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The Nutrient Content of the Eggs of Five Breeds of Hens

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As PART of the rapid development of a poultry industry in Guatemala, several different imported breeds are being tested for their suitability for the area. With increased production, eggs are expected to gain in importance as a human dietary component. Since there was evidence that genetic differences in the nutritive value of hen eggs may be significant (Scrimshaw *et al.*, 1945), it was deemed desirable to determine the extent of this variation in the principal breeds being tried in Guatemala City, one of the centers of this poultry development.

If the eggs of any particular breed appeared to contain significantly more of the nutrients at present in short supply in the local diets, the cultivation of this breed could be recommended. Furthermore, knowledge of the variations in the nutritive value of eggs produced and sold in Guatemala City would be of value to nutritionists responsible for the calculation of the nutrient content of diets.

In the present report, the variations in the content of 13 essential nutrients or food components in eggs from five breeds of hen are presented.

MATERIALS AND METHODS

White Leghorn, New Hampshire, Barred Plymouth Rock, Rhode Island Red and White Plymouth Rock chicks were imported from the United States. All were fed *ad libitum* a uniform ration consisting of 40% of a poultry concentrate[1] mixed with sorghum and a small percentage of yellow corn. The ration so designed provided sufficient quantities of known nutrients.

When nearly ready to lay, each bird was placed in an individual cage in a commercial poultry farm near Guatemala City, at an altitude of 4,984 feet. The average environmental temperature during the period of collection of the eggs was 16.4°C. The age range of the birds was from 8½ to 13 months as shown in Table 1.

Four eggs from each of ten or eleven hens of each breed were collected during the period from February 8 to February 18, 1955. They were brought daily to the laboratory, and kept under refrigeration until the collection was completed. The weight of the shell, white and yolk was determined separately and the two latter constituents from the four eggs of each hen were then combined and analyzed. The samples were stabilized following the technique described by Munsell *et al.* (1949).

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[1] The percent composition of the concentrate, as guaranteed by the manufacturer, the California Milling Corp., Los Angeles, California, was the following: protein, 44.86; fat, 6.58; fiber, 6.30; calcium, 3.72; phosphorus, 2.12; nitrogen free extract, 18.08; sodium chloride, 0.85; ash, 13.96. It contained per pound, vitamin A, 10.573 USP units, vitamin D, 913 AOAC units; riboflavin, 6.67 mg.; pantothenic acid, 8.55 mg.; niacin, 36.05 mg.; choline, 1347.25 mg.; manganese, 141.1 mg.; iodine, 1.80 mg.; cobalt, 1.20 mg.; iron, 36.60 mg.; copper, 3.30 mg.; zinc, 3.04 mg. It also contained per ton, aureomycin, 17.0 gm.; diamine penicillin, 4.0 gm. and vitamin B_{12}, 6.0 mg.

TABLE 1.—*Components of eggs of five different breeds of hen showing a relationship to age*

Breed[1]	Number	Age in months	Weight in grams				Total solids, gm./100 gm.	Fat, gm./100 gm.	Calories/ 100 gm.
			Total egg	Shell	White	Yolk			
W.L.	10	8.5	56.8±0.8[2]	6.9±0.2	32.8±0.9	18.5±0.4	24.8±0.3	8.9±0.2	145±2
W.P.R.	11	10.5	60.6±0.8	7.5±0.1	33.2±0.6	19.1±0.3	26.5±0.3	10.4±0.2	155±3
B.P.R.	10	10.5	59.3±0.7	6.9±0.1	33.2±0.6	19.9±0.4	26.2±0.3	10.0±0.2	155±3
N.H.	10	12.0	59.0±1.0	7.0±0.2	31.5±0.8	20.4±0.4	26.7±0.4	10.5±0.3	160±3
R.I.R.	11	13.0	60.9±0.7	6.8±0.1	32.9±0.6	21.3±0.2	26.9±0.2	11.2±0.2	164±2
All Breeds	52	10.9	59.3±0.4	7.0±0.1	32.7±0.3	19.6±0.2	26.2±0.2	10.2±0.2	156±4

[1] W.L. =White Leghorn.
W.P.R. =White Plymouth Rock.
B.P.R. =Barred Plymouth Rock.
N.H. =New Hampshire.
R.I.R. =Rhode Island Red.
[2] Mean and Standard Error.

