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Performance Comparison and Nutritional Requirements of Five Commercial Layer Strains in Phase IV

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Abstract: Five commercial white egg layer strains (Current-Bovans, Older-Bovans, Oldest-Bovans, Experimental-Bovans, and Dekalb) were used to compare performance and nutrient requirements when fed three protein levels (16.00, 14.85 and 13.99%). There were eight replicates of 15 hens (67 wk of age) for each treatment and the trial lasted 10 weeks. The results showed that there were no interactions between protein and strain on feed intake, egg production, egg mass, egg weight, feed conversion, egg specific gravity, and body weight of hens. Protein had significant effects on feed intake, egg mass, egg weight, egg specific gravity, and body weight. There were significant strain effects on feed intake, egg production, egg mass, egg weight, feed conversion and egg specific gravity. Current-Bovans had the best overall performance among the five layer strains. However, Dekalb had significant higher egg weight compared to Bovans. The best performance of Current-Bovans and Dekalb was obtained with hens fed the diet containing 16.00% protein. Current-Bovans hens required 16.5 g protein, 640 mg TSAA, 856 mg lysine, and 296 kcal ME per hen daily or 0.31 g protein, 12.00 mg TSAA, 16.07 mg lysine, and 5.55 kcal ME per g egg for the best performance. Dekalb hens required 17.8 g protein, 691 mg TSAA, 925 mg lysine, and 319 kcal ME per hen daily or 0.34 g protein, 13.04 mg TSAA, 17.45 mg lysine, and 6.03 kcal ME per g egg for the best performance.

Key words: Strain, nutrient requirements, protein, bovans, dekalb

Introduction

The Hendrix Group, the owner of Bovans White has developed several strains of Bovans White, which is the second most abundant Leghorn population in US after Hy-line W-36. Genetics are continually changing to improve performance and profits. Bateman *et al.* (2002a, 2002b, 2003) reported that there were significant strain effects on egg production, egg weight, feed consumption, and egg specific gravity among several strains in Phase I, II, and III. It is important for commercial leghorn industry to know how to feed non-molted hens during Phase IV and which strain has the best performance.

Studies have been conducted to determine the nutritional requirement of Bovans White (21-65 week). Bateman *et al.* (2002a, 2002b, 2003) reported the nutrient requirements of Bovans White hens in Phase I (21-36 week), Phase II (40-52 week), and Phase III (54-65 week). As hens get older, the nutrient requirements decrease. If the nutrient content of diets fed to old hens is the same as that of diets fed to young hens, some of nutrients may be wasted and cost of production may increase. It is important for commercial Leghorn industry to know the nutritional requirements of laying hens at different ages. No research has been done with these non-molted strains in US in Phase IV (67-76 wks). Therefore, the objective of this study was to identify which strain had the best performance among five layer strains, and to determine the nutritional requirements that allow for the best performance in Phase IV.

Materials and Methods

Four layer strains of Bovans White (Current-Bovans, Older-Bovans, Oldest-Bovans, and Experimental-Bovans), and one layer strain of Dekalb White (Dekalb) were used. Diets containing 16.00, 14.85 and 13.99% protein were formulated based on lysine (Table 1). Each of five layer strains was fed three different diets. There were eight replicates of 15 hens (67 wk of age) for each treatment and the trial lasted 10 weeks. Replicates were equally distributed into upper and lower cage level to minimize cage level effect. Three birds were housed in 40.6 × 45.7 cm cage and five adjacent cages consisted of a group. Birds in each replicate shared a feed trough and had access to drinking cups. Feed and water were supplied *ad libitum*. This experiment was conducted in a computer regulated, environmentally controlled house with an average daily temperature of approximately 26°C. A standard lighting program (14 hour light: 10 hour dark) with a light intensity of 0.5 foot candles was used. Egg production was recorded daily, feed consumption and egg weight were recorded weekly, and egg specific gravity was recorded monthly. Egg weight and egg specific gravity were measured using all eggs produced during two consecutive days. Egg specific gravity was determined using 11 gradient saline solutions varying in specific gravity from 1.060 to 1.100 with 0.005-unit increments (Holder and Bradford, 1979). Mortality was

