Poultry Nutrition

Protein and Energy Intake Requirements for Laying Hens

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Story in Brief

Ration formulation techniques were utilized to provide laying hens housed in individual laying cages with graded intake levels of protein ranging from 13 to 19 grams of protein per hen per day. The recommended protein intake requirement for laying hens has been set at 16.5 grams of protein per hen per day by the National Research Council. All of the experimental rations which were fed, regardless of ration protein level, were designed to meet the recommended energy intake level of 300 kilocalories per hen per day.

In three separate feeding trials involving this approach, it was found that there were no statistically significant differences in body weight change, percent egg production, or egg weight among the hens fed the different protein intake levels. Energy intake approximated 300 kilocalories per hen per day regardless of the energy density of the laying ration which was fed. This finding establishes the fact that the energy intake requirement of the laying hens used in this series of studies was between 275 and 300 kilocalories per hen per day, and is in line with current energy intake recommendations.

The fact that egg production was equivalent regardless of protein intake indicates that the current recommendation of 16.5 grams of protein intake per hen per day may not be valid for laying hens maintained in a caged environment. It should be noted in this connection that the amino acid content of the protein which was fed in these studies contained adequate quantities of 18 individual amino acids. Care was taken in the formulation procedure to be sure that no obvious amino acid deficiencies existed. This may account in part for the results which were obtained. Under commercial feeding conditions rations may not be formulated with this degree of attention to amino acid balance.

Introduction

Economic considerations in the Poultry Industry have brought about vertical integration and a continuing effort on the part of poultrymen to reduce production costs. Several approaches are being made in an effort to systematically reduce production costs. Among these is the use of a production system in which pullet replacements are grown in cages, and laying hens are maintained in individual laying cages during their entire productive life.

As the cage system of producing market eggs evolved, it became evident that the nutrient intake requirements of growing pullets as well as laying hens were considerably different from those required by chickens grown and maintained under floor conditions. Since laying hens and growing pullets eat until their energy requirement is met, calorie to protein ratios, and calorie to vitamin and mineral ratios become of prime importance in ration formulation, if adequate intakes of all other nutrients are to be met. This has made it necessary to first study energy intake requirements as they apply to caged pullets and hens during all stages of growth and egg production, and then to determine protein, vitamin, and mineral intake requirements in relation to these energy requirements.

The objective of this project is to obtain basic data on energy intake and the interrelationships between energy and other nutrients so that these data can be used to formulate practical nutrient intake standards for use by poultrymen under commercial production conditions in Oklahoma.

Experimental Procedure

General

Three feeding trials were conducted in a windowless caged layer laboratory on the Oklahoma State University Poultry Farm. The laboratory contains 576 individual wire cages which are arranged in twenty-four blocks with twenty-four cages per block. Each cage is ten inches wide, eighteen inches long, and is equipped with an automatic waterer, a feeder, and a feed storage container. The individual feed storage containers make it possible to weigh the feed separately for each hen, and permit the individual hen to be considered as an experimental unit.

The caged layer laboratory is equipped with an evaporative cooler, furnace, air ducts, and fans to control environmental temperature and ventilation. Environmental temperature during the three feeding trials varied from a high of 90°F. in the late summer and early fall to a low

of 60°F. in the winter months. The three feeding trials were conducted over a span of three years with each feeding trial being initiated in September of one year and terminated in January or February of the following year.

The hybrid hens used in the first feeding trial were DeKalb 131s while those used in the second and third trials were H&N Nick Chicks. The age of the hens at the beginning of the feeding trials was 22 weeks for trials one and two, and 20 weeks for trial three. In all cases, the pullets were maintained in floor pens on litter during the entire growing period, and fed a series of pullet replacement grower rations developed through research at Oklahoma State University.

As the caged layer laboratory has no windows, artificial light is supplied by incandescent lights which are controlled by automatic time clocks. In all three feeding trials the laying hens received fourteen hours of continuous light and ten hours of continuous darkness until egg production reached fifty percent. At this point the length of daily light was increased by fifteen minutes each week until the laying hens were receiving seventeen hours of continuous light and seven hours of darkness each day. The laying hens remained on this lighting schedule until the end of the experiment.

