# Research Note: Comparison of 3 methods used for estimating cook loss in broiler breast meat

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**ABSTRACT** The objective of this study was to evaluate different methods used for estimating cook loss in broiler breast fillets (pectoralis major). Two experiments were conducted. In the first experiment, intact fillets were weighed, cooked to 75°C, and then subjected to 1 of 3 postcook handling treatments: cooling for 5 min at room temperature before reweighing (**5-minute**), cooling at room temperature until they reached room temperature before reweighing (**RT**), or cooling in ice water until they reached room temperature before reweighing (**IW**). In the second experiment, breast fillet portions were used to compare the effects of endpoint temperature (53°C, 57°C, 68°C, 75°C, or 90°C) on cook loss estimation by the 5-minute and RT methods. Breast fillets were collected from local chicken processing plants and trimmed to similar weight prior to cooking. Cook loss, cook loss retention, and total cook loss after 24 h in cooked fillets were measured for comparisons. Data showed that cook loss (<17%) and total loss (19.3%) estimated with the IW method were lower ($P < 0.05$) than those with the 5-minute and RT methods (19–21% for cook loss and 21.1–21.3% for total loss), which did not differ from each other. When the endpoint temperature was ≥75°C, no differences in cook loss estimates or moisture loss were noted between the 5 min and RT methods (after 3 h cooling). However, when the temperatures were 53°C to 75°C, cook loss estimations were significantly different ($P < 0.05$) between the 5 min and RT methods (more than 4%). Reduced endpoint temperature resulted in increasing differences (from less than 5% to more than 9%) in cook loss estimates. These results demonstrate that endpoint cooking temperature and postcooking sample handling methods may affect cook loss estimates in broiler breast meat.

**Key words:** chicken fillet, cooking loss, cook yield, endpoint temperature, pectoralis major

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## INTRODUCTION

Cook loss of meat is an important meat quality attribute and commonly used to assess water-holding capacity of meat. Cook loss indicates raw muscle protein characteristics and meat functionality and directly influences the yield and the quality of further-processed meat products (Li et al., 2013). Therefore, the estimation of meat cook loss could contain essential information for understanding factors that influence meat quality and predicting meat behaviors during further processing and postprocessing handling. Comparison of different cook loss estimation methods will provide meat industry with useful information regarding factors that may also impact cook yield in practice and standardization of cook loss estimation and with better understanding of the potential differences in cook loss estimation published in literature.

Cook loss is expressed as the percentage of weight lost in meat during cooking. Three different methods have been reported in the literature for estimating cook loss in poultry meat. Although all of the methods involve weighing samples precook and then cooking to a specified internal temperature, the methods differ in how the samples are handled postcook before reweighing. One method referred to as the "**5-minute**" method, requires the cooked samples to be removed from the heat, and cooled at room temperature for only 5 min before obtaining the postcook weight (Lyon et al., 2005). This method is often used to prepare cut samples for assessment of eating quality by a sensory panel and



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samples are usually near the endpoint cooking temperature on postcook reweighing. Another method referred to as the "room temperature (**RT**)" method requires that the temperature of the cooked samples passively reach ambient temperature before reweighing (Lee et al., 2014). The third method referred to as the iced water method (**IW**) uses ice water immersion to rapidly cool the cooked samples to ambient temperature before reweighing (Tasoniero et al., 2016). There is a lack of comparisons of these 3 methods in estimating cook loss in chicken breast meat.

It has been well known that the endpoint temperatures affect meat cook loss. Dawson et al. (1991) reported that a cook loss varied from 0.8 to 2.9% for broiler meat and 2.9 to 7.4% for hen meat when the aseptic processing media temperatures varied from 120°C to 145°C. Murphy and Marks (2000) found weight loss in ground chicken breast meat varied significantly between the endpoint temperatures of 40°C, 50°C, 60°C, 70°C, and 80°C. Similar results were also reported for beef muscle (Bertola et al., 1994). The structural changes of proteins due to different cooking temperatures can alter water-holding capacity (Tornberg, 2005). Our preliminary observation showed that there were differences in cook loss estimates in meat between the 5-minute and RT methods if the endpoint temperature changed by a few degrees (unpublished data). Therefore, the investigation of effect of the endpoint temperature will further enhance our understanding of the variation that exists in the estimation of cook loss in broiler breast meat with the different postcooking sample handling methods. Thus, the objective of this study was to evaluate the effect of the different methods on estimation of cook loss in broiler breast fillets (pectoralis major) and the effect of the endpoint temperature on the estimation with the different methods.

