Automated Microbiological Sampling of Broiler Carcasses

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ABSTRACT The accepted, highly accurate method of whole bird rinsing for microbiological sampling of processed poultry carcasses (particularly for Salmonella) was automated and standardized. A multiunit bird rinser was designed, fabricated, and compared microbiologically with the standard manual rinsing procedure. No major differences in total plate counts and Enterobacteriaceae counts were found, and Salmonella recovery by both procedures was identical.

(Key words: Salmonella, poultry, mechanical shaker, microbiological sampling)

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INTRODUCTION

Of the different techniques used to sample for numbers and types of microorganisms on processed broiler carcasses, one of the most satisfactory, particularly for recovery of Salmonella, is the whole carcass rinse (Barnes et al., 1973; van Schothorst et al., 1976; Cox et al., 1978). Cox et al. (1981) reported that rinsing a freshly processed broiler carcass with a low volume (100 ml) of sterile water provided an adequate sample for detecting Salmonella.

This sampling technique with a low volume rinse (Cox et al., 1981) involves placing the fresh processed broiler in a polyethylene bag with 100 ml of sterile water and shaking the bag vigorously by hand for 1 min. When properly performed, this shaking may become extremely tiring, especially if a great number of carcasses are sampled. Inadequate shaking action may decrease efficiency of transfer of bacteria to the rinse medium; thus, detection of types of bacteria that are often present in only small numbers, such as Salmonella, may become uncertain.

The objective of this study was to design, fabricate, and test a practical mechanical device to replace hand shaking. The mechanical shaker should standardize the shaking motion and turbulence, regardless of the number of carcasses to be sampled. Both a single unit sampler and a multiunit sampler were tested (Dickens et al., 1983).

MATERIALS AND METHODS

The single unit sampler (Figs. 1 and 2) incorporated three main components: 1) a cam-operated, pendulum-type, mainframe; 2) a power transmission source; and 3) a container and container holding assembly.

The pendulum-type mainframe consisted of a pair of stationary aluminum arms bolted to the support base and a pair of movable arms bolted to the top of an aluminum yoke. An aluminum block with a .95-cm hole in the center was bolted to the top of each pair of arms. A bolt connected the two pairs of arms and established a pivot point. The container and container mounting assembly were installed below the pivot point, midway between the two movable arms. The container mounting assembly was designed to permit positioning and maintaining the container at any desired angle throughout the shaking sequence. This was accomplished by mounting a section of stainless steel tubing midway between the movable support arms. A section of 1.59-cm heater hose was compressed inside the tubing and was held by a .95-cm bolt and a 2.5-cm flat washer. The threaded end of the bolt was placed through the hose, and as the nut tightened, the hose was compressed inside the tubing to create a frictional pivot point for the container assembly.

The cam, a steel disc, had a teflon-coated protrusion, which was inserted into the circular slot cut in the yoke. Rotation of the cam caused the yoke and the bottom of the movable arms to oscillate horizontally, providing the shaking motion. The cam was driven by a 1/4 hp, 1725 rpm electric motor. The combination of the 5-cm diameter drive pulley and the 30-cm driven pulley created a shaking frequency of 287.5 strokes/min. The placement of the holding assembly in conjunction with the cam size
resulted in the container being moved horizontally 4.1 cm during shaking.

To compare the single unit sampler with the hand-shaking technique for effectiveness, three runs were made with processed broiler carcasses obtained from a local processing plant. For each run 20 carcasses were individually placed in polyethylene bags with 100 ml of sterile water. Ten of the carcasses were hand shaken for 1 min by experienced technicians and the other 10 were shaken for 1 min in the single unit sampler. The total aerobic plate count (TPC) and Enterobacteriaceae count (ENT) were determined on the rinse fluid.

Forty additional carcasses were each inoculated with approximately 8 cells of a nalidixic acid resistant strain of *Salmonella beidelberg*. Twenty of these carcasses were hand shaken and the other 20 were mechanically shaken.

After testing the single unit sampler, a multiunit sampler (Figs. 3 and 4) was designed, fabricated, and tested. This sampler, which was capable of shaking from 1 to 6 carcasses simultaneously, was constructed of heavy stainless steel strap, tubing, and angle iron. It consisted of two sections: 1) a mainframe with a dual track, and 2) a shaking and rotating assembly.

The mainframe support legs were fabricated of 5-cm stainless steel square tubing and the
FIG. 3. Isometric of multiunit sampler.

support base of 5-cm stainless angles. A track was welded to the mainframe to support the shaking and rotating assembly. Two small bearings were mounted on each side of the track to eliminate side play and to minimize friction during shaking (Fig. 3). The mainframe was 1.2 m long and .9 m wide.

Power from a 1/2 hp single phase 1725 rpm motor was transferred through a 15:1 ratio gear head; thus, the resultant output of the shaker was 115 rpm. A 10.8-cm steel disc on the gear head output shaft with a 1.9-cm steel protrusion 3.8 cm from its center acted as the cam to create the shaking action (Fig. 5).

The cam was connected with a rigid link arm with a bearing on each end to a rigid support welded to the upper assembly. The bearings permitted the rigid link to oscillate; thus, the cam moved the upper assembly back and forth an overall distance of 7.6 cm.

