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The Effect Of Temperature and Storage Time on Weight Loss of Table Eggs

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Introduction

Modern egg grading equipment allows extremely precise measurement of individual egg weights. Electronic egg scales can be adjusted to 1/10 gram per egg gradations and a series of such scales can weigh 30 eggs or more per second or 108,000 or more eggs per hour. The latest versions of this equipment can sort eggs to the legally allowed minimum weight per egg (54.34 grams/egg for large eggs) while at the same time making scale adjustments to assure that the 12 eggs in each carton weigh the required weight per dozen (56.7 grams times twelve (24 ounces per dozen for large eggs - USDA).

In general, two-thirds of all eggs weigh within + or - 4.0 to 5.0 grams of the average weight. This variation is what yields eggs of different legal definitions with corresponding differing values within a single sample. With highly accurate scales, shell egg processors commonly set their scales to the minimum single egg weight definition and at the time of packing, egg weights satisfy legal requirements..

Egg weights, though, are not stable under all methods of handling and excessive weight loss may result in underweight eggs at some point in the distribution chain. Several previous studies have shown the importance of implementing proper rotation of egg inventories and refrigeration to minimize the loss of weight and to preserve interior egg quality. The purpose of this research is to demonstrate some of the factors which can affect egg weight loss and to quantify these losses.

Experimental Procedures

Two dozen large and two dozen extra large processed (washed, oiled and cartoned) eggs were sampled from a commercial egg processing plant. An additional three dozen unprocessed eggs from 32 week old layers and three dozen unprocessed eggs from 113 week old layers were also used from the same source. Eggs were transported to the Extension office where each egg (120) was identified and weighed and then placed in five different storage configurations:

1. Processed, foam cartons, household refrigeration (45° F.) (large and extra large eggs).
2. Processed, foam cartons, room temperature (72° F.) (large and extra large eggs).
3. Unprocessed, fiber filler flats, refrigerated (32 & 113 week old layers)
4. Unprocessed, fiber filler flats, room temperature (32 & 113 week old layers)
5. Unprocessed, fiber filler flats, room temperature + fan (32 & 113 week old layers).

Each egg was weighed daily to the nearest one-tenth gram for the first 7 days and weekly thereafter through 28 days of age. Cracked, very porous and severely body checked eggs were determined by candling. Their data was removed from the final analysis. Cracked eggs lost weight at a much faster rate than intact eggs. No conclusions could be made about weight loss in porous and body checked eggs. At the conclusion of the test (28 days), all eggs were broken and shell thickness and Haugh unit measurements were taken.

Results

Processed eggs with refrigeration (45°) lost weight at approximately one-half the rate of similar eggs stored at room temperature (70° F.). Refrigerated eggs lost .9 and 1.1% of their original weight (cartons and flats respectively) with 7 days of storage. Comparable eggs stored at room temperature lost 1.6 and 2.0% of their original weight.

(Table 1 and Figure 1) Refrigerated eggs kept for 28 days of storage lost 3.1 and 4.3% of their original weight (cartons and flats respectively) compared to eggs stored at room temperature which lost 6.0 and 8.0% of their original weight (Figure 2). In all cases, the eggs on flats (refrigerated or room temperature), lost weight at a higher rate than for cartoned eggs (Figure 3). Fan ventilation appeared to have only minimal effects on the rate of weight loss.

Cracked eggs (non-leakers) were observed to lose weight at a much higher rate than sound eggs (Table 2 and Figure 4). Cracked eggs stored with refrigeration on flats lost 12.7 and 11.3% of their weight (32 week and 113 week old hens respectively) compared to 4.2 and 4.4% for intermingled sound eggs. This is equivalent to a loss of 7.1 and 7.6 grams of weight for the cracked eggs versus 2.5 and 2.7 grams of weight for the sound eggs (32 week and 113 week old hens respectively). No attempt was made to quantify the extent of shell breakage, but it was observed that the more serious breakage was associated with the greater loss of weight.

