Bobwhite Quail Eggs: Some Measurements and a Method for Estimating the Weight of Egg Contents

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Introduction

The effect of agricultural chemicals on wildlife has attracted much attention in recent years. The study of the effect of such chemicals on wild birds has included the determination of chemical residues in eggs found in the field. Unfortunately, many of the eggs may be partially dry or may contain an embryo which makes it difficult to present residue data on the basis of the original fresh egg contents. STICKEL et al. (1973) discussed this problem, and presented equations for estimating the egg volume for eggs from bald eagles, ospreys and eastern brown pelicans using only the measurements of length and width of the eggs.

The study reported herein discusses the effect of temperature on the weight loss of bobwhite quail (Colinus virginianus) eggs, provides information concerning quail egg dimensions, and presents an equation for estimating the fresh weight of the contents of bobwhite quail eggs using only the measurements of egg length and width.

Materials and Methods

Eggs used in this study were obtained from our own bobwhite quail flock. Fifty fresh eggs were selected and placed on an egg flat in a refrigerator for storage while another 50 eggs were held in the laboratory at room temperature. The refrigerator temperature ranged from 1 to 7° C. with an average of 3.3° C. during the period of storage. Room temperature ranged from 21.6 to 28.8° C. with an average of 23.7° C. Nine relative humidity readings in the refrigerator ranged from 27 to 32% with an average of 29%. Ten relative humidity readings in the laboratory ranged from 29 to 37% with an average of 33%. Refrigerated eggs were weighed 115 times over a 309 day period while room temperature eggs

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were weighed 85 times over a 265 day period using an H10 Mettler balance. At termination of the storage period the length and width of the eggs were measured using a vernier caliper, the eggs were broken out to observe the interior quality and the shell thickness (including shell membranes) was measured in three places at the large end of each egg using a dial micrometer.

A second study involved 85 fresh quail eggs of a variety of sizes which were selected on 3 different occasions in samples of 50, 10 and 25 for the measurement of the weight of egg contents and the measurement of egg dimensions. Eggs were weighed, the length and width measured and the eggs broken out. The shell with adhering shell membranes from each egg was cleaned of albumen, weighed and this weight subtracted from the total egg weight to determine the weight of the contents. A regression equation was calculated for egg length x width in cm versus the weight of egg contents in gm. Egg width was measured at the widest part of the egg.

Results and Discussion

A summary of measurements from the 100 eggs used in the storage experiment is found in Table I while a plot of the regression lines for the egg weight data listed in Table II is found in Fig. 1. A summary of the data used to calculate the regression equation for the prediction of the weight of egg contents is contained in Table III while the regression line is plotted in Fig. 2.

It is apparent in Fig. 1 that the rate of egg weight loss due to evaporation of moisture was about two times as rapid at room temperature as at refrigerator temperature. This difference is primarily a temperature effect since relative humidity was actually higher in the laboratory than in the refrigerator. It appears that shortly after 200 days the rate of weight loss of the room temperature eggs began to decrease and the eggs were approaching a dried condition. This was not true for the refrigerated eggs. At 195 days the room temperature eggs were 44% of initial weight while at 202 days the refrigerated eggs were 70.4% of initial weight (Table II). After 265 days all the room temperature eggs were broken out and found to contain dried up yolk and albumen materials. After 309 days, all the refrigerated eggs were broken out and 32 (68.1%) were found to contain considerable moisture while 15 (31.9%) appeared to be dry to the extent that no liquid yolk or albumen was present.

TABLE I

Summary of the measurements of stored bobwhite quail eggs.[a,b]

	Fresh egg weight (gm)	Egg weight at termination of storage (gm)	Egg weight loss (gm)	Egg length (cm)	Egg width (cm)	Shell thickness (mm x 10^{-3})
			Refrigeration (0-309 days)			
Number	50	47	47	47	47	47
Range	7.804-11.586	3.139-8.043	2.668-6.792	2.90-3.45	2.25-2.58	196-267
Average	9.991	5.811	4.182	3.15	2.44	236
SD	±0.695	±1.386	±1.305	±.129	±.069	±15.7
SE	±0.098	±0.202	±0.190	±.019	±.010	± 2.3
CV	6.96%	23.85%	31.21%	4.09%	2.82%	6.65%
			Room Temperature (0-265 days)			
Number	50	47	47	47	47	47
Range	7.580-11.473	2.745-4.281	4.835-7.133	2.80-3.40	2.10-2.58	185-274
Average	10.057	3.716	6.288	3.18	2.42	226
SD	±0.755	±0.328	±0.447	±.137	±.083	±18.5
SE	±0.107	±0.048	±0.065	±.020	±.012	± 2.8
CV	7.51%	8.83%	7.11%	4.30%	3.42%	8.18%

[a]SD = Standard deviation; SE = Standard error; CV = Coefficient of variation.

