POULTRY NUTRITION

Efficiency of Utilization of Dietary Phosphorus By Caged Turkey Breeder Hens When Fed Rations Supplemented With Live Yeast Culture

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Story in Brief

A sixteen-week feeding trial was conducted with turkey breeder hens maintained in individual laying cages to determine the effect that live yeast culture had on the utilization of both available and total dietary phosphorus. Criteria used to measure the efficiency with which the dietary phosphorus was utilized included level of egg production, egg weight, egg specific gravity, body weight change, feed intake and reproductive performance. The sixteen experimental rations which were used contained two dietary calcium levels and four dietary phosphorus levels within each calcium level, with each calcium-phosphorus combination being fed with and without the addition of live yeast culture. Measurements were made during the course of, and at the end of consecutive four-week intervals as the sixteen-week feeding trial progressed.

The data obtained indicate that a dietary calcium level of 2.25 percent was required for a maximum response in terms of level of egg production, egg weight and egg specific gravity. The addition of live yeast culture to the breeder ration brought about an increase in egg production, egg weight and egg specific gravity, particularly at the two lower dietary phosphorus levels (available phosphorus 0.23 percent/total phosphorus 0.48 percent; and available phosphorus 0.13 percent/total phosphorus 0.36 percent). These two dietary phosphorus levels are well below those recommended for use in commercial turkey breeder rations from the standpoint of available phosphorus. A near statistically significant difference in feed intake between the breeder hens fed the live yeast culture supplemented rations and the unsupplemented rations, along with statistically significant increases in both phosphorus and calcium intake, indicate that an increased intake of calcium and phosphorus was responsible in part for these differences. However, it must be pointed out that the phytase action of the live yeast culture, as previously reported, probably converted at least a part of the phytin phosphorus to

phosphate and substantially increased the level of dietary available phosphorus. Apparently there were no differences in body weight change or reproductive performance, as measured by percent hatch of fertile eggs, among the turkeys fed the four dietary phosphorus levels.

The overall results indicate that the efficiency with which dietary phosphorus was utilized by turkey breeder hens was significantly increased by the addition of live yeast culture to the ration. Supplementation of commercial turkey breeder rations with live yeast culture could bring about a reduction in ration cost by decreasing the amount of relatively high-cost phosphorus supplement that is currently required.

Introduction

Research with broilers at the Oklahoma Agricultural Experiment Station has shown that the phytase activity in live yeast culture significantly increases the efficiency with which dietary phosphorus is utilized. This increase in efficiency of utilization is due to the fact that the phytin phosphorus in the feed ingredients of plant origin is converted by the action of the phytase to phosphate which can be readily absorbed and utilized. This action significantly increases the amount of available dietary phosphorus, and an equal amount of available phosphorus in the form of inorganic phosphorus supplements can be eliminated from the ration. This reduction in the amount of relatively high-cost phosphorus supplements becomes a significant factor in reducing overall ration cost.

A similar situation would exist insofar as the cost of turkey breeder rations is concerned provided the live yeast culture brings about an increase in the efficiency of phosphorus utilization in the same way as it was observed to do with broilers. The feeding trial reported in this paper was designed to determine if the addition of live yeast culture to a breeder ration fed to turkey breeder hens maintained in individual cages would increase the efficiency with which dietary phosphorus was utilized. In addition, some attention was directed toward dietary calcium level in order to determine if the dietary level of calcium could be substantially reduced in line with the reduction in total dietary phosphorus.

Material and Methods

One hundred forty-four turkey breeder hens which were 34 weeks of age were housed in individual laying cages. The laying cages were arranged in eight blocks with sixteen cages per block. The sixteen experimental rations which were fed were distributed at random among the sixteen turkey breeder hens within each block. This arrangement provided eight individually-fed breeder hens per experimental ration. In addition, it was possible to estimate variation in treatment response due to position within the house itself. Each individual laying cage was equipped with a feeder, an automatic water fountain and a feed container.