For the determination of moisture, ether extract, crude fiber, total ash, and calcium, the methods of the Association of Official Agricultural Chemists were used (1945). Phosphorus was estimated by the method of Lowry and López (1946) and iron according to the recommendations of Hill (1930) modified by Jackson (1938) and Moss and Mellon (1942). The thiochrome method (Hennessey and Ceredo, 1939) as applied by Munsell *et al.* (1949) was employed for the estimation of thiamine. Riboflavin was analyzed fluorometrically, after adsorption of interfering fluorescent materials in a florosil column (Munsell *et al.*, 1949; and Hodson and Norris, 1939). The carotene content was determined by the method of Wall and Kelley (1943) which measures essentially β-carotene, and vitamin A according to Sobel and Werbin (1946, 1947). Niacin was assayed by the microbiological method of the Pharmacopoeia of the United States of America (1947). The factors employed by the United States Department of Agriculture (Woot-Tsuen Wu Leung *et al.*, 1952) were used to calculate the number of Calories per 100 g. of egg.

RESULTS

The weight for the whole egg and its structural components, as well as the percentage of total solids, fat, and Calories are given in Table 1. The breeds are listed in order of increasing group age, each group being completely homogeneous with respect to this parameter. This order also proved to be the sequence in which the yolk, total solids, fat, and Calorie content increased.

The values for nitrogen, ash, phos-

TABLE 2.—*Components of eggs of five different breeds of hen showing significant differences among breeds*

Breed[1]	Number	Average content per 100 grams				
		Nitrogen, gm.	Ash, gm.	Phosphorus, mg.	Vitamin A, mg.	Carotene, mg.
W.L.	10	2.02±0.03[1]	0.8±0.06	96± 7	0.153±0.008	0.030±0.002
W.P.R.	11	1.99±0.02	1.3±0.14	108±12	0.103±0.016	0.030±0.003
B.P.R.	10	2.05±0.02	0.9±0.09	131±12	0.118±0.008	0.038±0.002
N.H.	10	1.97±0.02	1.0±0.02	193±16	0.069±0.010	0.026±0.004
R.I.R.	11	1.96±0.02	0.9±0.02	93± 6	0.099±0.010	0.029±0.002
All Breeds	52	2.00±0.01	1.0±0.04	124± 7	0.108±0.006	0.031±0.001

[1] Abbreviations same as Table 1.

TABLE 3.—*Components of eggs of five different breeds of hen showing no significant differences*

Breed[1]	Number	Average content in milligrams per 100 grams				
		Calcium	Iron	Thiamine	Riboflavin	Niacin
W.L.	10	60±3[1]	3.5±0.5	0.07±0.005	0.28±0.01	0.05±0.004
W.P.R.	11	58±2	3.3±0.8	0.07±0.006	0.28±0.01	0.05±0.003
B.P.R.	10	60±2	2.4±0.2	0.08±0.011	0.22±0.03	0.05±0.005
N.H.	10	61±2	2.6±0.3	0.08±0.004	0.31±0.02	0.06±0.005
R.I.R.	11	66±2	2.7±0.2	0.07±0.006	0.27±0.02	0.05±0.004
All Breeds	52	61±1	2.9±0.2	0.07±0.003	0.27±0.01	0.05±0.002

[1] Abbreviations same as Table 1.

phorus, vitamin A, and carotene, presented in Table 2, although differing significantly among the breeds, do not show this relationship with group age. Table 3 contains values of calcium, iron, thiamine, riboflavin and niacin which showed no differences among the breeds studied.