[b]The difference in the number of eggs from the beginning of the storage period to the end is due to breakage.

TABLE II

Bobwhite quail egg weights at selected intervals during storage.[a]

Refrigerated			Room Temperature		
Days after ovi-position	Average egg weight (gm)	% of initial weight	Days after ovi-position	Average egg weight (gm)	% of initial weight
0	9.991	100	0	10.057	100
10	9.826	98.3	9	9.785	97.3
21	9.664	96.7	21	9.452	94.0
30	9.509	95.2	30	9.190	91.4
41	9.288	93.0	40	8.935	88.8
50	9.113	91.2	51	8.623	85.7
62	8.995	90.0	61	8.346	83.0
70	8.863	88.7	70	8.068	80.2
80	8.730	87.4	79	7.805	77.6
90	8.553	85.6	91	7.456	74.1
104	8.348	83.6	103	7.114	70.7
111	8.250	82.6	110	6.930	68.9
120	8.116	81.2	121	6.663	66.2
132	7.946	79.5	131	6.265	62.3
141	7.824	78.3	140	6.011	59.8
150	7.699	77.1	149	5.690	56.6
160	7.565	75.7	161	5.276	52.5
171	7.417	74.2	168	5.089	50.6
181	7.286	72.9	180	4.786	47.6
190	7.186	71.9	191	4.538	45.1
202	7.033	70.4	195	4.428	44.0
211	6.906	69.1	235	3.850	38.3
220	6.785	67.9	265	3.716	36.9
227	6.715	67.2			
239	6.570	65.8			
309	5.811	58.2			

[a]The data contained in this table are plotted in Fig. 1.

The regression equation for the linear portion of the room temperature egg weight curve is $\hat{Y} = 10.0881 - .0292X$ while the equation for the refrigeration egg weight curve is $\hat{Y} = 9.8497 - .0139X$ (Fig. 1). The regression coefficient for the room temperature curve (-29.2 mg/day) is approximately 2.1 times that for the refrigeration curve (-13.9 mg/day); thus, weight loss was about twice as rapid at room temperature compared to refrigerator temperature.

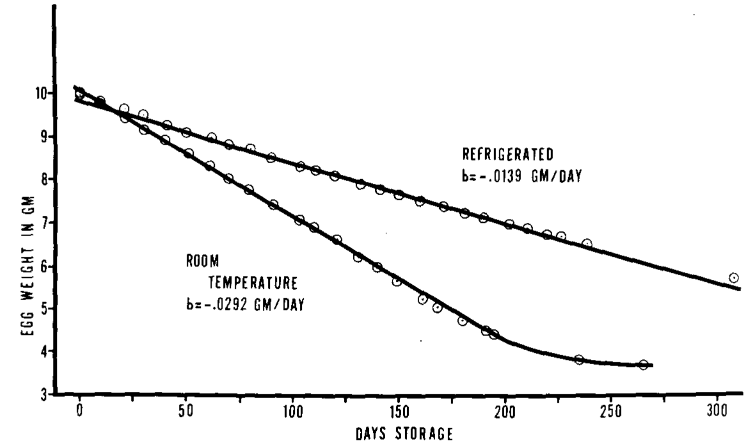

Fig. 1. Changes in bobwhite quail egg weight with storage at refrigeration temperature and room temperature. The regression equation for refrigerated eggs from 0 to 309 days of storage is $\hat{Y} = 9.8497 - .0139X$. The regression equation for room temperature eggs from 0 to 195 days of storage is $\hat{Y} = 10.0881 - .0292X$.

The coefficient of variation (CV) for fresh egg weight was found to be 7.51% for the room temperature eggs. At 265 days, when the eggs were essentially dry, the CV was 8.83% and the standard deviation was less than half of that for the fresh egg weight (Table I). The CV for fresh egg weight was found to be 6.96% for the refrigerated eggs. However, at 309 days, the refrigerated eggs were still losing weight and the CV was 23.85% with a standard deviation twice that of the fresh egg weight. The CV for the actual weight loss was 31.21%. This variation in weight loss among eggs before they reach the dry state is probably due to individual differences in shell thickness, shell porosity and egg size. It is clear that eggs intended for storage and to be used for later analysis should be weighed as soon after oviposition as possible to eliminate analytical error due to evaporative water loss. The eggs should be stored in a refrigerator, preferably at high humidity, to minimize weight loss.

