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Research Article

Influence of Genetic Selection on Rearing Parameters and Production Performance of Two Leghorn Type Pullets, 1940 Random-Bred Control Versus W-36 (2016) Commercial Strain Grown under the Same Regimen

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Abstract

The aim of this study was to expand the period of selection history by evaluating the pullet growth characteristics of two genetic stocks of Leghorns reared under identical conditions 1940 Leghorn Strain (WL40) from the University of Arkansas and a 2016 Commercial Hy-Line W-36 (WLCC) from Hy-Line were housed in the same environment, comparing rearing production characteristics from the day of hatch until 16 weeks of age. All chicks were hatched at the Prestage Department of Poultry Science at North Carolina State University and raised in the same cage-rearing facility, with 14 birds per brooding cage then reduced to 10 birds per cage. Pullets were weighed bi-weekly, and feed weigh-backs were concurrent to determine body growth, feed consumption, and utilization. Pullet starter was fed from 0-6 weeks, a grower from 6-12 weeks, and a developer from 12-16 weeks. Diets were provided ad libitum, and mortality was recorded daily. The experiment was a randomized block design using a 2 ×3 factorial design, 2 genetic strains, and 3 dietary phase regimens and all data were statistically analyzed using a one-way ANOVA. Both strains responded similarly, showing an increase in body weights with the 2016 commercial strain exhibiting heavier weights with no significant differences ($P>0.05$) in all feed phases. Results from this data suggest that layer selection over the years had neutral adverse effects on body weights or feed conversion reared in the same environment and current commercial diet. This indicated that selection preferences for desirable traits such as body weights and feed conversion have been successfully implemented for optimal performance benefiting the 2016 pullet.

Background

There are few random-bred strains of Leghorns available and there is limited information in strain comparison with reference to rearing practices. Previous research has illustrated that rearing conditions can affect both growth and egg production. The rearing period of pullets is deemed critical and plays an important role in the successful transition to today's diverse housing systems for laying hens. According to de Haas. et al. [1] early life experiences establish long-lasting effects on the brain and body, impacting brain function, behavior, and physical health throughout the lifespan of an animal. Rearing management can also influence bird development.

Differences in both physical and social environments experienced between rearing and laying hen facilities can affect bird adaptability and productivity during the layer phase. Rearing pullets in environments that mimic future housing systems during lay is thought to ease the transition between these phases. Despite its key role, research into the rearing housing and management of pullets and its effects over a bird's lifetime has been a relatively neglected field until recently with the focus emphasized on housing systems. Of the heritable traits and characteristics, body weight and feed utilization have remained dominant for the expression of genetic differences.

The aim of this study was to expand the period of selection history by evaluating the pullet growth characteristics of two genetic stocks of Leghorns reared under identical conditions. The objective of this study included an assessment of the relationship between body weights and feed conversion within the rearing dietary phases of the different strains.

Materials and Methods

Strain and Strain Management

A total of 1500 Fertile hatching eggs for the 1940 random-bred control strain were provided by the University of Arkansas, Fayetteville, Arkansas. The 1940 random-bred control strain eggs were set with 720 hatching eggs provided by Hy-Line, NC, from a 2016 white leghorn W36 breeder flock. All chicks were hatched and grown at the Prestage Department of Poultry Science at North Carolina State University in Raleigh, NC. The chicks were hatched, neck-tagged, and subsequently placed with 14 birds per cage in a Petersime battery cage ($332cm^2$ per bird). Each cage contained 2 nipple drinkers parallel to each other and a feeder trough. Continuous light was provided at 10ftc. (100 lux) with continuous light for the first 2 days and steadily declined to 10 hr maintained ending at 16 wks of age displayed in Table 1 (Anderson, 2016). Water and feed were supplied ad libitum. The pullet rearing diets consisted of a starter, grower, and developer. The pullet starter was supplied from 0-6 weeks of age, the

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pullet grower was supplied from 6-12 weeks of age, and the pullet developer was supplied from 12-16 weeks of age. Table 2 shows the composition of diet formulations for each dietary phase. Table 3 illustrates the proximal feed analyses of each dietary phase. Pullets were beak trimmed at 9 d of age using a Lyons Precision beak trimmer with a 7/64-in. guide hole. The trim was a block cut with an approximate blade temperature of 1,100°F (dull red). Beak trimming for all birds was completed in less than 1 d. Pullets were not retrimmed at any point in the rearing period. All birds were vaccinated. All animal use and experimental procedures were approved by the NCSU Institutional Animal Care and Use Committee.