Table 1: Ingredients and nutrient composition of experimental diets

Ingredients (%)	Diet 1	Diet 2	Diet 3
Corn	64.39	67.95	70.62
Soybean meal (48% protein)	22.52	19.56	17.35
$CaCO_3$	7.24	7.25	7.26
Hardshell[1]	2.00	2.00	2.00
Dicalcium phosphate	1.29	1.31	1.32
Poultry oil	1.61	1.01	0.56
NaCl	0.39	0.39	0.39
Vitamin Premix[2]	0.25	0.25	0.25
Mineral premix[3]	0.25	0.25	0.25
DL-Methionine	0.07	0.03	0.01
Calculated analysis (%)			
CP (%)	16.00	14.85	13.99
ME (kcal/kg)	2865.64	2865.64	2865.64
Ca (%)	4.00	4.00	4.00
AP (%)	0.34	0.34	0.34
Methionine (%)	0.33	0.29	0.26
Metionine+Cystine (%)	0.62	0.56	0.52
Lysine (%)	0.83	0.75	0.69

[1]Hardshell = large particle (passing US mesh #4 and retained by US mesh #6) $CaCO_3$ supplied by Franklin Industrial Minerals, Lowell, Florida.

[2]Provided per kilogram of diet: vitamin A, 8,000 IU; cholecalciferol, 2,200 ICU; vitamin E, 8 IU; vitamin B_{12}, 0.02 mg; riboflavin, 5.5 mg; $_D$-calcium pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; folic acid, 0.5 mg; vitamin B_1 (thiamin mononitrate), 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; vitamin K (menadione sodium bisulfate complex), 2 mg.

[3]Provided per kilogram of diet: manganese, 65 mg; iodine, 1 mg; ferrous carbonate, 55 mg; copper oxide, 6 mg; zinc oxide, 55 mg; sodium selenium, 0.3 mg.

determined daily and the feed consumption was adjusted accordingly. Body weight was obtained by weighing 3 hens per group at the end of the experiment. Egg mass and feed conversion (g feed/g egg) were calculated from egg production, egg weight and feed consumption.

Data was analyzed using general liner model procedure (PROC GLM) in SAS (2000). A 5 × 3 factorial design was used to analyze data of performance of five layer strains fed 3 diets. If differences in treatment means were detected by ANOVA, Duncan's Multiple Range Test was applied to separate means. Statements of statistical significance are based on a probability of ($P \leq 0.05$).

Results and Discussion

Feed consumption: There was no significant interaction between strain and protein on feed consumption of five layer strains (Table 2). There was a significant strain effect on feed consumption. Feed consumption of Current-Bovans was significantly lower than that of Older-Bovans, Oldest-Bovans, and Dekalb, but was similar to that of Experimental-Bovans. There were no significant differences in feed consumption among Older-Bovans, Oldest-Bovans, and Dekalb. Protein had a significant effect on feed consumption. As protein level increased from 13.99 to 16.00%, feed consumption linearly increased from 102.86 to 105.55 g/h/d, resulting in a net increase of 2.69 g/h/d. This result was in agreement with that of Holcombe *et al.* (1976), who reported that hens fed diets deficient in protein could decrease feed consumption.

Egg production: There was a significant strain effect on egg production (Table 2). Current-Bovans had egg production at 81.06%, which was significantly higher than the other three Bovans strains and Dekalb. This result was consistent with the previous reports that strain significantly affected egg production (Bateman *et al.,* 2002a, 2002b, 2003). Protein did not significantly affect egg production, and there was no significant interaction between strain and protein on egg production.

Egg mass: A significant strain effect on egg mass was observed (Table 2). Current-Bovans had the highest egg mass among five strains. Protein had a significant effect on egg mass. As protein level increased from 13.99% to 16.00%, egg mass linearly increased from 47.60 to 50.40 g, resulting in a 5.88% increase in egg mass. There was no significant interaction between strain and protein on egg mass.

Egg weight: There was a significant strain effect on egg weight (Table 2). Egg weight of Dekalb was significantly higher than that of four Bovans strains. There were no significant differences in egg weight among four Bovans Strains. Protein had a significant effect on average egg weight. Protein linearly increased egg weight from 62.35 to 64.47 g, resulting in a net increase of 2.12 g. There was no significant interaction between strain and protein on egg weight. This result was in agreement with the previous reports that egg weight was significantly affected by strain and protein (Bateman *et al.,* 2002a, 2002b, 2003).

Feed conversion: A significant strain effect on feed conversion was observed (Table 2). Feed conversion of Current-Bovans was significantly lower than that of other four strains. Oldest-Bovans had the highest feed conversion among five strains. Feed conversion was not significantly affected by protein. There was no significant interaction between strain and protein on feed conversion.