Each feeding trial was divided into ten periods with fourteen days in each period. Individual body weight and feed consumption data were collected at the end of each period. In the case of the third feeding trial, body weight data were collected at the beginning of the experiment, at the end of five periods (one-half of the time on experiment), and again at the end of ten periods (when the experiment was completed). Egg production was recorded daily, and all eggs were weighed individually.

Appropriate statistical analyses were made on the data collected during each experimental period, and on the combined data for all ten periods within a given feeding trial. The following responses were involved in these analyses: feed consumption, protein consumption, energy consumption, body weight gain, percent egg production, and egg weight.

Feeding Trial 1

Eighteen experimental rations were fed in this feeding trial. Each ration was fed to twenty-four individually caged hens. The experimental rations were formulated to provide the laying hens with estimated daily protein intakes ranging from 15 to 19.25 grams in increments of 0.25 grams. All experimental rations were isocaloric and designed to provide an estimated daily energy intake per hen of 300 kilocalories of metabolizable energy.

Feeding Trial 2

Twenty experimental rations were fed in this feeding trial. Each ration was fed to twenty-one individual caged hens. The experimental rations contained four energy densities and five protein levels in a 4 x 5 factorial arrangement of treatments. The estimated daily protein intake levels per hen were 14, 15, 16, 17, and 18 grams. The daily feed intakes per hen were estimated to be 96, 106, 116, and 126 grams for the four energy densities. These estimated intakes of protein and feed were based on a daily energy intake of 295 kilocalories of metabolizable energy per hen. Dietary volume was held constant at 170 milliliters dry measure per 295 kilocalories for all of the experimental rations.

Feeding Trial 3

Twenty-four experimental rations were fed in this feeding trial with each ration being fed to twenty-four individually caged hens. These rations contained four energy densities and six protein levels in a 4 x 6 factorial arrangement of treatments. Estimated daily energy intake levels of 240, 261, 286, and 316 kilocalories of metabolizable energy were provided in the four energy densities with estimated daily feed intake at 100 grams per hen. On the basis of 100 grams of feed intake per hen per day, estimated daily intake levels per hen were set at 13, 14, 15, 16, 17, and 18 grams of protein.

Results and Discussion

Feeding Trial 1

The data for feeding trial 1 are summarized in Table 1. There were no statistically significant differences in percent egg production, egg weight, or body weight gain. Statistically significant differences in protein intake per hen per day were obtained with actual protein intake per hen per day varying from a low of 13.8 grams to a high of 18.3 grams. Differences in daily feed and energy consmption per hen were statistically significant, but were small in magnitude.

It is apparent that the hens ate until their energy requirements were met with actual energy intake per hen per day varying from a low of 266 kilocalories of metabolizable energy to a high of 317 kilocalories. Average energy intake per hen per day for all experimental rations was 288 kilocalories. Differences in feed consumption were directly related to differences in energy consumption. This is to be expected, since all of the experimental rations were isocaloric. These data indicate that 13.8 grams of protein intake per hen per day may be near the lower limit for satisfactory egg production.

Table 1. Data Feeding Trial 1.

	Experimental Ration Number																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Feed cons. per day (gm)	95	93	88	94	95	92	96	101	92	93	92	93	90	89	89	91	90	93
Energy cons. per day (Kcal)	293	288	266	281	294	286	296	313	284	287	285	289	280	276	277	280	278	288
Protein cons. per day (gm)	14.4	14.4	13.8	15.0	15.5	15.3	16.1	17.3	15.9	16.3	16.4	16.9	16.6	16.1	16.9	17.5	17.5	18.3
Percent egg production	80	78	77	78	80	79	77	79	82	77	77	80	80	80	77	79	80	79
Av. egg wt. (gm)	53	53	53	53	52	53	54	55	54	53	52	53	52	53	53	53	52	55
Body wt. gain(gm)	120	132	175	145	173	130	204	192	137	186	168	210	162	210	261	269	173	150

Feeding Trial 2

The data for feeding trial 2 are summarized in Table 2. There were statistically significant differences in feed consumption due to energy density. Actual feed consumption varied from a low of 103 grams to a high of 129 grams as ration energy density decreased. This is as expected since it has been demonstrated that the energy density of a ration exerts considerable control upon feed consumption, and hens do eat to meet a specific energy intake requirement regardless of the energy of the ration.