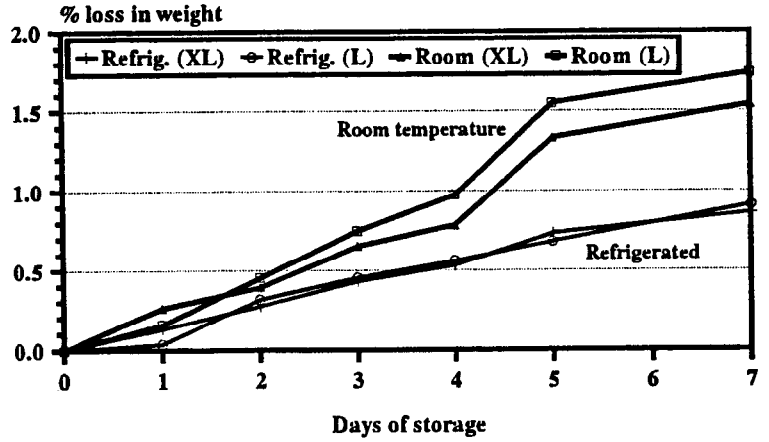
Table 1: Egg weight change with different treatments and storage periods *

Treatment	Initial weight	Stored 7 days	Stored 14 days	Stored 21 days	Stored 28 days
EGG WT. (G)					
Carton/refrig.	60.45	59.92	59.59	59.02	58.55
Carton/room	60.67	59.68	58.91	57.99	57.03
Flat/refrig.	60.19	59.53	59.04	58.29	57.59
Flat/room	58.28	57.09	56.02	54.87	53.62
Flat/room/fan	59.18	57.89	56.88	55.53	54.25
EGG WT. LOSS (G)					
Carton/refrig.		.54	.86	1.43	1.90
Carton/room		.99	1.77	2.69	3.64
Flat/refrig.		.66	1.15	1.90	2.60
Flat/room		1.19	2.26	3.41	4.66
Flat/room/fan		1.29	2.30	3.65	4.93
EGG WT LOSS (%)					
Carton/refrig.		.88	1.42	2.37	3.14
Carton/room		1.64	2.91	4.44	6.02
Flat/refrig.		1.09	1.90	3.15	4.31
Flat/room		2.03	3.87	5.83	7.97
Flat/room/fan		2.18	3.88	6.17	8.33

* CARTON = one dozen foam carton, closed with processed eggs, FLAT = 30 egg fiber flat un-processed eggs, REFRIG = 45 degrees F. in household refrigerator, ROOM = 72 degrees F., FAN = household fan blowing on flat of eggs.

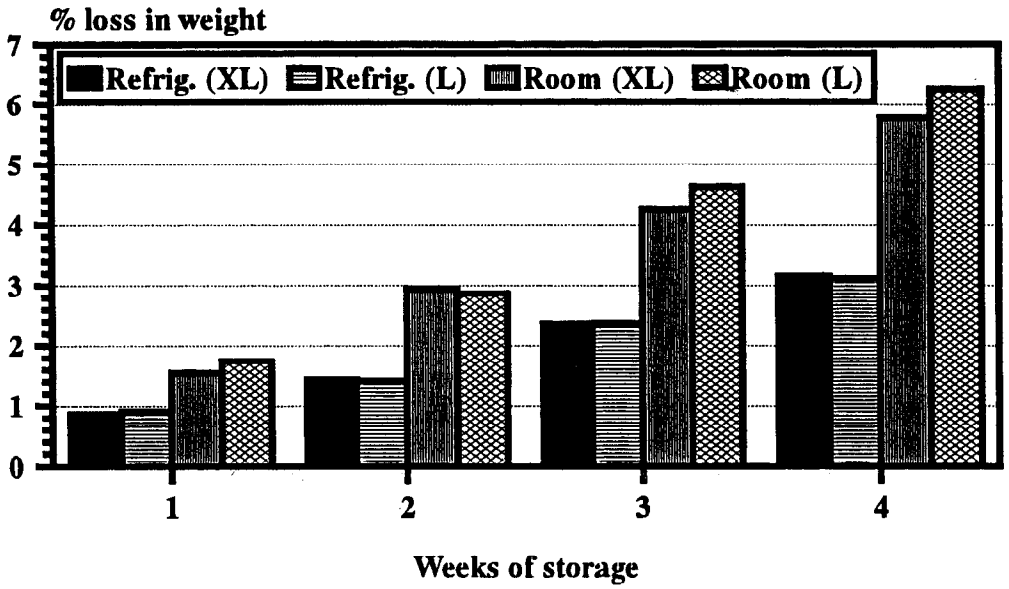
Figure 1: The effect of temperature and storage period on egg weight loss

