

Changes in the performance of turkeys -1966 to 2003

A comparative study has revealed the remarkable changes that genetics and nutritional management have played in developing commercial turkeys since the 1960s.

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The performance of commercial turkey populations has changed dramatically over the past 50 years.

Recently the author and a number of his colleagues conducted a study to compare the performance of our modern turkey strains with that of a random-bred strain that was developed in 1966 and which has been bred at random without growth rate or any other form of selection since that time. The random-bred used (*i.e.* the RBC2) was initiated in 1966 (Nestor *et al.*, 1967) using two of the most popular white-feathered commercial strains at the time. It continues to be maintained at the Ohio Agricultural Research and Development Centre. The primary objective of the study was to compare the relative performance of the RBC2 versus composite pens of the three primary turkey breeds when placed during 2003 when they were grown on dietary regimens that were representative of what was being fed to commercial turkeys in 1966 and 2003.

The study was designed to measure the relative contribution of genetics and nutritional management to the changes in production and processing traits during the 37-year period from 1966 to 2003.

Table 1. 2003 feeding program and calculated analyses of the diets

Diet code	T03-1	T03-2	T03-3	T03-4	T03-5	T03-6	T03-7	T03-8
Wks. fed for toms	1-2	3-4	5-6	7-8	9-10	11-13	14-16	17+
Approx. amt. (Kg/tom)	0.4	1.0	2.0	3.5	5.0	6.0	7.0	Mkt.
Wks fed for hens	1-2	3-4	5-6	7-8	9-10	11-13	14-16	17+
Approx. amt. (Kg/Hen)	0.3	0.8	12.0	1.8	2.5	3.7	5.0	Mkt.
Feed form	Fine	Course	Pellet	Pellet	Pellet	Pellet	Pellet	Pellet
<i>Calculated analysis</i>								
kcal ME/kg	2950	2950	3000	3100	3250	3350	3400	3550
C. Protein, %	27.5	26.5	25.5	23.5	21.5	20.0	18.0	14.5
Lysine, %	1.80	1.70	1.65	1.45	1.35	1.20	1.05	0.85
Met + Cys., %	1.20	1.15	1.10	1.00	0.95	0.90	0.80	0.60
Threonine, %	1.15	1.10	1.00	0.90	0.80	0.70	0.60	0.50
Calcium, %	1.45	1.40	1.30	1.20	1.15	1.10	1.00	0.85
NPP, %	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.45
Sodium, %	0.18	0.18	0.18	0.20	0.20	0.22	0.22	0.22

Materials and methods

The study consisted of a 2 x 2 x 2 factorial arrangement of treatments with 4 replicate blocks of the 8 treatment pens. That is, two strains (RBC2 vs. modern), the two sexes (toms and hens), and two dietary regimens were used that were thought to be representative of what was being fed to turkeys in 1966 and 2003. All treatment pens for the modern strain consisted of a composite of 5 birds each of Nicholas, BUTA, and Hybrid turkeys.

The 1966 diets were based on those published by Ensminger (1967) who stated that they were representative of diets being fed in that year. The modern diets were designed by NC State nutritionists based on current field experience as to the types of diets that were being fed in early 2003. For the 2003 dietary regimen, both starter diets were fed as crumbles, and all grower and finisher diets were fed as pellets. All diets for the 1966 dietary regimen were fed as mash, with the starter being fed from 0 to 56 d (days), the grower from 57 to 112 d, and the finisher from 113 to 196 d of age. The 2003

dietary regimen was fed as 7 different rations by two-week periods from hatch to 98 d of age. The 2003 finisher diet was fed from 99 through 196 d of age. The modern 2003 diets were fed as crumbles for the first four weeks, and as pellets, thereafter. Water and feed were supplied for *ad libitum* consumption. The calculated analyses of the two sets of diets are provided in *Tables 1 & 2*. Body weight, feed consumption and cumulative mortality were measured at 2-week intervals from hatch to 112 days of age and at 4-week intervals from 112 to 196 days of age. Relative changes in the yield of the carcass without giblets, body parts and offal were calculated from weight data taken at 112, 140, 168, and 196 days.

Results and discussion

For reasons that are not totally clear, the growth rate of all of the turkeys used in this study was below normal. The RBC2 was 15 to 20% lighter in weight than its sib flocks in Ohio (Nestor, 2004), and the modern strain was 7% above and 9% below year 2003 field flocks at 116 and 20

weeks of age. This was largely due to the fact that North Carolina experienced an extremely hot humid spring and summer throughout the time when these birds were 10 to 28 weeks of age.

The *body weights* for some of the ages measured are provided in *Table 3*. Using the average BW for both sexes for the modern strain on the modern feed, ver-

Table 2. Year 1966 turkey and feeding program*, with mash fed throughout.

Feed code	T66-1	T66-2	T66-3
Diet	Starter	Grower	Finisher
Weeks of age fed	0 - 8 wks	9 -16 wks	17 wks - Mkt
<i>Calculated analysis</i>			
kcal ME/kg	2,800	2,930	3,000
Crude protein, %	29.0	22.0	17.0
Lysine 5	1.72	1.14	0.80
Methionine + Cystine, %	0.92	0.69	0.57
Calcium, %	1.47	1.28	1.35
NPP, %	0.69	0.58	0.77

* From Ensminger (1967).

