local commercial processor. Each morning of an experimental trial, five coops loaded with six birds each were transported from the loading dock to the laboratory.

The water used for scalding the test broilers was heated to about 57°C (135°F) in all the trials. Two scalding water conditions were tested in conjunction with this study. To obtain data for carcasses scalded in clean water, the first six carcasses of each trial run (a total of 24 carcasses) were processed before the addition of the fecal material mixture to the scalding. Simulation of commercial scalding water conditions was accomplished by adding a 3 kg mixture of fecal material, feathers, and blood to 750 L of clean water in the scalding [7]. The materials for the mixture were scraped from the live receiving dock floor and the blood tunnel of a commercial processing plant. Samples of the materials were transported to the laboratory where they were divided into 3-kg (\approx 6 lbs) lots, sealed in plastic bags, and stored at -40°C (\approx -40°F) until needed for the trials. Blood obtained from the freshly slaughtered carcasses was collected and poured into the

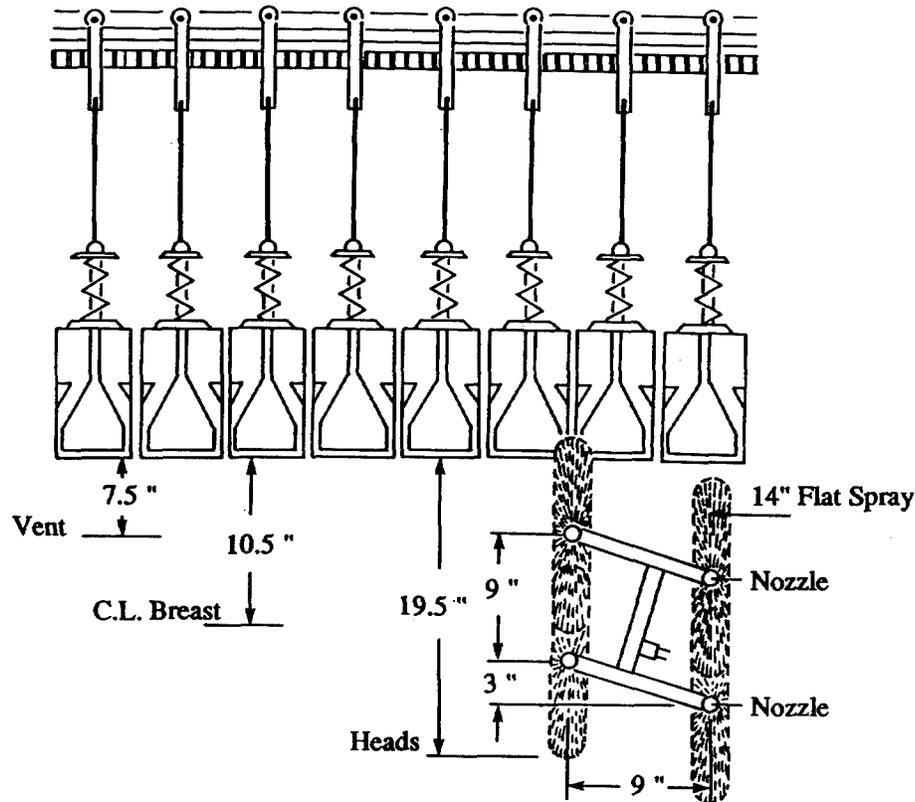


FIGURE 1. Experimental washer set-up on the picking line

scalding water. The circulating pump inside the scaldler provided thorough mixing and distribution of the fecal mixture and blood within the scalding medium. As a check on the scaldler water conditions, samples of the water were taken at scheduled intervals of time for laboratory analysis. The total solids content of the scaldler was compared to solids content values determined from commercial scalders.

Washers were designed to completely cover the carcasses with water on a single pass through the nozzles (Figure 1). Conveyor speed was set so that water was sprayed on each carcass for about 4.5 s, approx. equal to a 1.8 m (≈ 6 ft) washer on a 24.4 m/min (≈ 80 ft/min) commercial processing line.