The sixteen experimental rations were formulated to contain dietary nutrient levels equivalent to those recommended for use under commercial production conditions with these nutrients being provided in the form of feed ingredients commonly used in commercial rations. The basal ration presented in Table 1 was modified to provide the dietary levels of calcium, phosphorus and live yeast culture as described in the discussion which follows.

Deviations from standard recommendations were made for both calcium and phosphorus. Dietary calcium levels of 2.25 and 1.5 percent were used. The dietary calcium level of 2.25 percent is the dietary level recommended for use under commercial production conditions. The dietary level of 1.5 percent represents a reduction in total dietary calcium level. This reduced dietary calcium level was included in order to provide a number of different calcium to phosphorus ratios and to determine if dietary calcium requirements would be altered in anyway under the conditions of this feeding trial.

Four dietary phosphorus levels were included. These were: available phosphorus 0.45 percent with a total phosphorus level of 0.70 percent (standard recommendation); available phosphorus 0.34 percent with a total phosphorus level of 0.59 percent; available phosphorus 0.23 percent with a total phosphorus level of 0.48 percent; and available phosphorus 0.13 percent with a total phosphorus level of 0.36 percent. These four dietary phosphorus levels were used in combination with each of the two dietary calcium levels which were previously described. The eight experimental rations formulated in this way were fed both with and without the addition of 2.5 percent of live yeast culture. Supplementation of these eight experimental rations with live yeast culture increased the total number of experimental rations to sixteen.

The sixteen experimental rations were fed to the turkey breeder hens during a feeding period of sixteen weeks. The overall feeding period was divided into four time intervals (periods) with four weeks in each period. Data were collected during or at the end of each four-week period and a statistical analysis of these data was made on a period by period basis. Measurements which were taken included feed consumption from which calcium and phosphorus consumption were calculated, body weight, egg production, egg weight, egg specific gravity and reproductive performance in terms of hatchability.

Results and Discussion

Egg production data expressed in percent by periods is presented in Table 2. There were no statistically significant differences at the 5 percent level of probability in percent egg production due to dietary phosphorus level, dietary calcium level or live yeast culture supplementation within any given period. However, there was a live yeast culture × calcium level interaction in Period 1 ($P<.16$) and Period 2 ($P<.08$); and in Period 3 the increase in egg production which was brought about by the addition of the live yeast culture was statistically significant at the 10 percent level of probability.

Table 1. Basal ration used in formulating the sixteen experimental rations

Ingredients	Percent
Tallow, feed grade	5.12
Yellow corn, ground	58.81
Soybean oil meal (44%)	23.55
Meat and bone scrap (50%)	1.67
Blood meal (80%)	1.71
Dried whey (12%)	0.68
Alfalfa meal (17%)	0.68
dl Methionine	0.11
Vitamin mix[1]	0.25
Phosphorus supplement (Ca 22%, P 18%)	1.79
Calcium carbonate	5.07
Trace mineral mix[2]	0.06
Salt	0.50

[1]Contain per pound of vitamin mix: Vitamin A 1,600,000 IU; Vitamin D_3 600,000 IU; Vitamin E 5400 IU; Menadione Sodium Sulfite Complex 400 mg; Riboflavin 1,000 mg; Niacin 3,000 mg; d-Pantothenic Acid 3,200 mg; Choline 80,000 mg; Thiamin 400 mg; Pyridoxine 400 mg; Vitamin B_{12} 1.6 mg; d-Biotin 20 mg; and Folic Acid 200 mg.

[2]Provides in the ration: Manganese 120 ppm; Zinc 80 ppm; Iron 60 ppm; Copper 10 ppm and Iodine 1.0 ppm.

Nevertheless, there were a number of real differences in percent egg production that were consistent throughout the experiment. There was some tendency for egg production to drop off as dietary phosphorus level decreased when no live yeast culture was fed. The addition of live yeast culture increased egg production at all dietary phosphorus levels, but this increase was particularly apparent at the two lower dietary phosphorus levels. The same trend was observed with both dietary calcium levels.