## MATERIALS AND METHOD

### Meat Samples and Cooking

In the first experiment, broiler breast butterflies (from 6-week-old birds), deboned at approximately 2 h postmortem, were collected from the deboning line of a local commercial processing plant (Athens, GA). The butterflies were transported to the laboratory on ice, vacuum-packed in individual cooking bags (Seal-a-Meal bag, The Holmes Group, EI Paso, TX), and stored in a −20°C freezer before use. The frozen butterflies were thawed in a refrigerator (4°C) overnight. Right and left fillets from the same butterfly were separated, trimmed, individually weighed, and evenly assigned to different treatments before they were vacuum-packed in individual cooking bags. Only fillets showing no emerging myopathies woody breast and spaghetti muscle were used in the study. The average breast fillet weight was 169.2 ± 28.6 g. Fillet samples were cooked to an endpoint temperature of 75°C in a Henny Penny MCS-6 combi oven (Henny Penny Corp. Eaton, Ohio) set at 84°C. Samples were removed from the oven and cooled down using the 5-minute, RT, or IW methods for estimating cook loss. A total of 36 single fillets were used in this experiment and the entire experiment was repeated twice on separate dates.

For the second experiment, broiler breast fillets from 8-wk-old birds and deboned at 3 h postmortem were collected from a commercial plant. The fillets were trimmed to remove extra fat and then cut into strips with dimensions of 2.5 × 2.0 × 5.0 cm. A total of 12 fillets and 5 strips per fillet were used for the second experiment. Each strip from the same fillet was assigned to one of endpoint cooking temperature treatments (or no more than one strip from the same fillet was used in the same endpoint temperature treatment) before samples were cooked. The average sample weight per bag was 77.7 ± 9.45 g. The samples were cooked in a water bath set at 54°C, 58°C, 69.5°C, 77°C, or 92°C until the targeted endpoint temperatures of 53, 57, 68, 75, or 90, respectively, were reached. The same cooked samples were reweighed after cooled down at ambient temperature for 5 min and then reweighed again 3 h later (after meat temperature reached ambient/room temperature). Temperature profiles of oven/water-bath and meat samples during cooking were monitored using 2 handheld digital thermometers fitted with a hypodermic needle probes (Doric Digital Thermometer, Model 450-ET, Doric Scientific, San Diego, CA). Using a water bath in this experiment instead of the combi oven, which was used in experiment 1, could provide a precise control of the endpoint temperature, even cooking of meat samples (or ensuring that the inside is properly cooked without overcooking the outside), and avoiding potential overcooking because of a large difference between the target temperature and cooking temperature. The target temperatures were selected based on the denaturation temperature of different proteins in muscle that have been demonstrated to be responsible for meat cook loss (such as 53°C for myosin, 57°C for collagens, 68°C for actin, and 90°C for most muscle proteins) (Tornberg, 2005) and cooking temperature recommended for poultry meat or our laboratory practice (like 75°C).

### Measurements of Cook Loss, Cook Loss Retention, and Total Loss

After cooking in either the oven (intact fillets) or water bath (cut strips), the samples (still in cooking bags) were cooled and reweighed according to treatment specifications (5-minute, RT, or IW) to estimate cook loss. Before reweighing, fillets/cut samples were removed from cooking bags, and their surfaces were dried with a paper towel. The temperature changes in cooked fillets during cooling were also monitored using handheld digital thermometers fitted with hypodermic needle probes. In the first experiment, after the samples were reweighed postcooking, they were placed back into the cooking bags and stored at room temperature overnight before being reweighed again. The cook loss, cook loss retention, and/or total loss were calculated using following formula:

$$\% \text{ Cook loss} = 100 \times (W_1 - W_2) / W_1$$

$$\% \text{ Cook loss retention} = 100 \times (W_2 - W_{24}) / W_2$$

$$\% \text{ Total loss(24h)} = 100 \times (W_1 - W_{24}) / W_1$$

where $W_1$ is weight of raw meat samples before cooking, $W_2$ is the postcook weight of the samples cooled with 3 different methods, and $W_{24}$ is weight of cooked samples stored at ambient temperature overnight (about 24 h) from the time the cooked samples were removed from the oven.

### Statistical Analysis

Data were analyzed by the General Linear Model procedure of the SAS (version 9.2, SAS Institute Inc., Cary, NC). The model included estimating methods as fixed effects and replication as random effects. Duncan's test was used for multiple comparisons to identify significant differences between means ($P < 0.05$). For the endpoint temperature effect on cook loss, data were analyzed using PROC MIXED procedure of SAS (version 9.2, SAS Institute Inc., Cary, NC). The effects of estimating methods (5-minute vs. RT) and endpoint temperature (53°C, 57°C, 68°C, 75°C, or 90°C) were analyzed as a 2 × 5 factorial design. The model included estimating methods, endpoint temperature, and their two-way interactions as fixed effects. Because there was significant interaction between the 2 main factors, one-way ANOVA was used for further analysis of data, and Duncan's test was used for multiple comparisons to identify significant differences between means ($P < 0.05$).

## RESULTS AND DISCUSSION

### Comparison Between 3 Estimating Methods

Table 1 shows cook loss, cook loss retention, and total loss of whole broiler breast fillets by 3 estimating methods. There were no significant differences ($P > 0.05$) in cook loss and total loss between the 5-minute and RT methods; however, cook loss and total loss estimated with the IW method were lower ($P < 0.05$) than those with the other 2 methods. On the other hand, cook loss retention in the RT samples were lower ($P < 0.05$) that those in the IW and 5-minute samples which did not differ from each other. The difference may result from the cooling time needed in RT method, in which free moisture released because of heat denaturation of muscle protein has more time to move out of meat after cooking than that in the other 2 cooling methods. Our data collected from the endpoint temperature study below also provide an evidence for the hypothesis. These results demonstrate that the post-cooking sample handling methods used to estimate cook loss of broiler breast fillets could affect the results and indicate that the IW method can reduce cook loss in cooked chicken breast meat products because of cooking.

### Effects of Endpoint Temperature

Table 2 shows that there was significant interaction between 2 cook loss estimating methods and the endpoint temperature ($P < 0.0001$). Overall, the cook loss increased as the endpoint temperature increased (Table 2) regardless of estimate method. This result is consistent with the data published by Murphy and Marks (2000), which showed that cook loss significantly increased ($P < 0.0001$) from 23°C to 80°C. The increases in cook loss in meat have been attributed to water loss from changed muscle structure during thermal treatments (Bertola et al., 1994; Tornberg, 2005; Hughes et al., 2014).

Table 2 also shows that the differences in cook loss estimation between 5-minute and RT methods varied with the endpoint temperature in cooked meat. When the endpoint temperature was either 75°C or 90°C, after the 5-minute estimation of cook loss, no significant/notable fluid loss was found when the samples were evaluated after 3h cooling at ambient temperature. However, when the endpoint temperature was between 53°C and 68°C, the differences in cook loss estimates between these 2 methods were different ($P < 0.05$), ranging from 4.3 to 9.6%, with reduced endpoint temperature resulting in increased differences. In addition, it is of interest to point out that there were significant differences in cook loss between the endpoint temperatures 53°C,

**Table 1.** Cook loss, cook loss retention, and total loss (24 h) of intact breast fillets (pectoralis major) estimated with 3 different methods with the endpoint temperature of 75°C (means ± SD, n = 12, replications = 2). The fillets were cooked in a combi oven at 84°C.