Manifolds for the spray nozzles were fabricated from 1.25-cm ($\approx 1/2$ -inch) inside diameter copper tubing. The washers post-scald (W_1) and post-pick (W_2) were constructed with a spray nozzle manifold on each side of the shackle line which allowed for full spray coverage of the carcasses passing through the

washer. The spray nozzles selected for W_1 were 1/4-inch National Pipe Threads (NPT) Floodjets (Spraying Systems, Inc., 1/4 K 7.5). The nozzles are rated to deliver 5.7 L/min (≈ 1.5 gpm) at 275.8 kPa (≈ 40 psi) line pressure and have a spray angle of about 125° at that pressure. A total of eight nozzles was used on W_1 , four on each side of the conveyor line.

Water at approx. 57°C ($\approx 135^\circ\text{F}$) for W_1 was supplied from a thermostatically controlled steam mixing valve. Hot water was piped through a pressure regulator equipped with a pressure gauge to each manifold of the washer.

Spray nozzles selected for the W_2 were 1/8-inch NPT full cone (Spraying Systems, Inc., 1/8 gg 3.0). They are rated at 2.2 L/min (≈ 0.57 gpm) at 275.8 kPa (≈ 40 psi) and at that pressure have a spray angle of approx. 60° . Potable tap water (approx. 16°C , $\approx 60^\circ\text{F}$) and 275.8 kPa (≈ 40 psi) was supplied to the manifolds of the W_2 . Line pressure was monitored by a gauge mounted in the supply line.

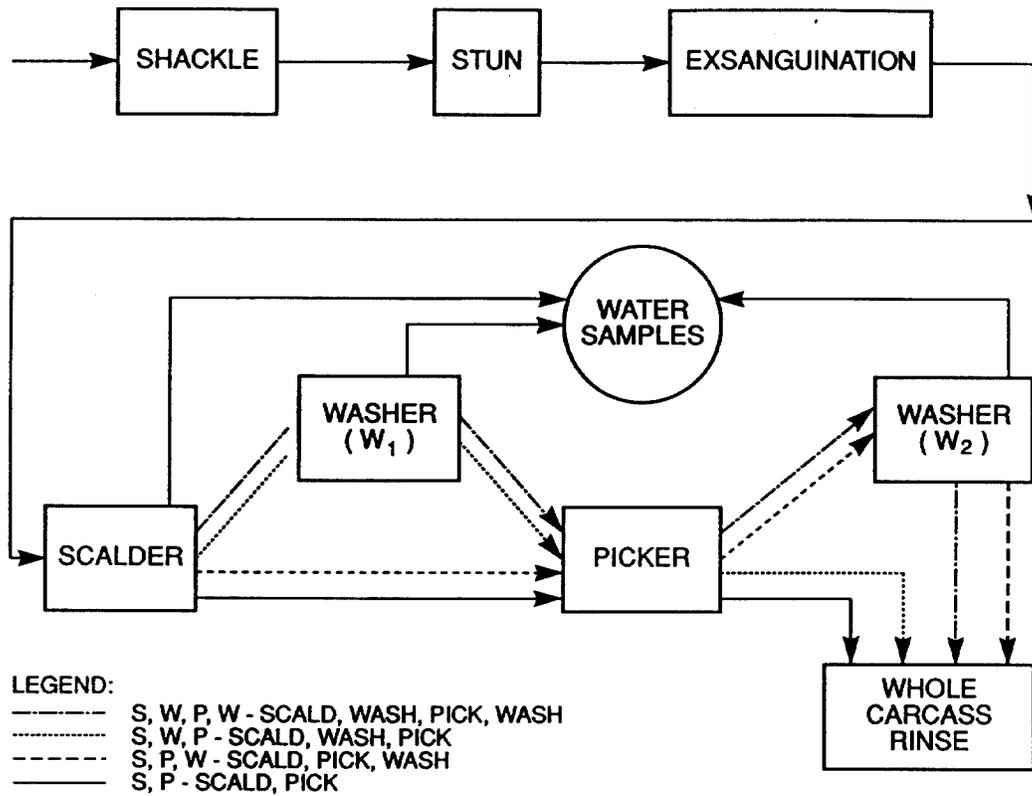


FIGURE 2. Flow chart of processing, treatments, and sampling points

EXPERIMENTAL PROCEDURE

The flow of the carcasses through the processing facilities and the experimental treatments is shown in Figure 2.