Egg specific gravity, final body weight, and mortality: There was no significant interaction between strain and protein on egg specific gravity (Table 2). Strain had a significant effect on egg specific gravity. Dekalb had the highest egg specific gravity, and Experimental-Bovans had the lowest egg specific gravity. Protein can significantly affect egg specific gravity. Hen fed the diet containing 13.99% protein had significantly higher egg specific gravity than hens fed the diets containing 14.85 and 16.00% protein. The improvement of egg specific gravity in hens fed the diet containing 13.99% protein

Table 2: Effect of strain and protein on performance of five strains (67-76 wk of age)

Factor		Feed intake (g//hen/day)	Egg production (%)	Egg mass (g/hen/day)	Egg weight (g)	Feed conversion (g feed/g egg)	Egg specific gravity (unit)	Body weight (kg)
Protein	16.00%	105.55[a]	78.18	50.40[a]	64.47[a]	2.10	1.0749[b]	1.96[a]
	14.85%	103.59[ab]	75.66	48.03[b]	63.56[b]	2.17	1.0748[b]	1.90[b]
	13.99%	102.86[b]	76.40	47.60[b]	62.35[c]	2.17	1.0756[a]	1.84[b]
Strain	Current-Bovans	101.59[b]	81.06[a]	51.03[a]	62.96[b]	2.00[d]	1.0756[b]	1.83
	Older-Bovans	105.29[a]	77.95[b]	48.94[b]	62.82[b]	2.16[bc]	1.0757[b]	1.93
	Oldest-Bovans	105.45[a]	74.65[c]	46.92[c]	62.86[b]	2.26[a]	1.0743[c]	1.91
	Exp-Bovans	101.42[b]	76.17[bc]	48.07[bc]	63.12[b]	2.12[c]	1.0732[d]	1.89
	Dekalb	106.25[a]	73.90[c]	48.43[bc]	65.54[a]	2.21[ab]	1.0765[a]	1.93
16.00% Protein	Current-Bovans	103.16	82.93	53.27	64.26	1.94	1.0751	1.89
	Older-Bovans	104.97	76.60	48.86	63.78	2.15	1.0762	1.93
	Oldest-Bovans	105.92	74.23	47.23	63.63	2.25	1.0739	1.98
	Exp-Bovans	102.26	77.90	49.69	63.83	2.06	1.0731	2.00
	Dekalb	111.44	79.26	52.95	66.87	2.11	1.0760	1.99
14.85% Protein	Current-Bovans	102.88	79.79	50.17	62.91	2.06	1.0755	1.85
	Older-Bovans	106.19	78.98	49.88	63.20	2.14	1.0751	1.94
	Oldest-Bovans	104.10	74.74	46.87	62.69	2.23	1.0740	1.91
	Exp-Bovans	101.75	74.54	47.05	63.16	2.17	1.0726	1.81
	Dekalb	103.00	70.22	46.19	65.84	2.24	1.0766	1.97
13.99% Protein	Current-Bovans	98.74	80.46	49.65	61.72	2.00	1.0763	1.75
	Older-Bovans	104.71	78.26	48.09	61.47	2.18	1.0759	1.92
	Oldest-Bovans	106.31	74.97	46.67	62.25	2.29	1.0749	1.84
	Exp-Bovans	100.23	76.07	47.46	62.37	2.12	1.0739	1.86
	Dekalb	104.30	72.22	46.14	63.93	2.28	1.0769	1.83
SEM		1.11	1.86	1.17	0.49	0.04	0.0004	0.10
ANOVA		----------	----------	----------	Probability	----------	----------	----------
Protein		0.0273	0.0931	0.0005	0.0001	0.0811	0.0120	0.0007
Strain		0.0004	0.0001	0.0010	0.0001	0.0001	0.0001	0.0730
Protein × Strain		0.0639	0.1556	0.0603	0.7291	0.6707	0.6266	0.3456

[a-d]Means within a column and under each main effect with no common superscripts differ significantly