Thus it can be concluded that there was a substantial increase in egg production which was brought about by the addition of live yeast culture to the breeder ration. This increase was most pronounced at dietary phosphorus levels below the dietary levels recommended for use in commercial breeder rations. These data give a strong indication also that the live yeast culture is responsible for an increase in the efficiency with which nutrients other than phosphorus are being utilized. This is based upon the fact that the increase in efficiency of utilization (as measured by level of egg production) is evident even though recommended dietary levels for all nutrients are being fully met.

The egg specific gravity data and egg weight data are summarized in Table 3. There were a number of relationships among dietary calcium level, dietary phosphorus level and live yeast culture supplementation which provide evidence that these three factors were closely related to shell strength, as measured by egg specific gravity and egg weight. There was a live yeast culture × dietary calcium level interaction related to egg specific gravity in Period 2 ($P<.13$), and a dietary calcium level × dietary phosphorus level interaction in Period 3 ($P<.05$). A dietary calcium level of 2.25 percent produced an average egg specific gravity class value of 4.85 as compared to 4.46 for the dietary calcium level of 1.5 percent in Period 1 ($P<.01$), and average class values of

Table 2. Egg production data by periods in percent

Phosphorus level (percent)	Calcium level 2.25%							
	Period 1		Period 2		Period 3		Period 4	
	No LYC[1]	LYC	No LYC	LYC	No LYC	LYC	No LYC	LYC
Available 0.45/total 0.70	62.9	65.6	54.9	56.7	45.5	46.9	28.1	40.6
Available 0.34/total 0.59	62.9	62.1	50.9	56.3	41.5	52.7	42.9	47.8
Available 0.23/total 0.48	61.6	64.3	51.3	66.5	40.6	46.9	39.3	43.3
Available 0.13/total 0.36	59.4	70.1	52.2	60.7	45.5	54.9	50.9	43.8
	Calcium level 1.50%							
	Period 1		Period 2		Period 3		Period 4	
Phosphorus level (percent)	No LYC	LYC	No LYC	LYC	No LYC	LYC	No LYC	LYC
Available 0.45/total 0.70	68.8	59.8	61.2	55.8	49.6	50.4	40.6	56.3
Available 0.34/total 0.59	64.3	63.4	55.8	65.2	34.8	43.8	41.1	46.9
Available 0.23/total 0.48	62.1	62.5	60.7	55.4	52.7	52.7	64.7	48.2
Available 0.13/total 0.36	57.6	60.3	58.0	50.9	39.7	48.7	42.0	46.9

[1]Live Yeast Culture.

Table 3. Specific gravity and egg weight data

Phosphorus level (percent)	Calcium level 2.25%						
	Period 1				Period 2		
	NQO LYC[1]		LYC		No LYC		LYC
	Sp. gr.[2]	Egg wt.	Sp. gr.	Egg wt.	Sp. gr.	Egg wt.	Sp. gr.
		(g)		(g)		(g)	
Available 0.45/total 0.70	5.11	87.3	4.98	83.7	3.53	82.6	4.44
Available 0.34/total 0.59	5.20	84.0	4.89	84.6	4.22	86.7	4.74
Available 0.23/total 0.48	4.68	83.1	4.84	83.9	3.61	77.4	3.96
Available 0.13/total 0.36	4.97	80.9	4.17	86.0	3.71	76.4	4.06
	Period 3				Period 4		
Available 0.45/total 0.70	3.10	80.9	3.36	78.3	1.75	57.4	2.50
Available 0.34/total 0.59	4.25	78.7	4.31	89.9	3.91	66.7	2.89
Available 0.23/total 0.48	3.08	79.2	3.70	75.6	2.95	54.8	2.66
Available 0.13/total 0.36	3.98	90.4	3.51	90.4	2.74	65.9	2.58
	Calcium level 1.50%						
	Period 1				Period 2		
Phosphorus level (percent)	NO LYC		LYC		No LYC		LYC
	Sp. gr.	Egg wt.	Sp. gr.	Egg wt.	Sp. gr.	Egg wt.	Sp. gr.
		(g)		(g)		(g)	(g)
Available 0.45/total 0.70	4.16	83.6	4.34	83.3	4.04	87.1	3.98
Available 0.34/total 0.59	4.71	83.0	4.45	84.1	4.02	86.1	3.52
Available 0.23/total 0.48	4.65	83.6	4.29	82.2	4.24	85.9	3.35
Available 0.13/total 0.36	4.27	81.3	4.81	82.0	3.25	75.6	4.03
	Period 3				Period 4		
Available 0.45/total 0.70	3.48	79.0	3.58	76.0	1.98	43.6	3.29
Avialable 0.34/total 0.59	3.23	64.6	3.00	82.6	2.23	66.6	2.81
Available 0.23/total 0.48	3.67	88.4	3.97	85.5	3.19	87.8	2.33
Available 0.13/total 0.36	2.38	76.5	3.23	75.4	2.73	57.0	3.14

