Cooperative Extension - - - - University of California

No. 25 August 1982

Progress In Poultry

"THROUGH RESEARCH"

EGG SHELL DAMAGE - 2

IN THE CAGE AND DURING COLLECTION

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In the mid seventies, Cooperative Extension personnel of the University of California surveyed the extent of egg shell damage in 117 commercial laying flocks throughout the state. This project was designed to determine the extent of shell damange following collection and delivery to the egg room and the effects of subsequent washing. This report emphasizes the egg collection portion of the study. Washer damage was discussed in Progress in Poultry, Number 12 August 1978.

PROCEDURES

A six hundred egg sample was used for each flock. Eggs were gathered on filler flats by farm workers and placed on racks. Some of the more obvious cracks and leakers may have been separated during collection. All eggs were hand-candled by Extension personnel before and after washing. Cracks and leakers were identified by the type of crack, weighed and the thickness of the dry shell was measured using an Ames thickness gauge (with membranes intact). A thirty-egg random sample of sound shelled eggs was selected to represent the weight and shell thickness of the non-cracked portion.

Cracks were defined as follows:

Collision	= Indented, radiating pattern
Wire	= Indented, linear pattern
Line	= Not indented, linear pattern
Toe	= Small circular opening
Smash	= Severe indented damage
Loss	= Shell membrane broken, liquid exuding

Other data recorded included the age and molting history of the flock, strain of chicken, make of washer, washer temperature, date and the location of the processing plant.

RESULTS AND DISCUSSION

Overall cracks plus loss averaged 4.36% for the 117 flocks surveyed. The 86 non-molted flocks in the study averaged 4.35% with an average flock age of 55 weeks. Figure 1 illustrates the frequency distribution of the observed egg breakage prior to washing.

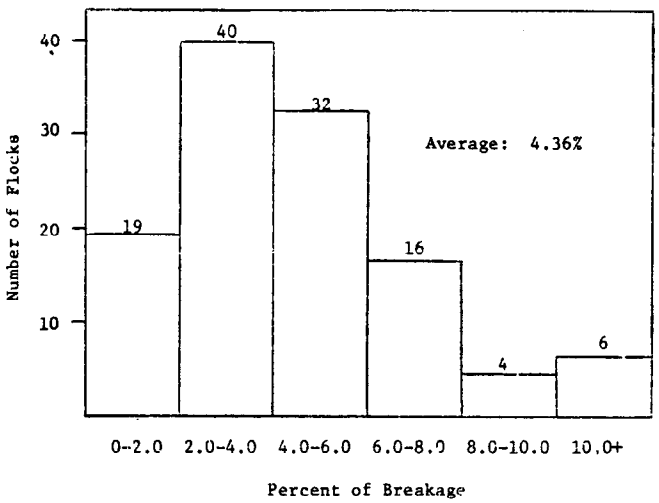

Fig. 1. Frequency distribution of egg breakage prior to washing.

Factors Affecting Breakage

1. Strain of Chicken

Data from six commercial strains of White Leghorns were analyzed. No inference should be made by the reader that these data apply to these same strains today. Table 1 summarizes the egg weight, shell thickness and egg breakage data adjusted to a common age of 55 weeks. Molted flocks are excluded from the remainder of this report. Egg weights and shell thicknesses were significantly different by strain, while egg breakage was not.

2. Age of Flock

The percentage of cracked eggs in the three younger groupings was not significantly different (Table 2). This parallels the absence of shell thickness differences shown in Table 3.

Egg breakage showed a significant increase with increasing egg weight in the youngest age grouping (20-39 weeks of age) and when all data is combined, but a decreasing pattern in the 60-79 week grouping (Table 2 and Figure 2). In both cases, the highest breakage is associated with the smallest proportion of the sample

The decreasing egg breakage pattern as eggs get larger in the 60-79 week grouping parallels an increasing pattern of shell thickness in these eggs (Table 3). Seventy percent of the 20-39 week data was sampled in the summer and fall. Seventy percent of the 60-79 week data was sampled in the winter and spring. In addition, the older groupings may include a significant amount of natural molting which would tend to give us higher shell thickness values.