Stunning and exsanguination: Six broilers were used in each treatment group. The broilers were electrically stunned before slaughter. The stunner was set to deliver approx. 50 volts and 30 mA for 10 seconds through a brine solution. The operating parameters for the laboratory stunner are comparable to those suggested for commercial stunners. After stunning, the sample broilers were slaughtered by severing the carotid arteries with a sharp knife. A 90 s bleedout was set for all carcasses. Thereafter the carcasses were removed from the restraining cones and placed in the picking line shackles. Blood from the carcasses was drained into a bucket and subsequently emptied into the scald. The picking line conveyor was started and the carcasses were transported into the scald.

Scalding, rinsing and defeathering: When all carcasses were submerged in the scald, the line was stopped for 2 min, which is approx. equal to commercial scald times. After scalding the conveyor was switched on and, upon exiting the scald, the carcasses were either washed (W₁) or picked.

For the experimental runs, the two scald water conditions evaluated were: 1) filled with clean hot potable water, and 2) contaminants added to clean hot potable water to simulate commercial scalding conditions.

The experimental treatments were: (I) scald, wash W₁, pick, wash W₂; (II) scald, wash W₁, pick; (III) scald, pick, wash W₂; and (IV) scald, pick. All of the trials were run in same order as listed for the above treatments.

The supply water to W₁ was turned on while the carcasses were in the scald to flush the cold water from the pipes and adjust the flow to approx. 18.9 L/min (≈5 gpm). After washing, the carcasses were either removed

TABLE 1. Mean aerobic bacterial counts of defeathered carcasses subjected to various wash treatments and two different scald water conditions

TREATMENT ^A	AEROBIC COUNTS (log ₁₀) BASED ON TYPE OF SCALD WATER	
	Carcasses from dirty water	Carcasses from clean water
I	5.01 ^a	4.82 ^a
II	4.91 ^a	4.99 ^a
III	5.21 ^a	4.97 ^a
IV	5.02 ^a	4.99 ^a

^A I = scald, wash, pick, wash; II = scald, wash, pick; III = scald, pick, wash; IV = scald, pick

^a Means within a row or column with the same superscript are not significantly different (P ≥ .05).

from the conveyor for microbial sampling or defeathered by a one pass operation in the picking machine. In our laboratory defeathering process, carcasses remain inside the picker for about 30 sec, which approximates the picking time for carcasses passing through a series of four in-line pickers.

Immediately after the defeathering operation, each carcass was removed from the processing line, put into a sample bag containing 100 mL sterile physiological saline (0.85%), sealed, and placed in containers on a multi-unit shaking machine [8]. After mechanical shaking for 1 min, the sample bag was opened and the carcass discarded. The bags containing the rinse solution were identified by treatment groups and placed on ice in a cooler. In the laboratory, rinse water samples were poured from the bags into sealable sterile beakers for further processing.

The aerobic and *Enterobacteriaceae* microorganisms were enumerated by a modified most probable number (MPN) procedure and the counts estimated by Thomas' formula [9]. Ten-fold serial dilutions were made by transferring 1 mL of the recovered rinse solution into 9 mL of nutrient broth (Difco), mixing, and transferring to the next tube in the series. This procedure was repeated through the tenth tube in the series. The tubes were incubated over night at 37°C (≈99°F). Tubes showing visible growth were recorded as positive for aerobic microorganisms and MPN estimate were calculated. Enumeration of *Enterobacteriaceae* was accomplished by subculturing tubes in the aerobic series that exhibited turbidity. Brilliant Green (BG) Bile 2% (Difco) with 1% glucose mixture containing a gas tube was added to the samples and incubated over night at 37°C (≈99°F). Those tubes with visible growth and gas pro-

duction were recorded as positive for *Enterobacteriaceae* and the MPN estimate was calculated.