Actual daily protein intakes per hen were 15, 15.8, 15.1, 17.4 and 19.1 grams. These differences in actual protein intake were statistically significant. However, regardless of actual protein intake per hen per day there were no statistically significant differences in body weight gain, percent egg production, or egg weight.

Feeding Trial 3

The data for feeding trial 3 are summarized in Table 3. As had been observed previously in feeding trial two there were statistictlly significant differences in feed consumption and energy consumption per hen per day. As energy density decreased, there was an increase in feed consumption. Energy intake per hen per day varied from a low of 292 kilocalories of metabolizable energy to 326 kilocalories. Average energy consumption was 305 gilocalories per hen per day which again approximates the recommended energy intake of 300 kilocalories per hen per day. Actual grams of protein intake per hen per day were 14.1, 14.3, 14.6, 16.2, 17.3, and 17.7. As was observed in the two previous two feeding trials these differences were statistically significant and do bracket the recommended daily protein intake per hen of 16.5 grams. Again there were no statistically significant differences in either percent egg production, or average egg weight regardless of energy or protein intake. Even though there were statistically significant differences in body weight gain, all hens gained steadily during the entire experiment and the body weight gains which were made are well within the range one would expect under practical production conditions.

Conclusions and Recommendations

Laying hens apparently eat to meet a very definite daily energy intake requirement which approximates 300 kilocalories of metabolizable energy. In order to be sure that the daily intake of protein and other required nutrients are adequate, dietary levels must be related to estimated energy intake. In addition, the daily intake requirement of all nutrients must be contained in the weight and volume of feed that the

Table 2. Data Feeding Trial 2.

	Ration Energy Density				Ration Protein Levels				
	1	2	3	4	1	2	3	4	
Feed cons. per day (gm	103	110	120	129	118	116	111	114	118
Energy cons. per day (Kcal)	317	306	308	302	312	310	297	301	314
Protein cons. per day (gm)	17.2	16.6	16.5	16.3	15.0	15.8	16.1	17.4	19.1
Percent egg production	78	76	79	78	76	78	77	78	80
Av. egg wt. (gm)	51	50	52	51	50	52	51	51	52

Table 3. Data Feeding Trial 3.

	Ration Energy Density				Ration Protein Levels					
	1	2	3	4	1	2	3	4	5	6
Feed cons. per day (gm)	99	108	117	123	119	112	107	111	111	108
Energy cons. per day (Kcal)	311	308	304	295	326	306	292	304	305	294
Protein cons. per day (gm)	16.1	15.8	15.7	15.2	14.1	14.3	14.6	16.2	17.3	17.7
Percent egg production	78	80	78	77	78	76	74	81	81	79
Av. egg wt. (gm)	50	52	50	50	51	50	48	50	51	51
Body wt. gain (gm)	298	252	141	219	196	238	251	276	259	266

laying hen can and will consume under the management system being used.

The data reported in this paper indicate that the daily protein intake requirement of laying hens in cages may be less than the 16.5 grams currently recommended. Under the conditions of this series of feeding trials, ample opportunity was given to the laying hens to select daily protein intake without being restricted by excessive energy intake. The data indicate that the minimum daily intake of protein selected was approximately 14 grams. There is sufficient evidence to indicate that this level of protein intake supported egg production equally as well as did daily protein intake levels up to 19 grams.

Layer rations for use under practical feeding conditions might well be designed by poultry nutritionists to provide 14 grams of protein per laying hen per day. This would constitute a substantial saving in ingredient cost since this represents a saving in protein intake of approximately 15 percent. Care must be taken however, in the formulation procedure, to be sure that the intake requirements of 18 individual amino acids are fully met.