When an investigator is analyzing eggs from a laboratory quail flock, the fresh weight and age of the eggs are generally known. However, eggs collected in the field are usually of unknown age and may be in a partially dried state. It is apparent from the previous discussion that egg weight of a partially dried egg would be of limited value for expressing analytical results. STICKEL et al. (1965) pointed out that residue concentrations in partially dried osprey eggs from the field were exaggerated as much as 8 times when analytical results were based on the weight of egg contents.

The 85 fresh quail eggs used for calculating the regression involving weight of egg contents were selected for good shell quality and to represent a wide range of egg weights (Table III). The correlation coefficient for the regression of weight of egg contents on egg length x egg width is $r = .938$ while the regression equation is $\hat{Y} = 1.432\ x - 2.517$ (Fig. 2). The average percent difference of the actual weight of egg contents from the predicted weight was 3.21% when the signs of the differences were disregarded. The range of percent differences from the actual weight of contents was -9% to +11.1% and the standard deviation was ±2.54%. The 95% confidence belt for Y values is included in Fig. 2. It would appear that the regression equation presented above should provide an easy and reasonable method for estimating the fresh weight of egg contents for bobwhite quail eggs of unknown age collected in the field.

TABLE III

Summary of the measurements from 85 bobwhite quail eggs used in the calculation of the regression of the weight of egg contents on egg length x width.[a]

	Fresh egg weight (gm)	Egg shell weight (gm)	Egg contents weight (gm)	Egg length (cm)	Egg width (cm)
Range	5.544-10.676	0.761-1.299	4.818-9.461	2.70-3.37	2.00-2.60
Average	8.891	1.074	7.817	3.09	2.33
SD	±1.057	±0.119	±0.963	±0.151	±0.116
SE	±0.115	±0.013	±0.104	±0.016	±0.013
CV	11.89%	11.08%	12.32%	4.89%	4.98%

[a]SD = Standard deviation; SE = Standard error; CV = Coefficient of variation.

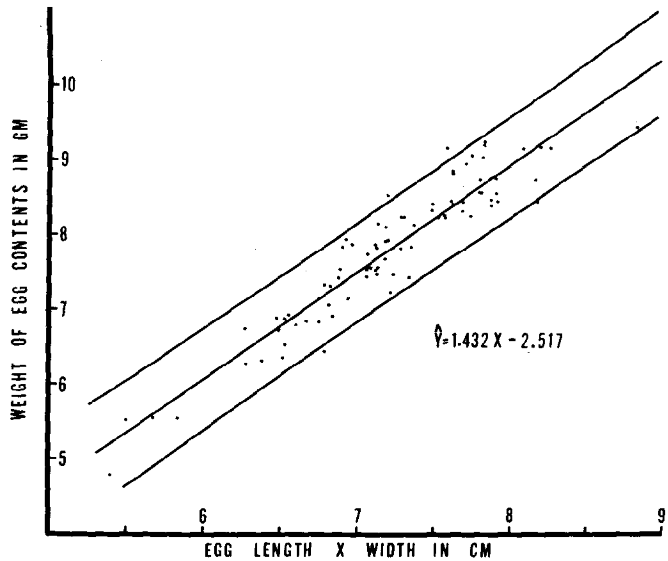

Fig. 2. The regression of the weight of bobwhite quail egg contents in gm on egg length x egg width in cm. The 95% confidence belt for Y values is included. The correlation coefficient r = .938.

The weight of the egg shell with membranes was found to average about 12% of the whole egg weight. The coefficients of variation were greater for egg weight, length and width for the 85 eggs used to study weight of egg contents than for the eggs used in the storage study. This was due to the fact that the storage eggs were selected for uniformity of size.

It has been found in the studies reported herein that evaporative moisture loss from bobwhite quail eggs is greatly accelerated at room temperature as compared to refrigerator temperature and that at any given point in time the amount of moisture loss in stored eggs varies with each egg. In addition, a regression equation has been presented which will provide a reasonable estimate of the fresh weight of the contents of quail eggs when only egg length and width are known.

References

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