The Effect of Dietary Weight and Density upon Feed Consumption of Laying Hens

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The determination of precise nutrient requirements for laying hens has been hampered throughout the years by inability to predict and control nutrient intake. Research by Hill (1956), Berg *et al.* (1956), and Mayer (1953) has shown that dietary energy level has an influence on total food intake. A series of experiments with normal as well as with cropectomized chicks was carried out by Fisher and Weiss (1956) to study the effects of fiber *per se* on feed consumption. This work indicated that fiber *per se* was an important factor which influences feed consumption independently of the energy level of the diet. Fiber *per se*, up to a given dietary level, stimulated feed consumption; beyond that level feed consumption remained relatively constant. It was found that efficiency of feed utilization was not sacrificed when fiber was added (simultaneously with fat) to high energy diets, but it was actually improved.

Dietary bulk has been shown to be a factor which affects feed consumption. Couch and Isaacks (1957) were successful in restricting the protein and energy intake of growing pullets by substituting 18.2 percent of oat hulls for an equivalent amount of milo. The energy-fiber interrelationship has been expressed by Marz *et al.* (1957) as an energy-volume ratio. It was shown that neither energy nor density alone proved to be a satisfactory criterion for measuring the effectiveness of a grower diet.

Research work designed to study and control nutrient intake in poultry has been in progress at the Oklahoma Agricultural Experiment Station for the past four years. Considerable information has been obtained in this area. However, the effects of dietary weight and volume upon the nutrient intake of laying hens need further investigation.

The primary purpose of the experiment described in this report was to study the effects of dietary weight and volume upon the nutrient consumption of laying hens. At the same time, a study was made to measure more accurately the dry volume of a variety of feed ingredients and mixed diets.

Experimental Procedure

The experimental design for the entire experiment is shown in Table 1. An experimental basal, shown in Table 2, was formulated which supplied 16 grams of protein and 280 Calories of metabolizable energy per hen per day. The basal was used to mix nine experimental diets which contained washed blow sand at graded levels to regulate the dietary weight and polyethylene fluff at graded levels to regulate the dietary volume. These nine diets were designed to give three different dietary volumes in combination with three different dietary weights (Table 3).

TABLE 1. EXPERIMENTAL DESIGN

Expected daily feed consumption in grams	Expected daily feed consumption in millimeters		
	290	255	221
126	126-290 (1)	126-255 (2)	126-221 (3)
145	145-290 (4)	145-255 (5)	145-221 (6)
164	164-290 (7)	164-255 (8)	164-221 (9)

TABLE 2. COMPOSITION OF BASAL DIET AND THE VOLUME AS DETERMINED FOR EACH INGREDIENT

Ingredients	Volume	Weight
	ml/g	g
Fat (animal tallow)	1.119	9.5
Starch	1.340	12.5
Ground yellow corn	1.508	14.2
Oat mill feed	2.289	28.4
Alfalfa meal (17% protein)	1.872	1.9
Herring fish meal (74.6% protein)	1.779	2.9
Soybean oil meal (50% protein)	1.428	9.9
Blood meal (84% protein)	1.954	3.8
Gelatin	1.440	1.9
Dried whey	1.391	1.9
Corn fermentation solubles #3	2.059	1.9
Di-calcium phosphate	0.536	5.0
Calcium carbonate	0.803	3.3
Salt	0.763	0.5
dl-Methionine	—	0.1
Vitamin-Mineral concentrate*	2.059	1.0
Polyethylene fluff	4.510	—
Washed blow sand	0.616	—
Total		98.7

*Vitamin-Mineral concentrate supplied per daily diet: 3524 U.S.P. units of vitamin A, 529 I.C.U. of vitamin D_3, 2.6 I.U. of vitamin E, 1.3 mg of vitamin K, 0.0035 mg of vitamin B_{12}, 1.8 mg of riboflavin, 14 mg of niacin, 3.5 mg of pantothenic acid, 220 mg of choline chloride, 12 mg of manganese, 0.38 mg of iodine, 0.26 mg of cobalt, 10 mg of iron, 0.7 mg of copper and 10 mg of zinc.

Thirty-six commercial hybrid laying hens, nine months of age, were obtained on June 8, 1962, housed in individual laying cages, and fed a control diet which had been found to be satisfactory for laying hens. Ten days later on June 18, 1962, four hens were placed on each of the nine experimental diets. The experiment continued for six two-week experimental periods.

In order to measure the dry volume of the ingredients and mixed feed, several different methods were tried. The first method was to pour the dry feed into a graduated cylinder and read the volume. The results proved to be extremely variable. A procedure of shaking or tapping the graduated cylinder was then tried and was found to be fairly accurate. However, this procedure did not give repeatable results, since only the time and not the degree of shaking or tapping could be controlled. The most satisfactory data were obtained using a small vibrating machine to shake the feed for a predetermined length of time. The vibrating machine was a foot massager which had been adapted to hold a graduated cylinder. One minute of vibration was found to give the most constant repeatable data.