Days 1 through 7



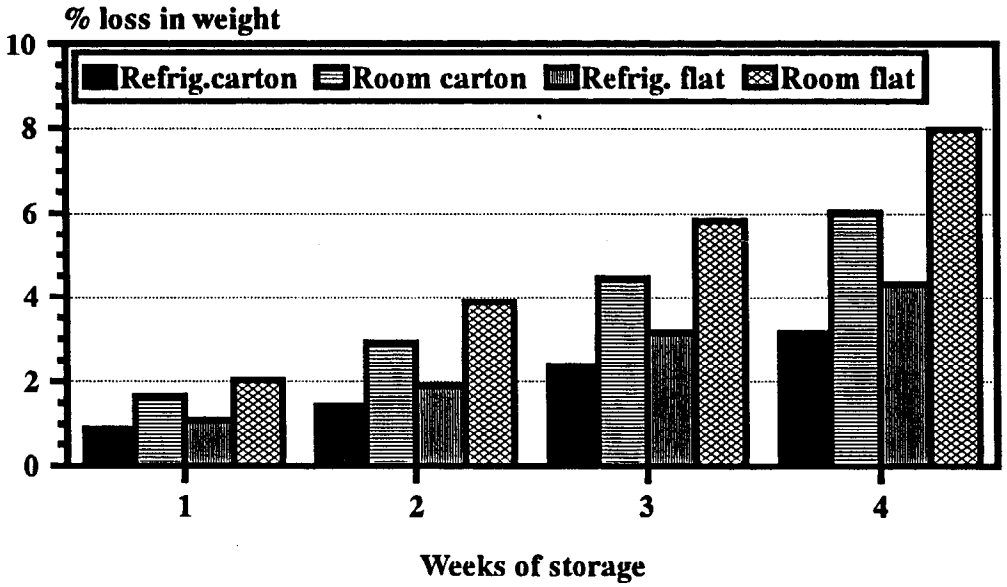
Refrig. = 45 degrees F., Room = 72 degrees F.

Figure 2: The effect of temperature and storage period on egg weight loss
Weeks 1 through 4



Refrig. = 45 degrees F., Room = 72 degrees F.

Figure 3: The effect of temperature and storage period on egg weight loss
One dozen foam carton vs open 30 egg flat - Weeks 1 through 4



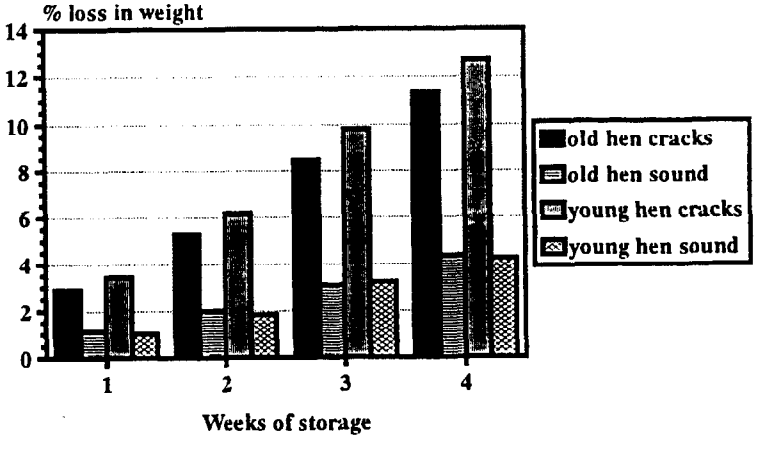
Refrig. = 45 degrees F., Room = 72 degrees F.

