

EFFECT OF AGE, SEX AND AGING DURATION ON ABSORPTION AND RETENTION OF CHILL WATER BY SLAUGHTERED BROILERS

Louis L. Young^a and J. K. Northcutt^b^a Richard B. Russell Agricultural Research Center, ARS, USDA and ^b Department of Poultry Science, University of Georgia, Athens, Georgia USA**Key words:** poultry meat, chiller, moisture absorption, quality**Background**

In the USA and some other countries, poultry carcasses are chilled immediately after slaughter by immersion in chilled water or an ice-water mix. Legal limits on the amount of moisture which can be absorbed and retained vary from country to country and among classes of poultry. For Example, under USA regulations chickens weighing less than 2.1 kg are allowed up to 8 % added water, but larger chickens are allowed only 6 % added water. For turkeys, the amount of added water varies from 4.3 % to 8 % according to the weight of the birds; however, these regulations are currently under review. Many factors are known to affect moisture absorption and retention including temperature, skin lacerations and time in chiller, but more information is needed in order to make workable regulations. Moreover, all segments of the food industry are instituting statistical quality control systems including the poultry industry. Control of variation under such systems is critical. That control can only be achieved if the underlying factors responsible for the variation are known. Basic data are needed which describe relationships between biological and processing variables which affect added moisture content. This study addressed that need.

Objective

The objective of this study was to assess effects of birds' age, sex and post-slaughter aging duration on moisture absorption and retention during ice water immersion chilling.

Methods

Fifty-six broiler type chickens were reared under commercial-like conditions. At 37, 42, 44, 46, 49 and 51 days of age, eight randomly selected birds were electrically stunned and slaughtered using conventional US standards which included chilling in a mechanically agitated ice-water tank. Giblets were separated from the carcasses. Sex of each carcass was assessed by examination of the gonads at slaughter. After slaughter and chilling, the carcasses were packed in ice with drainage. Each carcass was manually weighed immediately before and 5 minutes after chilling (prechill and 0 hour weights, respectively). Two carcasses from each group of eight were also weighed after aging times of 2 hours, 4 hours and 6 hours postchill (stored weight). Moisture absorption and retention were calculated as,

$$\text{Absorption} = 100 ((\text{postchill weight} - \text{prechill weight}) / \text{prechill weight})$$

and

$$\text{Retention} = 100 ((\text{prechill weight} - \text{stored weight}) / \text{prechill weight}).$$

The experiment was replicated four times for a total of 224 birds.

Data were analyzed by ANOVA using replicates, age, sex and aging time as main effects. Interactions among main effects were tested for statistical significance ($P < 0.05$) using the residual mean square. There being no statistically significant interaction effects, the data were pooled over main effects. All analyses were conducted with the aid of the SAS statistical package using the GLM procedure (SAS[®] Institute, 1994). In all cases, $P < 0.05$ was considered statistically significant.

Results and Discussion

Effect of the birds' age on moisture absorption and retention are shown in Table 1. Absorption was unaffected by age until the birds exceeded 42 days averaging 4.7 %, at which time it abruptly increased to an average of 10.7 %. Moisture retention followed a similar trend averaging 3 % for birds 42 days old or less and 7.6 % for birds older than 42 days. In a previous report, Young *et al.* (2001) reported that yield of meaty parts increased substantially after 42 days of growth, reflecting growth of muscle tissue. Since moisture is absorbed mainly into soft tissues, this increase in absorption and retention is likely a reflection of growth of those tissues. Regulators must remain cognizant of these absorption and retention differences in developing added water regulations, and plant operators may need to alter chilling protocols according to the size of birds being processed.

Effects of sex on moisture absorption and retention are shown in Table 2. While the overall moisture absorption and retention averaged 8.3 % and 5.7 %, respectively, there were significant differences between sexes. Carcasses from female birds consistently absorbed more water from the chillers and retained it during aging than did carcasses of male birds. This difference likely reflects sex differences in muscle mass between birds of the same age. In the report cited previously (Young *et al.*, 2001), carcasses from females yielded higher proportions of breast filets than did those of males. As in the case of age differences, this larger proportion of muscle tissue in the female carcasses allowed them to absorb and retain more moisture than did the male carcasses. In the USA, separate sex rearing is not a common practice at the present time; however, should integrators begin raising males and females separately to gain greater control over growth and efficiency, the processors might have to alter chilling protocols to remain within statutory limits. These sex differences also increase variation in moisture absorption by carcasses from mixed sex flocks, which must be taken into account in

developing quality control programs.

Effects of aging time on moisture retention are shown in Table 3. Moisture retention declined precipitously during the first two hours postchill from an initial 7.8 % to a consistent average of 4.9 % at 2, 4, and 6 hours postchill. Many commercial poultry purchasing agreements stipulate that the carcasses or at least the front halves must be stored for a period prior to cutting up or freezing to allow dissipation of muscle ATP in order to prevent toughening. In the USA those requisite aging periods have traditionally been six to eight hours, but the efficiency and productivity of today's processing plants have forced many processors to reduce this aging time to a minimum, generally about three hours postchill (Sams, 2001). Clearly there is loss of absorbed moisture during the aging period, especially during the first hours. When purchasers report package under weights due to excessive moisture loss by iced poultry in transit, one reason could be very short aging durations. Poultry shippers should be cognizant of this effect of aging time and either provide sufficient over weight at shipping time or ensure that the poultry is aged sufficiently prior to shipping.

Conclusions

This study clearly shows that a number of variables affect moisture absorption and retention by ice-water chilled broilers including the birds' age, sex and aging duration. These variables must be factored into regulations and quality control programs. They might be especially important sources of carcass-to-carcass variation in moisture absorption and retention.

References

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TABLE 1. Effect of age on moisture retention and absorption by chilled broiler chickens

Age	Moisture absorption	Moisture retention
(d)	(%)	(%)
37	5.2 ^c	3.0 ^d
39	5.3 ^c	3.5 ^d
42	3.5 ^c	2.5 ^d
44	9.2 ^b	6.5 ^c
46	11.5 ^{a,b}	8.2 ^{a,b}
49	9.8 ^{a,b}	6.8 ^{b,c}
51	12.4 ^a	8.7 ^a
SEM	0.36	0.27

^{a,b,c,d} Means in the same column bearing no common superscripts differ significantly (P < 0.05).

TABLE 2. Effect of sex on moisture retention and absorption by chilled broiler chickens

Sex	Moisture absorption	Moisture retention
	(%)	(%)
Male	7.4 ^b	5.2 ^b
Female	9.1 ^a	6.2 ^a
SEM	.036	0.27

^{a,b} Means in the same column bearing no common superscripts differ significantly (P < 0.05).

TABLE 3. Effect of aging time on moisture retention and absorption by chilled broiler chickens

Aging time	Moisture retention
(h)	(%)
0	7.8 ^a
2	5.2 ^b
4	5.1 ^b
6	4.3 ^b
SEM	0.27

^{a,b} Means in the same column bearing no common superscripts differ significantly (P < 0.05).