Results and Discussion

The values of the volume measurements for each feed ingredient are given in Table 2 along with the formula for the experimental basal. It can be seen from the summary of the feed intake data in Table 4 that the expected and actual feed consumption values did not always agree. However, there are some patterns which can be delineated from these data. None of the high-volume daily diets (1, 4, and 7) was consumed at the expected 290-milliliter dietary volume. It might be assumed from these data that the 290-milliliter dietary volume was actually exerting some influence upon feed intake. It can also been seen that the hens fed the low-dietary-weight and the high-dietary-weight diets (1, 2, 3 and 7,

TABLE 3. COMPOSITION OF EXPERIMENTAL DIETS

Ingredients	Diet numbers								
grams	1	2	3	4	5	6	7	8	9
Basal	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7
Polyethylene fluff	27.3	20.2	11.3	26.1	16.8	8.1	22.8	13.8	5.1
Washed blow sand	—	7.1	16.0	20.2	29.5	38.2	42.5	51.5	60.2
Total	126.0	126.0	126.0	145.0	145.0	145.0	164.0	164.0	164.0

TABLE 4. EXPECTED AND ACTUAL FEED CONSUMPTION VALUES IN MILLILITERS AND GRAMS

	Diet numbers								
	1	2	3	4	5	6	7	8	9
Expected cons. (ml)	290	255	221	290	255	221	290	255	221
Actual cons. (ml)	245	223	213	253	278	240	249	221	223
Expected cons. (g)	126	126	126	145	145	145	164	164	164
Actual cons. (g)	111	118	125	127	155	160	138	138	160

8, 9, respectively) did not consume feed at the expected intake levels. Apparently there is a need for sufficient dietary weight to stimulate feed consumption, but excess dietary weight may actually restrict feed intake. It would appear from these data that there is an optimum dietary weight level. The feed intake data from the hens fed diets 5 and 6 indicate that dietary volume may not have as much influence upon feed consumption when combined with certain dietary weight levels as when combined with dietary weight levels above and below the optimum.

The performance data of the hens in this experiment are presented in Table 5. There are no definite trends in the production pattern to indicate that feed intake had any influence on egg production. However, it can be seen that the hens fed diets 5 and 6 were among the highest producers. There was a gain in body weight on all of the low-dietary-volume diets (3, 6, and 9). Hens on the other diets lost weight with the exception of those fed diet 5. This indicates that the two higher dietary volume levels were restricting feed intake to the point that hens could not gain weight except on the middle dietary weight level (diet 5), which appeared to be the optimum dietary weight used in this study. Even though the hens fed diet 9, which is the diet which contained the highest dietary weight and the lowest dietary volume, were able to consume enough feed to gain the most body weight, as dietary weight was increased in the high dietary volume diets (1, 4, and 7), there was a linear increase in body weight loss. Apparently both weight and volume are influencing the amount of feed that a hen can consume. Even though the birds on diet 7 lost the most body weight, egg production was maintained at one of the highest levels in the study. This fact shows the extent to which a laying hen will draw from her body stores to maintain egg production. This production rate, however, could not have been maintained over a long period of time. Had this experiment continued for a longer time, egg production of the hens fed diet 7 likely would have dropped.

The protein consumption data in Table 5 depict the same pattern that is illustrated in the feed consumption data in Table 4. It can be seen that hens fed diets 5 and 6 consumed the most protein, and were the only hens to consume more than the expected level of 16 grams. Even though these hens consumed the most protein, the efficiency of protein utilization as measured by the amount of protein required per egg was not much different than that observed with some of the other experimental diets. This is true because egg production on diets 5 and 6 was maintained at a high level. The hens fed diet 7 utilized the protein most efficiently. This is due to the fact that feed consumption was relatively low and egg production relatively high. The same efficiency picture is shown by the energy consumption and Calorie-per-egg data.

There were no obvious disadvantages to feeding polyethylene or sand to laying hens. However, it should be pointed out that no control diets were used in this experiment which did not contain polyethylene and sand. However, from past performance records, these hens apparently performed as well as could be expected for 9-month-old birds.

It should be pointed out that the measurement of the volume of feed ingredients and of mixed feeds is still in the experimental stage. Precise information on feed volume is very incomplete and the authors feel that more measurements will have to be made. The dry volume measurement will be checked against a water displacement procedure which has been worked out by Begin (1960). Future measurements will be determined by both the dry volume procedure and by the water displacement procedure.

TABLE 5. OVERALL PERFORMANCE OF HENS FED THE EXPERIMENTAL DIETS

	Diet numbers								
	1	2	3	4	5	6	7	8	9
Egg production (%)	62.7	59.2	60.2	60.7	63.2	69.5	65.2	53.6	63.7
Body wt. change (g)	−8.3	−2.9	+6.2	−12.5	+4.74	+3.18	−25.4	−3.89	+14.7
Protein cons. (g)	14.2	14.9	15.9	14.1	17.0	17.7	13.6	13.4	15.6
Protein per egg	22.6	25.2	26.4	23.2	26.9	25.5	20.8	25.0	24.6
Energy cons. (Cal.)	248	261	278	245	298	309	237	236	273
Cal. per egg	396	440	462	404	472	445	364	440	429

Summary

The data from this experiment indicate that both dietary volume and dietary weight play a part in regulating feed consumption. This is indicated not only by the feed consumption data but by the body-weight-change data. The body-weight-change data indicate that the hens would have consumed more feed had they not been restricted by dietary weight or dietary volume and in some cases by both. The normal tendency is for laying hens to consume enough feed when at all possible to maintain not only egg production but body weight as well. Since this experiment was run for a relatively short period of time and involved small numbers of birds, major conclusions cannot be drawn. However, these data indicate that a major experiment needs to be designed to study the effects of both dietary weight and dietary volume, as well as their interrelationships, upon feed intake.

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