Salmonella presence on a carcass was determined by measuring the volume of whole carcass rinse solution recovered and adding sufficient 10X strength nutrient broth to make the resulting solution equal to a nutrient broth whole carcass rinse solution. Following overnight preenrichment at 37°C (≈99°F) the nutrient broth was subcultured into tetrathionate BG broth (Difco), with an additional overnight incubation at 43°C (≈109°F) before plating on BG (Difco) and modified lysine iron agars [10]. Standard laboratory procedures previously described were used to process suspicious colonies of *Salmonella* [11].

Scalder water samples were taken at scheduled intervals throughout the trial runs. These samples were enumerated for total microbial content according to the procedure described above and total solids content according to methods previously reported [7].

RESULTS AND DISCUSSION

The study did not demonstrate a statistical difference in the microbiological profile of the defeathered carcass with either the spray washing treatments to the carcass (W₁ or W₂) or the scald water condition (clean versus contaminated). Carcasses that were spray-washed after picking yielded slightly lower, but not significantly lower, aerobic counts (Table 1) and *Enterobacteriaceae* counts (Table 2).

One unexpected result was a lower count for *Enterobacteriaceae* when the scald water had been contaminated and the spray wash applied to the carcasses. We expected a lowering of counts for both aerobic organisms and *Enterobacteriaceae* when clean water was

TABLE 2. Mean counts of *Enterobacteriaceae* from defeathered carcasses subjected to various wash treatments and two different scald water conditions

TREATMENT ^A	ENTEROBACTERIACEAE COUNTS (log ₁₀) BASED ON TYPE OF SCALD WATER	
	Carcasses from dirty water	Carcasses from clean water
I	4.11 ^a	4.54 ^a
II	4.51 ^a	4.79 ^a
III	4.16 ^a	4.60 ^a
IV	4.81 ^a	4.74 ^a

^A I = scald, wash, pick, wash; II = scald, wash, pick; III = scald, pick, wash; IV = scald, pick
^a Means within a row or column with the same superscript are not significantly different ($P \geq .05$).

available to scald the carcasses. The results indicate that, while a build-up of solids (dirt, blood, fecal material, etc.) occurred in the scald during operation, the carcass microbiological profile did not change significantly.

The *Enterobacteriaceae* results in Table 2 illustrate the generally accepted opinion that mechanical defeathering will negate the potential benefits obtained from the wash before picking. Note the differences in counts between spray washing after picking (treatment III) and spray washing before picking (treatment II).

Salmonella serogroup B was isolated from two of the 240 carcasses used in this study. The two *Salmonella* positive carcasses were found on the same day in treatment I carcasses (scald, wash, pick, wash) which had been scalded with dirty water. The same *Salmonella* serogroup was isolated from the runoff water of W₂; however, it was not isolated from samples of W₁ runoff. Treatment I carcasses were the first group scalded each trial day in the simulated scald water. *Salmonella*

was not isolated from either the runoff of W₁, W₂, or carcasses of the three subsequent trials run immediately following treatment I. Neither the picking machine nor the shields around W₁ or W₂ were decontaminated between treatment runs. With the present concern for cross contamination, these results were unexpected and will be studied in future research.

In summary, the results of the washing experiments did not show a significant difference in the bacterial counts for washed carcasses versus nonwashed carcasses after picking. The post-scald washer (W₁) appeared to remove a lot of loose particles and dirty water from the exterior surfaces of the carcasses. After scalding and washing, clumps of fecal material were still attached to the feathers around the vent and saddle area of the carcasses. The removal of this residual material needs to be accomplished prior to the carcasses contacting the picker fingers. Additional research in the area of pre-pick carcass cleaning is under consideration.

CONCLUSIONS AND APPLICATIONS

1. Spray washing of carcasses immediately after defeathering lowered bacterial counts but the decrease was not significant when compared to carcasses not washed after defeathering.
2. Carcasses washed both after scalding and defeathering tended to have lower bacterial counts than those washed only after defeathering, but were not statistically different from carcasses not washed after scalding and defeathering.
3. Post-scald washing removes many loose particles and much of the dirty scald water from feet, feathers, and skin of the carcasses.
4. Clumps of fecal material on feathers around the vent and breast areas survived the scalding and washing operations and were subsequently removed by the picking machines.
5. Removing the clumps of fecal material from the feathers, feet, and skin of the carcasses prior to picking is an important part of improving the overall microbial quality of processed poultry.

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