Table 1: Pullet House Light Schedule for 1940/2016 Rearing.

Age	Lux	Photoperiod (hr)
Days 1-2	10 ftc. (100 lux)	24
Day 3	1 ftc. (10 lux)	23
Week 1	1 to 0.5 flc. (10 to 5 lux)	22
Week 2	1 to 0.5 flc. (10 to 5 lux)	20
Week 3	1 to 0.5 flc. (10 to 5 lux)	18
Week 4	1 to 0.5 flc. (10 to 5 lux)	16
Week 5	1 to 0.5 flc. (10 to 5 lux)	14
Week 6	1 to 0.5 flc. (10 to 5 lux)	12
Week 7 through	1 to 0.5 flc. (10 to 5 lux)	10
Week 12	1 to 0.5 flc. (10 to 5 lux)	10
Week 13 – 16	1 to 0.5 flc. (10 to 5 lux)	10

Lighting schedule was identical for all birds through 16 weeks of age.

Diets Utilized

The assessment of the nutritional contribution to the improvement in pullet growth and efficiency was accomplished by placing both leghorn strains on the same dietary regimens that are currently being utilized in today's industry. The pullet-rearing diets were the same as those diets utilized in the 39th NCLP&MT and were delivered in mash form. Descriptions of all the diets involved are provided in Tables 2 & Tables 3-5, along with their laboratory analyses for protein, fat, fiber, and ash conducted by the North Carolina Department of Agricultural Consumer Services and Food and Drug Protection Division Laboratory. Both dietary regimens were based on corn and soybean meal.

Table 2: Composition of Diet Formulations for Rearing Periods.

Ingredient	Starter	Grower	Develop
Corn	1192.0	1172	1193.0
Soybean Meal	592.0	426.0	316.0
Wheat Midds	127.0	316.0	365.0
Limestone, gr.	34.0	37.0	80.0
Coarse Limestone			
Fat	10.0	10.0	10.0
Phosphate Mono/D	20.5	16.4	14.3
Salt	6.0	6.0	6.3
D.L. Methionine	4.1	3.1	2.9
Lysine 78.8%	1.6	2.3	2.1
T-Premix	2.0	2.0	2.0
Sodium Bi-carb	2.0	2.0	1.5
Prop Acid 505	2.0	2.0	2.0
Choline CL 60%	1.4	1.3	1.5
Hy-D 62.5 mg/lb	1.0	0.5	
Trace Min PMX[3]	1.0	1.0	1.0
L-Vitamin PMX[4]	1.0	1.0	1.0
.06% Selenium[5]	1.0	1.0	1.0
Ronozyme HI P (GT)	0.4	0.4	0.4
AMPROL 25 25%	1.0		
Total	2000.0	2000.0	2000.0
Protein %	20.0	17.6	15.5
ME kcal/kg	2926	2860	2805
Calcium %	1.00	1.00	1.80
A. Phos %	0.50	0.48	0.45
Lysine %	1.15	0.98	0.83
TSAA %	0.86	0.74	0.67

Table 3: Proximal Feed Analysis of the rearing Diets as fed.

	Unit	Starter	Grower	Developer
Dry Matter	%	90.7	90.29	90.7
Crude Protein	%	20.33	17.88	15.18
Nitrate Ion	%	0	0	0
Neutral Detergent Fiber	%	9.19	8.55	7.49
Acid Detergent Fiber	%	4.06	3.38	3.11
Non-fiber Carbohydrate	%	52.91	55.78	60.66
Fat	%	3.13	2.62	2.74
Calcium	%	1.12	1.08	1.01
Phosphorus	%	0.78	0.64	0.63
Sulfur	%	0.25	0.23	0.21
Magnesium	%	0.13	0.13	0.13
Sodium	%	0.11	0.12	0.09
Potassium	%	0.68	0.66	0.64
Copper	ppm	16	17	13
Iron	ppm	318	285	313
Manganese	ppm	144	143	123
Zinc	ppm	129	150	121
Ash	%	50.13	5.46	4.62
Aflatoxin	ppb	0	0	0