Table 1. Average egg weight, shell thickness and egg breakage by strain of chicken.

Strain	No. of flocks	Egg weight (grams)	Shell thickness (inches)	Cracks (%)	Loss (%)	Cracks + loss (%)
Kimber	6	58.6	.0145	2.97	.17	3.14
Shaver	22	60.9	.0146	4.45	.32	4.77
Hyline	24	62.1	.0150	3.59	.43	4.02
H & N	13	58.5	.0145	3.94	.55	4.49
DeKalb	7	61.2	.0147	4.42	.39	4.81
Babcock	14	62.3	.0145	3.64	.83	4.47
Total/Average	86	61.1	.0147	3.90	.45	4.35

Table 2. The effect of age and egg weight on average shell breakage[1/].

Egg wt. (g)	Age (weeks) 20-39	40-59	60-79	80+	Total
	No. of flocks 10	45	30	1	86
	% Broken				
<50	3.58	3.38	7.30	-	4.06
50-54	1.83	4.45	4.62	6.20	3.76
55-59	3.61	3.88	4.66	6.10	4.08
60-64	4.84	4.74	4.22	6.11	4.58
65-69	5.46	4.58	3.71	16.35	4.46
70-74	5.94	6.15	3.00	20.90	4.68
≥75	-	3.35	5.22	100.00	5.60
Average	3.63	4.47	4.18	10.33	4.34

1/Individual eggs measured; non-molted flocks

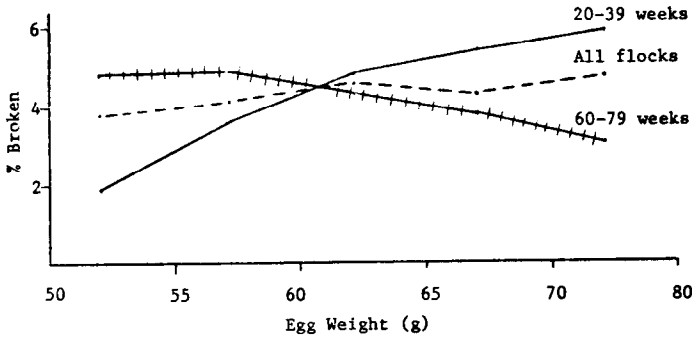

Fig. 2 The effect of age and egg weight on shell breakage.

Coefficients of correlation for the different age groups are as follows:

20-39 weeks	r = .965 **
40-59 weeks	r = .770 N.S.
60-79 weeks	r = -.950 *
All flocks	r = .916 *

* significant difference ($P<0.05$)
** significant difference ($P<0.01$)
N.S. not significant

Table 3 shows that there was practically no difference in mean shell thickness when age groups were compared. Increasing egg weight had a positive influence on shell thickness. Figure 3 illustrates the general pattern of increasing shell thickness with increasing egg weight. Age and shell thickness were negatively correlated with 50-59 gram eggs, but there was no correlation with eggs weighing 60 grams and above.

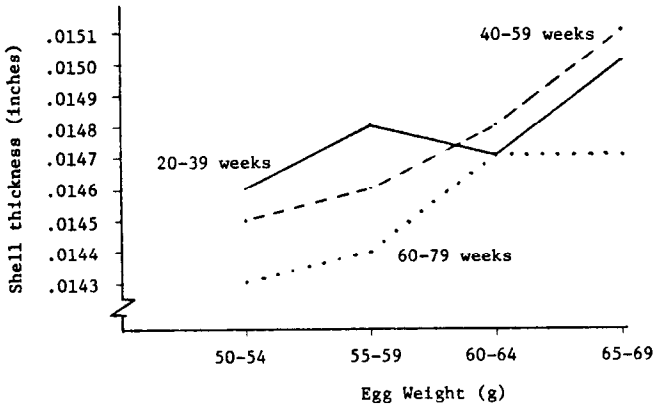

Fig. 3. The effect of egg size and age on shell thickness.