Table 2: Egg weight changes in cracked and sound shell eggs

Treatment	Inital Weight	Stored 7 days	Stored 14 days	Stored 21 days	Stored 28 days
Young hens	(32 wks)				
EGG WT. (G)					
Cracks	55.36	53.46	51.96	49.93	48.31
Sound	58.00	57.40	56.94	56.14	55.54
EGG WT. LOSS (G)					
Cracks		1.90	3.40	5.43	7.05
Sound		.60	1.06	1.86	2.46
EGG WT. LOSS (%)					
Cracks		3.44	6.15	9.81	12.73
Sound		1.03	1.83	3.21	4.24
Old hens	(113 wks)				
EGG WT. (G)					
Cracks	67.00	65.06	63.46	61.34	59.40
Sound	62.37	61.66	61.14	60.44	59.64
EGG WT. LOSS (G)					
Cracks		1.94	3.54	5.66	7.60
Sound		.71	1.23	1.93	2.73
EGG WT. LOSS (%)					
Cracks		2.90	5.28	8.45	11.34
Sound		1.14	1.97	3.09	4.37

Figure 4: The effect of temperature and storage period on egg weight loss

Sound shelled eggs vs cracked eggs - Weeks 1 through 4



Refrigerated flats = 45 degrees F., 32 vs 113 week old hens

Weekly data were analyzed for linear correlations. Very high R^2 values were observed between days of storage and weight loss (Table 3). Most predictions were extremely close to the actual observations as a result of the high correlations. Weight loss can be a very accurate predictor of the age of the egg if storage conditions are known.

Table 3. Linear regression equations for % egg weight loss through 28 days of storage

				% Weight Loss			
Treatment	a	b	R^2	7 days	14 days	21 days	28 days
Carton/refrig.	.02318	.10869	.989	.78	1.54	2.31	3.07
Carton/room	.09839	.20587	.993	1.54	2.98	4.42	5.86
Flat/refrig.	-.8116	.21404	.989	.97	2.04	3.11	4.18
Flat/room	-.0004	.27749	.994	1.94	3.88	5.83	7.77
Flat/room/fan	-.0302	.29128	.993	2.01	4.05	6.09	8.13

Y=a + b(x), Y = % weight loss, a = constant, b = x coefficient, x = days.

Egg quality measurements were made at 28 days (Table 4). All eggs stored at room temperature had no thick albumen. Albumen height for refrigerated eggs averaged 5.3 mm compare to 2.7 to 3.0 mm for eggs stored at room temperature. As a result, Haugh units averaged 70+ for refrigerated eggs compared to 44 to 48 units for eggs stored at room temperature. Ruptured yolks were also common in the eggs stored at room temperature and all eggs floated in non-salted tap water. There was no relationship between shell thickness and weight loss.

Table 4. Egg quality measurements at 28 days

Treatment	Egg wt. (g)	Albumen. ht. (mm)	Haugh units	Thick albumen (%)	Ruptured yolks (%)
Carton/refrig.	58.8	5.35	72.9	100	0
Carton/room	56.3	2.75	44.1	0	17
Flat/refrig.	55.4	5.30	72.3	100	0
Flat/room	54.2	2.75	45.1	0	0
Flat/room/fan	54.1	2.95	48.1	0	33

The economic effects of egg weight loss are associated with the extent of weight loss prior to grading as it affects the sorting of eggs into various weight classes and to the grade loss associated with an enlarged air cell. Under normal circumstances, eggs are weighed within 1 or 2 days of lay - before eggs have a chance to lose much weight. Technically, even 1 days delay could move eggs into the next lower weight class if they were "borderline" eggs in the first place. This could be costly during the summer with younger flocks when eggs are exposed to higher temperatures and lower weight egg classes are severely penalized at lower prices. The loss in grade as a result of an enlarged air cell are probably insignificant at egg ages of less than 1 week. A 2% loss in weight would theoretically increase the size of the air cell by approximately 1 cubic centimeter.