The shaking and rotating assembly (Figs. 3 and 5), also constructed of heavy stainless steel, was 1.2 m long and .3 m wide. The base was 7.6 cm × 7.6 cm × .6 cm angle iron with a 5-cm

FIG. 4. Multiunit sampler.
MICROBIOLOGICAL SAMPLING

FIG. 5. Shaking and rotating assembly of multiunit sampler.

diameter cam follower located 15.2 cm from the ends on both sides of the assembly. Three pieces of 5-cm square tubing were welded to the angle iron to maintain the separation of the angle iron frame. Two pieces of 1.2-m long, 5-cm flat steel straps were welded across the top of the tubing running parallel to the angle frame. Pillow blocks that supported the 1.9-cm diameter container support shafts were mounted on the strap straddling the 5-cm square tubing on each side.

A 1/20 hp 6 rpm full-load gear head motor was mounted on the strap to power the rotating portion of the assembly (Fig. 5). The power was transferred by a #35 roller chain through a 12-tooth driver and a 28-tooth driven sprocket on the center container support shaft. Two additional 28-tooth sprockets on the center container support shaft drove the other two container support shafts.

Because turning the rotating assembly did not fully load the motor, the revolutions per minute in this application were 7. The six sampling containers attached to the shafts of the rotating assembly rotated continuously during shaking and made three revolutions during each 1-min shaking cycle.

The containers and container holding assemblies for the multiunit sampler were the same as those for the single unit sampler. Suitcase latches secured the lids on both the single and multiunit samplers.

Both motors were controlled by an industrial type timer. With the timer “off”, the unit was controlled manually; in the automatic position, it could be set to operate for 1 min or any other preset time interval.

To compare the multiunit sampler with hand shaking for effectiveness, two runs were made with fresh processed broilers. For each run, 24 carcasses were individually placed in polyethylene bags with 100 ml of sterile water and 12 were hand shaken and 12 mechanically shaken. The TPC and ENT counts were determined on the resulting rinse water. Twelve of the carcasses were each inoculated with 8 cells of a nalidixic acid resistant strain of *Salmonella heidelberg*, then 6 were hand shaken and 6 shaken in the multiunit sampler. The number of positive recoveries of *Salmonella* was then determined. All TPC and ENT data were reported as logarithmic averages and expressed as microorganisms per milliliter of rinse fluid.

Analysis of variance was performed on the data to determine if there were significant differences between shaking methods in effectiveness of microorganism recovery. Individual method and replication means were compared by Duncan’s multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Detection of specific organisms is of greater importance than total plate counts when using the whole carcass rinsing procedure. The TPC and ENT were made to ensure the consistency of the test procedures.

Test results for the single unit sampler are given in table 1. Analysis of variance and Duncan’s multiple range test results showed no significant difference between shaking methods in effectiveness based on recovery of organisms for TPC and ENT (Table 1). The *Salmonella* recovery from hand shaken and mechanically shaken carcasses was identical.

Results for the multiunit mechanical shaker are also given in Table 1. Significantly higher (P<.05) TPC were obtained by hand shaking (Table 1); however, the difference was less than
TABLE 1. Mean microbiological counts ($\log_{10}$/ml of rinse water) obtained from broiler carcasses sampled by hand shaking and mechanical shaking.

<table>
<thead>
<tr>
<th></th>
<th>Total aerobic plate count</th>
<th>Enterobacteriaceae count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hand</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Single unit¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5.16</td>
<td>5.20</td>
</tr>
<tr>
<td>2</td>
<td>5.75</td>
<td>5.58</td>
</tr>
<tr>
<td>3</td>
<td>5.49</td>
<td>5.09</td>
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<tr>
<td>Mean</td>
<td>5.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.29&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Multiunit²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4.84</td>
<td>4.73</td>
</tr>
<tr>
<td>2</td>
<td>5.63</td>
<td>5.24</td>
</tr>
<tr>
<td>Mean</td>
<td>5.24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.98&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

¹,² Underlined means followed by different letters are significantly different (P<.05).

¹ Average of 10 samples.
² Average of 12 samples.

.3 log. The *Salmonella* recovery from hand-shaken and mechanically-shaken carcasses was identical.

Differences from Run 1 to Run 2 in the TPC and ENT counts using the multiunit shaker could be because processed broilers used in Run 2 were held overnight at 3°C, resulting in higher counts regardless of shaking method.

Variance from the mean were considerably less in the data from mechanically-shaken birds than that of hand-shaken birds. The variances for TPC and ENT for hand-shaken birds were .23 and .19, respectively, and for mechanically-shaken birds, .15 and .15.

From data presented, we feel the mechanical shaker is an accurate and practical alternative to hand shaking when numerous carcasses must be sampled. When a specific organism such as *Salmonella* is to be isolated, the data show the mechanical shaker to be as accurate as hand shaking.

To use the mechanical shaker for the purpose of obtaining the total microorganisms found on carcasses, a correction factor of 1.05 could be multiplied by the result to increase the accuracy of the total count.

Further research is continuing at the present time to adapt the multiunit sampler for sampling fresh processed turkey carcasses. Information on this adaptation will be forthcoming in the near future.

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REFERENCES