The failure to demonstrate age/breakage or age/shell thickness effects with such a large sample is somewhat puzzling. Normally, we would expect breakage to increase and shell thickness to decrease as the flocks get older. Separation of some eggs during collection may be partially responsible for this result.

Table 3. The effect of age and egg weight on average shell thickness[1/].

	Age (weeks)				
	20-39	40-59	60-79	80+	Total
Egg wt. (g)	No. of flocks				
	10	45	30	1	86
	Shell thickness (inches)				
<50	.0144	.0139	.0132	-	.0141
50-54	.0146	.0145	.0143	.0163	.0145
55-59	.0148	.0146	.0144	.0155	.0147
60-64	.0147	.0148	.0147	.0153	.0148
65-69	.0150	.0151	.0147	.0149	.0150
70-74	.0142	.0150	.0149	.0154	.0152
>75	-	.0143	.0151	.0138	.0147
Average	.0147	.0148	.0146	.0153	.0147

1/Individual eggs measured; non-molted flocks.

3. Shell Thickness

Overall effects of shell thickness as it relates to egg breakage is illustrated in the fact that the average cracked egg had a shell thickness of only .0139 inches as opposed to .0147 inches for the average sound egg -- a 5.4% thinner shell.

The thinnest shelled eggs (less than 0.012 inches) had a breakage rate 12.3 times as great as the thickest category (0.016 inches and above.). The chance of an egg in the thin-shelled group breaking before it reaches the egg processing plant is greater than one out of four. Table 4 gives the percentage of cracked eggs found in each egg shell thickness category.

Table 4. Percentage of cracked eggs by shell thickness category

Shell thickness (inches)	Cracked eggs (%)
<.0120	27.0
.0120-.0129	9.7
.0130-.0139	6.3
.0140-.0149	4.0
.0150-.0159	2.7
.0160 or greater	2.2

Shell thickness was significantly lower in the summer than in the winter months (Table 5), but the number of cracked eggs was highest in the fall and lowest in the spring. The reason for this disparity is not known unless it is due to an interaction between egg weight and shell thickness; these factors were lowest in the summer and highest in the winter.

The relationship of egg weight and shell thickness to the total percentage of cracked eggs candled after washing is shown in Figure 4. These calculated curves, based upon the data collected during the study, illustrate the effects of egg weight and shell thickness of egg breakage. These curves apply only to eggs with shells .0130 inches thick or greater.

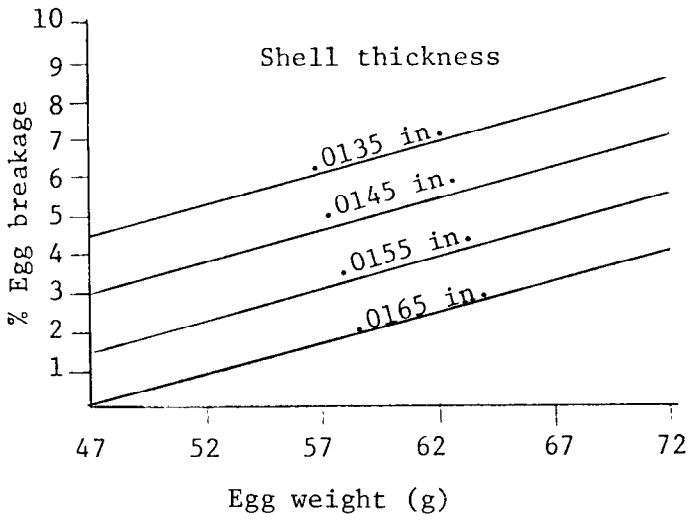

Fig. 4. The effect of egg weight and shell thickness on candled egg breakage after washing.

Table 5. Cracked eggs, egg weight and shell thickness by season[1/].

Season	Cracked eggs (%)	Egg weight (g)	Shell thickness (inches)	Ratio of shell thickness to egg weight x 100
Winter	4.09	62.0	.0150	.0242
Spring	3.01	60.6	.0148	.0244
Summer	4.56	58.9	.0142	.0241
Fall	5.52	61.8	.0146	.0236

1/Adjusted to 55 weeks of age.