DISCUSSION

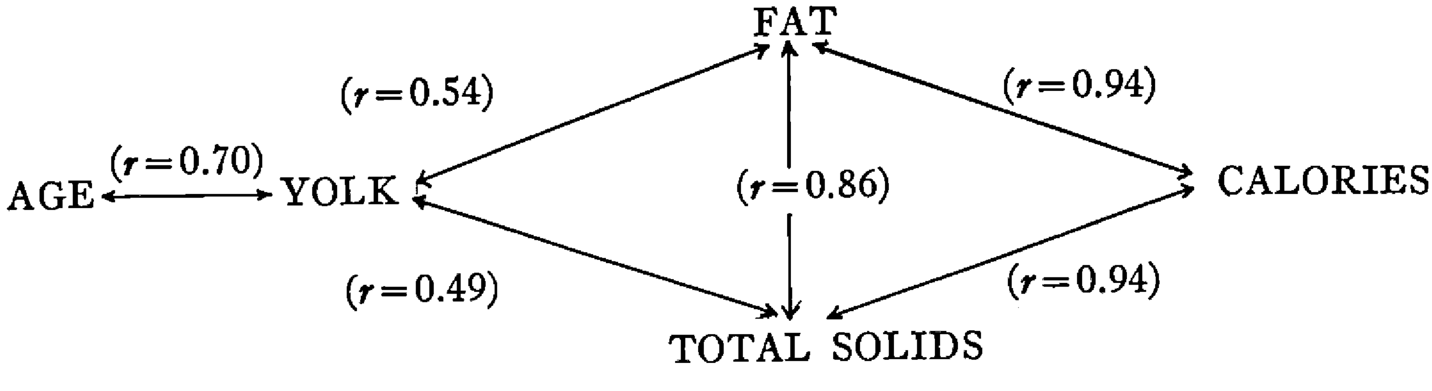
When the samples were taken it was not realized that the differences in age might be sufficient to influence the content of any of the constituents studied. However, as long ago as 1914 it was demonstrated (Curtis, 1914) that there is an increase in the yolk size with increasing age, particularly during the first laying year, although the weight of the albumin remains constant. In the present study the correlation between yolk weight and age confirms this observation.

Since 99% of the fat is contained in the yolk (Romanoff, 1932) and since the yolk contains much less water than the albumin, both total solids and fat also show a significant correlation with age. The final link in this chain is the close relationship of the total caloric value to the fat content which explains the rise in the latter with the age of the flock. These interdependences can be diagnosed as shown in the sketch below.

It does not appear from these data that breed differences *per se* are influencing any of these particular constituents.

The possibility that vitamin A stored during the growing period might have been slowly depleted during egg production is suggested by the tendency of the vitamin A content of the eggs to decline with the age of the birds. This seems unlikely, however, in view of the relatively high vitamin A content of the ration used. From the practical nutritional point of view, the variation in vitamin A would be significant in an area in which this essential factor is low in the diet, provided that eggs were consumed in any quantity. Unfortunately, eggs are usually not a common diet ingredient in such a situation.

The failure to find a significant genetic



difference in thiamine content was unexpected in view of a previous report (Scrimshaw *et al.*, 1945) that White Leghorn eggs had a significantly higher thiamine content than those of Barred Plymouth Rock and Rhode Island Red. Without further study it cannot be determined whether the lack of agreement is due to some unknown factors which obscured possible genetic differences in the present study or whether conversely unknown and uncontrolled factors were providing apparent breed differences in the previous work.

In view of this inconsistency in breed differences in thiamine, it would be desirable to repeat the present studies under different environmental conditions before accepting the conclusion that breed differences occur for nitrogen, ash, phosphorus, vitamin A, and carotene.

SUMMARY

Composite samples of four eggs from ten to eleven hens of each of five breeds, fed *ad libitum* a standard ration, were analyzed for 13 dietary constituents. The following series of interdependent positive correlations was observed: age with yolk ($r=0.70$), yolk with fat ($r=0.54$), yolk with total solids ($r=0.49$), fat with total solids ($r=0.86$), Calories with fat ($r=0.94$) and Calories with total solids ($r=0.94$). Significant differences among the breeds occurred for nitrogen, ash, phosphorus, vitamin A and carotene, although the content of these nutrients did not show any relationship with age and none of the breeds was superior in more than two nutrients. No significant differences were encountered among breeds for calcium, iron, thiamine, riboflavin and niacin. Of the breed differences, the only one of practical nutritional importance was the higher vitamin A content of the White Leghorn. The average values obtained per 100 grams for the eggs of all five breeds were: total solids, 26.2 gm.; fat, 10.2 gm.; nitrogen, 2.00 gm.; ash, 1.00 gm.; calcium, 61 mg.; phosphorus, 124 mg.; iron, 2.9 mg.; vitamin A, 0.108 mg.; carotene, 0.031 mg.; thiamine, 0.07 mg.; riboflavin, 0.27 mg.; and niacin, 0.05 mg. The average caloric value was found to be 156 Calories per 100 grams.

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