[1]Live Yeast Culture.

[2]Specific gravity expressed as follows: 1= 1.070, 2= 1.075, 3 =1.080, 4 = 1.085, 5 =1.090, 6 = 1.095, and 100.

Table 4. Phosphorus and calcium consumption data

Calcium level 2.25%

Phosphorus level (percent)	Period 1 P consumption[1] No LYC[3] T[4]	Period 1 P consumption[1] No LYC[3] A[5]	Period 1 P consumption[1] LYC T	Period 1 P consumption[1] LYC A	Period 1 Ca consumption[2] No LYC	Period 1 Ca consumption[2] LYC	Period 2 P consumption No LYC T	Period 2 P consumption No LYC A	Period 2 P consumption LYC T	Period 2 P consumption LYC A	Period 2 Ca consumption No LYC	Period 2 Ca consumption LYC
Available 0.45/total 0.70	35.7	23.0	36.3	23.5	114.9	115.1	32.6	21.0	38.4	24.9	104.9	121.6
Available 0.34/total 0.59	29.4	16.9	31.6	18.4	112.1	118.5	28.2	16.2	34.0	19.9	107.4	127.7
Available 0.23/total 0.48	24.7	11.8	27.4	13.7	115.6	123.1	26.6	12.7	29.0	14.5	124.5	130.4
Available 0.13/total 0.36	17.5	6.3	20.4	7.3	109.3	117.6	20.5	7.4	22.2	8.0	128.1	128.2
	Period 3						**Period 4**					
Available 0.45/total 0.70	35.3	22.7	38.3	24.8	113.6	121.4	34.7	22.3	39.2	25.4	111.7	124.2
Available 0.34/total 0.59	30.7	17.7	35.3	20.6	117.0	132.6	34.6	19.9	29.8	17.4	131.9	111.7
Available 0.23/total 0.48	27.2	13.1	27.8	13.9	127.7	125.2	24.2	11.6	31.9	15.9	113.3	143.5
Available 0.13/total 0.36	21.7	7.8	21.0	7.5	135.4	121.2	15.1	5.4	23.4	8.4	94.1	135.0