Table 6. Percent egg breakage by type of crack and age of flock.

Type of Crack	Age (weeks) 20-39	40-59	60-79	80+	Average
			(%)		
Collision	56.0	53.7	51.8	22.5	52.3
Wire	1.9	2.6	2.9	2.8	2.7
Toe	6.2	6.4	2.7	8.5	5.1
Line	27.8	32.2	35.4	49.3	33.5
Smash	8.1	5.1	7.2	16.9	6.5

Table 7. Percent egg breakage by type of crack and shell thickness.

Type of Crack	Less than .0120	.0120 to .0129	.0130 to .0139	.0140 to .0149	.0150 to .0159	.0160 and greater
			(%)			
Collision	61.5	55.6	55.1	56.2	55.0	40.9
Wire	3.8	2.5	3.0	1.8	.5	2.5
Toe	4.4	5.4	4.0	4.0	5.9	4.4
Line	23.6	33.5	36.6	35.7	35.5	46.5
Smash	6.6	2.9	1.4	2.4	3.1	5.7

Type of Breakage

As the flocks got older, we observed a significant change in the type of egg breakage (Table 6). Collision cracks exceeded line cracks two to one in the youngest flocks, but this relationship was reversed in the oldest flock. A similar reversal in the proportion of collision cracks to line cracks occurred as shell thickness increased (Table 7).

DISCUSSION

The amount of egg shell damage which occurs on commercial egg farms is dependent upon the interaction of two factors - the ability of an egg to withstand shock and the nature and severity of the shock. A two-inch drop from the chicken to the cage floor, in most cases, would not result in shell breakage. When an older hen producing thinner shelled eggs lays her egg in the same manner, we quite often observe egg shell damage.

Of the various factors examined in this study, shell thickness appears to be the most highly correlated to egg shell breakage. With each increment of thinner shells, egg breakage was observed to increase. The thinnest shelled eggs had a very high risk of breakage - one out of every four eggs.

Shell thickness can be controlled through strain selection, proper timing of molting and sale, adequate nutrient intake and avoidance of high environmental temperatures. During periods of decreased shell thickness, greater precautions must be taken to minimize severe shocks to the eggs.

The opportunity for eggs to be broken are many. Excessive noise in the laying house which frightens the hens during the early stages of shell formation can cause egg shell damage inside the bird resulting in "body-checked" eggs. Many of these eggs are down-graded in value.

The majority of egg shell damage occurs during or shortly following oviposition. Disturbances during the morning laying period should be avoided at all costs. This is not the time to operate mobile feeding or manure cleanout equipment. Frightened birds will often lay their eggs prematurely resulting in increased breakage. In addition, eggs are destroyed as birds jump around inside the cage.

The slope and rigidity of the cage floor also influence shell damage. A floor slope which is either too steep or too shallow will cause an increase in the amount of egg breakage.

Eggs must be collected often enough so that egg-to-egg contact in the rollout tray is minimized. Egg collection personnel must be properly trained and monitored to keep egg breakage to a minimum. The more careful individuals should be responsible for the more fragile eggs.

The amount of egg shell damage observed in this study is equivalent to a loss of 20 cents per hen per year. With 290 million laying hens in the United States, a conservative estimate of the cost of the egg breakage which occurs during laying and collection would be $58 million. Besides this, it is estimated that another two to four percent of all eggs are totally lost through the cage bottom and never counted. Another four percent are damaged during processing, delivery and marketing.

Management programs which emphasize strong shells and careful handling can keep egg breakage at a minimum. A continuous monitoring program and attention to the problem is essential.

REFERENCES

Bell, D. D. 1978. Egg Shell Damage - 1, During Washing. Progress in Poultry, August.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the various poultry firms who cooperated in this study. Also, we acknowledge the assistance of Farm Advisors: Robert Adolph, Ervin Bramhall, Stan Coates, Bill McKeen, Ralph Pfost, Fred Price and Bill Rooney in collection of the data.

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