Experimental Procedures

The birds were placed into 32 Alternative Design Battery Cages in a randomized block design using a 2 × 3 factorial design, 2 genetic strains, and 3 dietary phase regimens. Cages 1-16 housed the 2016 White Leghorn Control (WLC) and cages 17-32 housed the 1940 Random-bred Control (RBC). Mortality and the BW of all mortalities were recorded daily. All birds in each replicate were group weighed according to treatment assignment bi-weekly. Feed consumption was recorded bi-weekly along with feed weigh-back to determine the feed conversion ratio (FCR). At 16 weeks of age, all pullets were transported to a grow-out facility (Figure 1).

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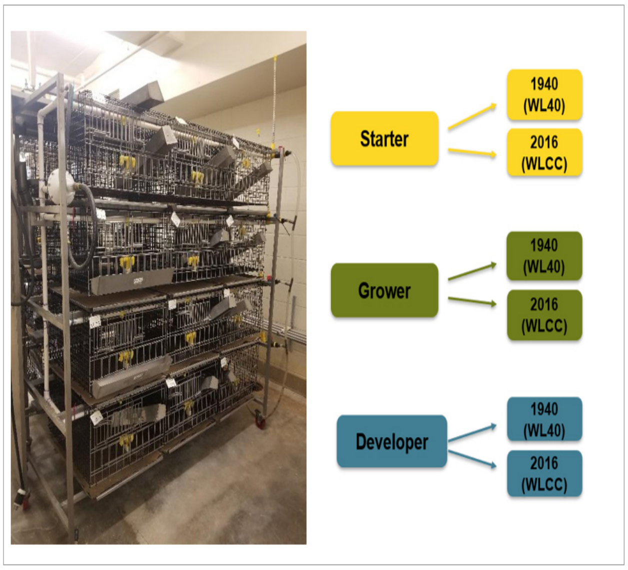

Figure 1: Experimental Design and Cage Layout.

[1] Alternative battery cage system located in Scott Hall at NCSU.

Statistical Analysis

All data were statistically analyzed using a one-way ANOVA (SAS 9.4, SAS Institute Inc., Cary NC). The data were analyzed as 0-6 wk (starter), 6-12 (grower), and 12-16 (developer). Feed conversions were analyzed for the entire rearing period. The two main effects were the 1940 WL40 and the 2016 WLCC leghorn strains and 3 dietary phases. All levels of significance were based on a probability value equal to or less than 0.05.

Results

The results are presented in two phases: the body weights (BW) of pullets from 2 weeks to 16 weeks of age and the feed consumed (FC) including feed conversion ratio (FCR); and total nutrient intake of pullets from 0 weeks to 16 weeks of age. The BW, FC, FCR, and total nutrient intake of the pullets are shown in Tables 4-7.

Body Weights

During the starter feed phase, illustrated in Table 4, both strains showed an increase in body weights over the 6-week period with the 2016 commercial strain exhibiting heavier weights with no significant differences ($P \geq 0.05$). During the grower diet phase, both strains showed an increase in body weight with the 2016 strain exhibiting slightly heavier weights. There were no significant differences between both strains during the grower diet phase ($P \geq 0.05$). During the developer diet phase, both strains showed an increase in body weight with the 2016 strain exhibiting slightly heavier weights. There were no significant differences ($P \geq 0.05$) between the strains during the developer diet phase.

Table 4: Bi-weekly Body Weights of the Hy-line W-36 and 1940 leghorn: Cage-reared.

Breed	--(Weeks of Age)--								
	0	2	4	6	8	10	12	14	16
	---(kg)---								
Hy-Line W-36	0.04	0.095	0.231	0.396	0.556	0.739	0.841	1.088	1.185
1940 Leghorn	0.029	0.068	0.186	0.332	0.491	0.658	0.745	0.963	1.036
SEM	0.027	0.031	0.042	0.048	0.053	0.065	0.069	0.071	0.074
p-value	0.059	0.181	0.208	0.364	0.523	0.698	0.793	1.025	1.103

[1] Significant differences ($P \leq 0.05$) within both strains are noted by different letters among columns of means

Feed Consumption

Bi-weekly feed consumption per strain, determined in Table 5, shows variations but no significant differences. Comparisons of feed efficiency, demonstrated in Table 6, were determined by FCR which is feed intake/body weight gain. There were no significant differences between the strains. On the contrary, the 2016 strain exhibited a higher feed conversion in comparison to the 1940 strain during weeks 2 and 4. However, during the remainder of the rearing period, the 1940 strain exhibited a higher feed conversion when compared to the 2016 strain. Total feed nutrient intake, livability, and flock uniformity are outlined.