Calcium level 1.50%

Phosphorus level (percent)	Period 1 P consumption No LYC T	Period 1 P consumption No LYC A	Period 1 P consumption LYC T	Period 1 P consumption LYC A	Period 1 Ca consumption No LYC	Period 1 Ca consumption LYC	Period 2 P consumption No LYC T	Period 2 P consumption No LYC A	Period 2 P consumption LYC T	Period 2 P consumption LYC A	Period 2 Ca consumption No LYC	Period 2 Ca consumption LYC
Available 0.45/total 0.70	35.6	22.9	38.2	24.4	76.3	79.5	37.3	24.0	38.4	24.5	80.0	79.9
Available 0.34/total 0.59	29.8	16.9	32.5	18.7	74.4	80.0	31.1	17.6	35.0	20.1	77.7	86.0
Available 0.23/total 0.48	23.8	11.2	23.0	11.5	72.8	69.1	25.4	11.9	25.7	12.8	77.6	77.0
Available 0.13/total 0.36	17.9	6.1	20.2	7.1	70.7	75.8	19.4	6.6	21.2	7.4	76.4	79.4
	Period 3						**Period 4**					
Available 0.45/total 0.70	39.7	25.5	39.5	25.2	85.0	82.3	44.1	28.4	38.8	24.8	94.6	80.8
Available 0.34/total 0.59	30.9	17.5	34.8	20.0	77.3	85.5	31.6	17.9	32.5	18.7	79.0	80.0
Available 0.23/total 0.48	27.5	12.9	27.8	13.9	84.3	83.5	27.4	12.9	24.7	12.4	84.0	74.2
Available 0.13/total 0.36	19.0	6.5	20.8	7.3	74.9	77.9	19.6	6.7	24.4	8.5	77.6	91.5

[1]Phosphorus consumption in grams per hen per 28 day period.
[2]Calcium consumption in grams per hen per 28 day period.
[3]Live Yeast Culture.
[4]T = total phosphorus.
[5]A = available phosphorus.

3.66 and 3.32 for these two dietary calcium levels, respectively, in Period 3 ($P<.17$). A somewhat similar situation was observed insofar as egg weight was concerned. Breeder hens fed a ration which contained a dietary calcium level of 2.25 percent laid eggs which weighed 84.2 grams as compared to 82.9 grams for breeder hens fed the ration with a dietary calcium level of 1.5 percent. In addition, there was a live yeast culture × dietary calcium level interaction in Period 2 ($P<.11$).

A comparison of the egg specific gravity data and egg weight data in Table 3 in terms of live yeast culture supplementation indicates that the values for both of these measurements tend to be higher when live yeast culture is fed. The greatest differences in these values were evident with those rations which contained the two lower dietary phosphorus levels. A similar observation relating to dietary phosphorus level has been discussed previously in this paper insofar as egg production was concerned.

Thus it would appear that a dietary calcium level of 2.25 percent more nearly meets the calcium intake requirements than does a dietary calcium level of 1.5 percent. Again, as had been the case with egg production, there was a real advantage to be gained by supplementing the breeder ration with live yeast culture.

Some idea as to what was happening can be obtained from the calcium and phosphorus consumption data which are summarized in Table 4. Feed consumption figures are not presented, but there was an increase in feed consumption when live yeast culture was fed in Period 1 ($P<.11$) and Period 2 ($P<.13$). This increase in feed consumption when live yeast culture was fed resulted in a statistically significant increase in both calcium and phosphorus intake as follows: Period 1 - calcium $P<.06$, phosphorus $P<.01$; Period 2 - calcium $P<.06$, phosphorus $P<.01$; and Period 3 - phosphorus $P<.06$. However, the increase in feed consumption and the increase in the intake of available phosphorus (dietary level of available phosphorus prior to consumption) would not provide an adequate amount of available phosphorus for absorption from the intestinal tract. Since the two lower dietary phosphorus levels appeared to be equivalent to the two higher dietary phosphorus levels when live yeast culture was fed, a significant amount of the phytin phosphorus must have been converted to phosphate through the action of the phytase in the live yeast culture. This action appeared to have been complemented also by the overall effect of the live yeast culture in bringing about an increase in the efficiency with which all nutrients were utilized.

Data on body weight change and reproductive performance are not reported. However, under the conditions of this experiment there appeared to be no significant effect of treatment on these two measurements.

Based upon these data it would appear that ration cost can be reduced through the use of live yeast culture in those situations where all dietary nutrient levels are near marginal or where the amount of phosphorus supplement needs to be reduced because supplies are relatively unavailable and expensive. Cost comparisons would need to be made in each specific case in order to determine if a real saving could be made.