TOWARDS A MODELING APPROACH TO MONITORING MOISTURE UPTAKE AND RETENTION BY ICE-WATER CHILLED BROILER CHICKENS

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Background

Recent changes in US Department of Agriculture regulations (USDA, 2001) require strict limits on the amount of added moisture that can be retained by water-chilled broiler chickens sold at retail in the United States. Moreover, the amount, if any, of retained moisture must be explicitly stated on the product label. Many US food manufacturers produce a great variety of products, each unique in the way it retains added water. Thus, if a manufacturer alters it's processing system or adds a new item to its product line, effects on retained moisture must be empirically evaluated, a time consuming and costly process. Effects of processing parameters on moisture retention by poultry have been studied for many years (Bigbee and Dawson, 1963; Thompson, *et al*, 1974). Reports indicate that the most important of these parameters include carcass size, time in chiller, pre-chiller and chiller temperature, and post-chilling storage time and temperature. Because of costs involved in empirically assessing effects of changes in manufacturing practices on moisture retention, a method is needed for forecasting those effects prior to implementation.

Objective

This report describes initial efforts in developing a statistical modeling approach to forecasting those effects. As new data become available on relationships between processing parameters and retained moisture, they can be added to the model.

Methods

Data from a study by Young and Northcutt (2001) which involved 240 commercially reared broiler chickens were used to establish linear relationships between moisture retention by uncut carcasses, pre-chill carcass weights and carcass conditioning time using the SAS REG® procedure. These relationships were then used in 10,000 iteration Monte Carlo simulations using input assumption data from a second study (Young and Smith, 2002). Results of forecast and observed moisture retention data were compared using Student's *t* test (Steel and Torrie, 1960).

Potential use of the model was demonstrated under a hypothetical situation in which a manufacturer considers harvesting a portion of his broilers prior to his normal 49 day rearing time in order to meet market demands for smaller parts. The question the manufacturer must answer is whether or not he can label the heavier- and lighter carcasses alike. Three populations of 1000 normally distributed variables with means and sd equal to the carcass weights at 37, 44 and 49 days of age in the previous study (Young and Northcutt, 2001) were generated using the SAS RANNOR® function. Hypothetical distributions were then created to represent populations containing equal numbers of weights from the 37 and 49-day-old birds and from the 44 and 49-day-old birds. A Monte Carlo simulation was used to project the distribution of moisture retention values using the two hypothetical carcass weight distributions and a N(4, 0.4) distribution of conditioning times as assumptions.

Results and discussion

Results of the regression analysis are presented in Tables 1 and 2. For each gram increase in carcass weight, moisture retention increased by 0.006% and for each hour of conditioning time up to six hours, retention decreased by 1.391%. When the model was applied using weight and conditioning-time data from the second study, mean moisture retention of 6.18% was forecast compared to 6.99 actual. This difference was not significant at the 0.95 level of probability, but it was significant at the 0.80 level. Even though the difference does not meet traditional scientific level of certainty, uncritical use of the model for forecasting mean moisture retention might present an unacceptable legal risk.

The model still has potential as a decision making tool, however. Figure 1 shows the forecast distribution of moisture retention values if the food manufacturer chose to harvest half his broilers at 44 days of age. The distribution is approximately normal with skewness and kurtosis values of 0.02 and 2.7, respectively. The mean and standard deviation values of 5.48% and 0.54 adequately describe the distribution. Thus, in this case, the manufacturer could use one mean and sd value to describe the added moisture in his product. Figure 2 shows the forecast distribution of moisture retention values if the manufacturer chose to harvest half his broilers even earlier, at 37 days of age. Clearly this distribution is bimodal with maxima at 2.1 and 5.8%, so the arithmetic mean of 3.92% cannot be used to describe the distribution. Instead it would be necessary for the manufacturer to provide separate labeling for the two classes of product.

Conclusions

This model offers an alternative to costly and time consuming empirical testing, but its usefulness for estimating moisture retention values which can be applied to product labeling must await further refinement.

Pertinent literature

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Table 1. Regression Coefficients of Carcass Weight and Conditioning Time on Retained Chiller Water.

Independent Variable	Estimate
Intercept	-3.605
Carcass Weight	0.006
Conditioning Time Post-Mortem	-1.391

Table 2. Forecast and Actual Means and Standard Deviations of Moisture Retention by Ice-Water Chilled Broiler Chickens

	Forecast	Actual
Mean	6.18	6.99
Standard Deviation	1.82	2.68

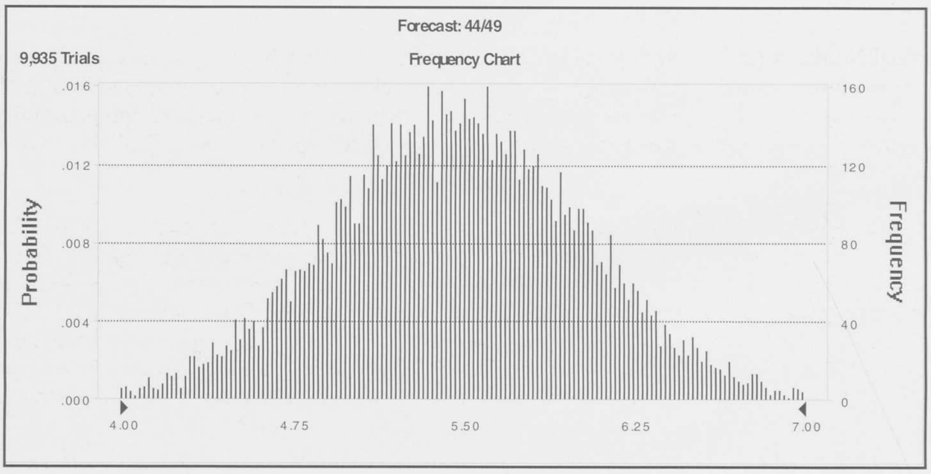

Figure 1. Forecast Distribution of Moisture Retention Values by Broiler Carcasses Harvested at 44 and 49 Days of Age

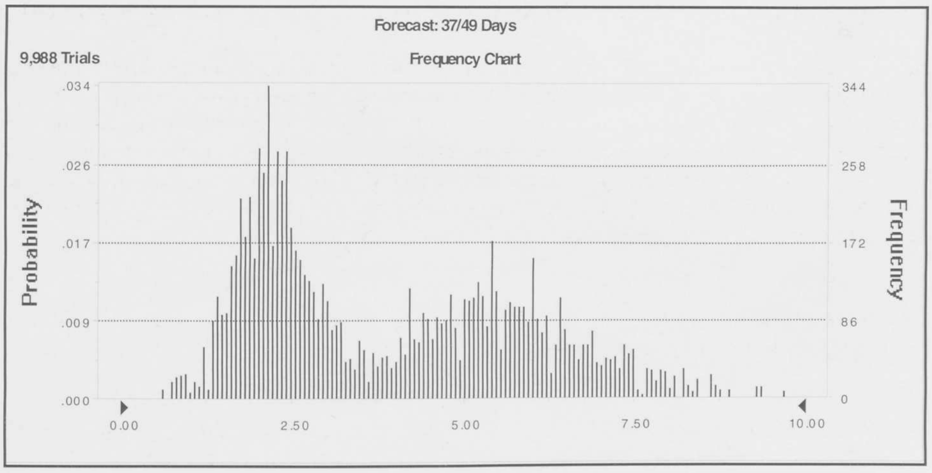

Figure 2. Forecast Distribution of Moisture Retention Values by Broiler Carcasses Harvested at 37 and 49 Days of Age