Table 3: Nutrient requirements of five layer strains

	Current-Bovans	Older-Bovans	Oldest-Bovans	Exp-Bovans	Dekalb
Nutrients required per hen daily					
Protein (g)	16.5	15.8	17.0	16.4	17.8
TSAA (mg)	640	595	657	634	691
Lysine (mg)	856	796	879	849	925
Dietary energy (Kcal)	296	304	304	293	319
Nutrients required to produce one gram egg					
Protein (g)	0.31	0.32	0.36	0.33	0.34
TSAA (mg)	12.00	12.17	13.90	12.75	13.04
Lysine (mg)	16.07	16.30	18.6	17.07	17.45
Dietary energy (kcal)	5.55	6.23	16.43	5.89	6.03

might be due to egg weight of hen fed the diet containing 13.99% protein being significantly lower than that of hens fed the diets containing 14.85 and 16.00% protein. Protein had a significant linear effect on final body weight of hens. As protein level increased from 13.99% to 16.00%, final body weight of hens linearly increased from 1.84 to 1.96 kg, resulting in a 6.5% increase in body weight. There was no significant interaction between strain and protein on body weight. During the 10 weeks trial, total mortality was 1.37%.

Both strain and protein had significant effects on performance of laying hens. Current-Bovans had the best performance among five layer strains (Table 2). However, Dekalb had significant higher egg weight compared to Bovans. The best performance of Current-Bovans, Oldest-Bovans, Experimental-Bovans, and Dekalb was obtained with hens fed the diet containing 16.00% protein, while the best performance of Older-Bovans was obtained with hens fed the diet containing 14.85% protein. Current - Bovans hens required 16.5g protein, 640 mg TSAA, 856 mg lysine, and 296 kcal ME per hen daily or 0.31 g protein, 12.00 mg TSAA, 16.07 mg lysine, and 5.55 kcal ME per g egg for the best performance (Table 3). Current-Bovans in Phase IV required 10% more protein, 10% more TSAA, and 24% more lysine than the values recommended by NRC (1994). Compared to hens of the other three Bovans strains and Dekalb, Current-Bovans hens had the best efficiency in utilizing nutrients to produce one gram egg (Table 3). Bateman *et al.* (2002a, 2002b, 2003) reported that Bovans White hens required 19.3 g protein, 753 mg TSAA, and 1052 mg lysine per hen daily in Phase I, required 18.6 g protein, 804 mg TSAA, and 987 mg lysine per hen daily in Phase II, and required 18.2 g protein, 696 mg TSAA, and 932 mg lysine per hen daily in Phase III. The nutrient requirements of Bovans White hens in Phase IV were less than those of hens in Phase I, Phase II, and Phase III (Bateman *et al.,* 2002a, 2002b, 2003).

Dekalb hens required 17.8 g protein, 691 mg TSAA, 925 mg lysine, and 319 kcal ME per hen daily or 0.34 g protein, 13.04 mg TSAA, 17.45 mg lysine, and 6.03 kcal ME per g egg for the best performance (Table 3). Dekalb hens in Phase IV required 19% more protein, 19% more TSAA, and 34% more lysine than the values recommended by NRC (1994). Bateman *et al.* (2002a, 2002b, 2003) reported that Dekalb White hens required 20.0 g protein, 782 mg TSAA, and 1093 mg lysine per hen daily in Phase I, required 18.2 g protein, 788 mg TSAA, and 966 mg lysine per hen daily in Phase II, required 17.9 g protein, 685 mg TSAA, and 916 mg lysine per hen daily in Phase III. The nutrient requirements of Dekalb White hens in Phase IV were less than those in Phase I, Phase II, but were similar to those in Phase III (Bateman *et al.,* 2002a, 2002b, 2003).

In conclusion, protein had significant effects on feed intake, egg mass, egg weight, egg specific gravity, and body weight. There were significant strain effects on feed intake, egg production, egg mass, egg weight, feed conversion and egg specific gravity. Current-Bovans had the best performance among five layer strains. However, Dekalb had significant higher egg weight compared to Bovans. The best performance of Current-Bovans and Dekalb was obtained with hens fed the diet containing 16.00% protein. Current-Bovans hens required 16.5 g protein, 640 mg TSAA, 856 mg lysine, and 296 kcal ME per hen daily or 0.31 g protein, 12.00 mg TSAA, 16.07 mg lysine, and 5.55 kcal ME per g egg for the best performance. Dekalb hens required 17.8 g protein, 691 mg TSAA, 925 mg lysine, and 319 kcal ME per hen daily or 0.34 g protein, 13.04 mg TSAA, 17.45 mg lysine, and 6.03 kcal ME per g egg for the best performance.

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