| Estimating method[1] | W[2] (g) | T[3] (min) | Cook loss (%) | Cook loss retention (%) | Total loss (%, 24 h) |
|---|---|---|---|---|---|
| RT | 172.0 ± 26.3 | 120 | 20.75 ± 2.41[a] | 0.79 ± 0.43[b] | 21.37 ± 2.37[a] |
| 5-minute | 167.9 ± 30.3 | 5 | 19.15 ± 3.12[a] | 2.41 ± 0.69[a] | 21.11 ± 2.75[a] |
| IW | 167.6 ± 31.2 | 13 | 16.88 ± 3.41[b] | 2.94 ± 0.86[a] | 19.34 ± 2.85[b] |

[a,b]Means within a column lacking a common superscript differ ($P < 0.05$).

[1]RT = cooked meat was cooled down to ambient temperature before reweighing; 5-minute = cooked meat was cooled down at ambient temperature for 5 min before reweighing; and IW = cooked meat was chilled down to room temperature in ice water before reweighing.

[2]W is the average weight of raw meat samples before cooking.

[3]T is time taken before cooked fillet samples were weighed. In the RT and IW methods, the fillets reached the ambient temperature before reweighing.

**Table 2.** Cook loss (%) of broiler breast meat samples and the probability levels based on estimating method, endpoint temperature, and interaction between them (means ± SD, %, n = 6). The samples were cooked in a water bath at a specifically targeted temperature.

| Treatment[1] | Cook loss (%) |
|---|---|
| 5-minute*53 | 7.41 ± 0.69[f] |
| 5-minute*57 | 9.23 ± 0.80[f] |
| 5-minute*68 | 14.56 ± 1.43[e] |
| 5-minute*75 | 22.28 ± 4.97[b] |
| 5-minute*90 | 31.89 ± 2.88[a] |
| RT*53 | 16.98 ± 1.65[d,e] |
| RT*57 | 18.80 ± 1.88[c,d] |
| RT*68 | 18.85 ± 2.08[c,d] |
| RT*75 | 21.19 ± 2.33[b,c] |
| RT*90[2] | – |
| EM[3] | <0.0001 |
| ET[3] | <0.0001 |
| EM*ET | <0.0001 |

[a-g]Means within a column lacking a common superscript differ ($P < 0.05$).

[1]5-minute = cooked meat was cooled down at ambient temperature for 5 min before reweighing; RT = cooked meat was cooled down to ambient temperature before reweighing.

[2]No significant/notable moisture loss was found when the sample was reevaluated after it was cooled for 3 h at ambient temperature following the 5-minute estimation.

[3]EM = Estimating Methods; ET = Endpoint Temperature.

57°C, and 68°C estimated with the 5-minute method; however, no significant differences were noted between these 3 temperatures in the estimates with the RM method. With the endpoint temperature of 68°C, Aaslyng et al. (2003) also found differences in cook loss between that determined immediately after pork meat was taken out of the oven and that after a 20 min resting time regardless of meat/animal type. Our data demonstrate that the endpoint temperature can influence the estimation of cook loss by different methods. The 5-minute method may result in more variation in the estimates. In addition, these results also indicate that internal temperature in meat from 53°C to 68°C may result in similar cook loss because of thermal denaturation of meat proteins. However, the moisture release from meat is much slower at the lower endpoint temperature than that at the greater endpoint temperature.

Data collected in the present study provide evidence that cook loss estimates can vary because of postcook sample handling methods and that differences between cook loss estimation methods depend on the endpoint cooking temperature. Cook loss estimate by the 5-minute method is similar to that by the RT if the endpoint temperature is 75°C or above. However, the estimate based the IW method is significantly lower than the other 2 methods, indicating that in application, the ice water method can be used to increase yield of precooked poultry meat products. When the endpoint temperature falls between 53 and 68°C, significant differences in the estimates exist between the 5-minute method and RM method, with the RM method producing much great cook loss estimates compared with the 5-minute method. The 5-minute method tends to underestimate meat cook loss and the RM method is recommended to avoid the variation in the estimation of cook loss in poultry meat.

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