Similarities were exhibited in both strains for protein, met energy, lysine, and TSAA. Those same similarities were observed for livability and flock uniformity having no significant differences.

Table 5: Bi-weekly Feed Consumption of the Hy-line W-36 and 1940 leghorn: Cage-reared.

Breed	-------------------------(Weeks of Age)-------------------------------							
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16
	---------------------------------------(kg per bird)-----------------------------------							
Hy-Line W-36	1.43	1.89	1.51	1.56	1.00	1.00	0.53	0.23
1940 Leghorn	1.37	1.79	1.60	1.68	0.95	1.12	0.47	0.32
SEM	0.031	0.061	0.037	0.041	0.037	0.052	0.038	0.026
p-value	0.156	0.184	0.271	0.169	0.313	0.204	0.572	0.273

[1] Significant differences ($P \leq 0.05$) within both strains are noted by different letters among columns of means.

Table 6: Total Nutrient Intake, Livability, and Flock Uniformity of the Hy-line W-36 and 1940 leghorn: Cage-reared

Breed	Protein	Met. Energy	Lysine	TSAA	Livability (1-112 d)	Flock Uniformity
	------------------(per bird to 112 days)-------------- (kg) (kcal) (g) (g) (%)					(% of pullets within ±10% of x)
Hy-Line W-36	1.051	12,158	43	33	99.9	96
1940 Leghorn	1.013	12,032	42.5	32	99.8	90.75
SEM	0.004	50.39	0.018	0.013	0.041	0.037
p-value	0.239	1.724	0.337	0.381	0.519	0.792

[1] Significant differences ($P \leq 0.05$) within both strains are noted by different letters among columns of means

Discussion

Variations in body weight can be attributed to genetic differences which can affect individual performance. Pullets are typically reared in groups according to their body weights in order to achieve improved performance within the flock. Genotype potentially has the ability to affect the body weights of poultry birds according to Korver et al., [2]. A study conducted by Gonzales et al. [3] supported this claim further explaining that strains have different genetic potentials equipped for growth [3]. Contrary to the thoughts related to growth, there were no significant effects of the rearing environment on growth performance and feed conversion throughout the dietary phases presented in this current study. One of the major criteria for identifying strains of high performance is through feed conversion. Previous research conducted by Rondelli et al. [4], Taha et al. [5] reported significant differences in the feed conversion of different chicken strains, however, no differences were observed displaying a reduction in feed conversion in this current study suggesting that the strains used were more genetically alike [4,5]. Both strains consumed around the same amount of feed throughout the rearing phases. It should be noted that the diets of each treatment group were nutritionally equal. As the

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rearing period progressed, a reduction in FCR in both the 1940 strain and 2016 strain was observed and could be related to potential lower maintenance requirements required by the pullets. These requirements could be due to a rapid growth increase in the proportion of energy used for growth relative to maintenance. Genetic selection can also be a factor determining the effects of the amount of feed required for maintenance as well as body size. This study indicates that selection over the years of layers had little effect on developmental body weights or feed conversion when reared in the same environment using current commercial diets, thus indicating that selection preferences for desirable traits such as body weights and feed conversion have been successfully implemented for optimal performance. The results from this data suggest that the selection of these layers over the 70+ years was focused on uniformity rather than body weights which did impact feed conversion of the pullets reared in the same environment and current commercial diets. This study indicates that selection preferences for desirable traits such as body weights and feed conversion have been successfully implemented for optimal performance subsequently in the layer phase [6-10].

Conclusion and Applications

a) Genetic selection for egg production does not appear to have altered pullet development during any of the rearing phases though the 1940 leghorn was consistently smaller [11-16].

b) Feed consumption using modern commercial diets was similar.

c) Understanding the interplay of nutrition and selection on production is important in that it may allow the industry to identify a pathway to improve nutrition and or understand genetics in pullets.

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