Table 5. The estimated effect of a 1% loss in egg weight on egg grade-out and value.*

Case wt. (Lbs)	Jumbo (%)	X. Lg. (%)	Large (%)	Medium (%)	Small (%)	PeeWee (%)	Value ¢/dozen
40.0	3	0	8	61	27	1	43.12
39.6	3	0	7	58	31	1	42.06
Diff.							-1.06
45.0	2	10	60	28	0	0	52.24
44.6	2	8	58	32	0	0	51.82
Diff.							-.42
50.0	11	52	34	3	0	0	54.75
49.5	9	50	38	3	0	0	54.65
Diff.							-.10

* 55¢ per dozen for large eggs and 46¢per dozen for medium eggs.

Table 5 illustrates the effect of a 1% reduction in egg weight for different egg weight classes using typical price relationships. No assumptions are made relative to loss in grade.

Discussion

Storage period, temperature, packaging materials and shell soundness were the key factors affecting the rate of weight loss in this experiment. Ventilation had a minimal effect and flock age appeared to have no effect on weight loss (data not shown). Weight loss, as expressed as a percent of initial weight, progressed linearly during the 4 week period studied. Refrigeration prolonged the use period for eggs by a factor of two when compared to room temperature storage. It is assumed that the rate of weight loss would be even faster under higher environmental holding conditions.

Commercial temperature holding conditions may differ from the conditions imposed in this study. Different samples within a storage room will require more or less time to reach stable temperatures based upon the type of packaging materials, storage procedures (stacking, palletizing), and air circulation patterns within the storage room. Maintenance of higher relative humidities (75-80%) are recommended to slow down the rate of evaporation. Household refrigerators are not noted for having high humidities. Humidity measurements for the refrigerator used in these studies averaged about 65-70%.

The effect of weight (moisture) loss in the egg would be associated with a parallel increase in air cell size. In general, we would assume that eggs packed in foam cartons and refrigerated similarly as in this experiment, would lose approximately 1% of their initial weight in about 9 days. This would result in an enlargement of the air cell of approximately .55 cubic centimeters - an insignificant amount as far as loss in grade is concerned. Under less optimum storage conditions and over a longer period of time, the decrease in air cell size would become more of an economic factor. Also, under these conditions, consumer acceptance of eggs would suffer.

Weighing eggs without tolerances for shrinkage at minimum weight definitions can result in eggs which fail to meet legal standards, especially when storage conditions are poor or prolonged. Rapid attainment of proper storage temperatures, thoroughness of oil coverage and high humidity storage will all delay the loss of moisture and preserve both the quality and weight of the eggs processed.

Selected readings

Numerous articles have been written on this subject. The ones listed below are only a few of the many.

1. Changes in Weight of Egg Stored in Water and in Air, Hall, G.O. and A.L. Romanoff, 1943, Poultry Science, Vol. 22, No.5, pp. 396-397.

2. Cooling and Holding Eggs on the Ranch, Henderson, S.M. and F.W. Lorenz, 1956, University of California Circular 405.

3. On-the-Farm Egg Processing, Henderson, S.M., 1957, Agricultural Engineering, Vol. 38, no. 8, pp. 598-601.

4. Nutrena's Egg Quality Experiments, Anonymous, 1960, Nutrena Farm Business Handbook.

5. Some Characteristics of Measures Employed for Determining the Interior Quality of Chicken Eggs, Bornstein, S. And B. Lipstein, 1962, British Poultry Science Journal, pp. 127-139.

6. Effect of Storage on Weight Loss in Eggs, Baker, R.C., 1987, Poultry Digest, July, pp. 276-278.

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