Table 3. Average strain body weights of modern 2003 and 1966 Rando bred turkeys when fed representative 1966 and 2003 diets by strain, diet, sex and age

Strain1	Diet2	Age (days)				
		56	112	140	168	196
2003	2003	4443	11987	13986	15923	17389
2003	1966	3022	10564	13762	16923	17682
1966	2003	2234	5515	6829	8263	9218
1966	1966	1699	5600	7258	8730	9511
Pooled SEM*		47	116	168	256	437

* Pooled Standard Error of the Mean

Figure 1. Modern 2003 (left) and 1966 RBC2 toms at 6 weeks of age



Figure 2. Modern 2003 vs 1966 RBC2 toms, 2003 diet



sus the old strain on the modern feed, the modern 2003 strain was approximately twice as heavy (i.e. 2.17, 2.05, 1.93, and 1.89 times) as the 1966 RBC2 at 112, 140, 168, and 196 days of age (Figure 1). The BW data also indicated that tom weights have increased by 186, 208, 227, and 241 g/year, and hens weights have increased by 164, 179, 186, and 205 g/year at 112, 140, 168, and 196 days of age, respectively, over the past 37 years. This is a somewhat more than what the worldwide field data collected and summarised by Ferket (2003) show, which indicates that tom weights at 126 days of age increased at a rate of 195 g per year from 1966 to 2003.

Feed efficiency was approximately 20% better in the 2003 tom turkey on the 2003 feed (2.638) than in the RBC2 tom on the 1966 feed (3.278) at 20 weeks of age. Feed efficiency to 25 lbs or 11 kg of body weight in the 2003 toms (2.132 at 98 days of age) was approximately 50% better than in the RBC2 toms (4.208 at 196 days of age). The number of days to reach that weight was halved during this period.

Roles of genetics and nutrition

Sherwood (1977), and Havenstein et al. (1994, 2003) reported that about 85 to 90% of the change in broiler performance from 1957 until the years they conducted their comparisons have been brought about due to the genetic selection practiced by commercial broiler breeding companies, and that the other 10 to 15%

has come about from changes in nutrition and nutritional management. One cannot reach such a clear conclusion from the data in this turkey study. The strains and sexes reacted very differently to the two dietary regimes over the course of the experiment. Table 3 summarises the relative differences in response to the two dietary regimens. Both sexes of both strains performed much better on the 2003 diets from hatch to 4 to 6 weeks of age than on the 1966 diets. Thereafter, with the exception of the modern hens, the birds on the 1966 diets began to perform better than those on the 2003 diets.

After 9 to 10 weeks of age (mid-May) it became very hot and humid and the birds on the 1966 diet which contained higher protein and lower energy started performing better than those on the higher energy/lower protein modern diets. It appears that the birds consuming the modern high energy diets reduced their intake as an adaptive measure to minimise their heat stress, and consequently the reduced protein intake limited their growth. In contrast, the birds consuming the 1966 diet containing lower energy and higher protein were able to consume more feed during heat stress, and therefore enough protein and other nutrients to support greater weight gain. This is not too surprising, since Veldkamp et al. (2002) recently reported that turkeys modulate feed intake when exposed to high ambient temperatures in relation to the caloric density of the diet.

Follow-up studies need to be conducted better understand how to feed market turkeys under high ambient temperatures. Thus, from this study, the answer one would give as to whether nutrition and nutritional management has improved performance during the past 37 years (i.e. from 1966 to 2003) is clearly dependent upon the age and the ambient temperature under which the measurement was taken.

Carcass yield

Carcass yield was calculated as the percentage of live weight following overnight feed withdrawal. Comparing the yield of the 2003 strains fed on the modern diet with the old RBC2 on the modern 2003 diet, showed increases of 6.0, 7.5, 6.0, and 6.7% in total carcass yield at 112, 140, 168, and 196 days of age over the 37-year period from 1966 to 2003. Most of the increase in overall carcass yield was due to the increase in percent breast yield, and specifically in the yield of the pectoralis major muscle (Figure 2). Comparing the total breast yield of the modern turkeys on the 2003 diet with that of the RBC2 on the 2003 diet shows differences of 4.5, 4.8, 5.8, and 6.3% in total breast yield at 112, 140, 168, and 196 days of age. Thus, the increase in breast yield is about 81 to 82% of the change in total carcass yield over the past 37 years in turkeys. The change in the

pectoralis major muscle showed differences of 3.9, 4.4, 5.8, and 6.3% at the same ages. Thus, one can conclude that changes in the pectoralis major muscle alone accounted for about 89% of the change in total breast meat, and about 73% of the overall change in carcass yield. Thigh yield has increased by 0.65% and femur yield has decreased by 0.35% over this period.

Summary and conclusions

The performance of modern market turkeys produced in 2003 was compared with that of random-bred turkeys started in 1966, when grown using representative 1966 and 2003 diets.

Growth rate to market age has approximately doubled during the 37 year period, from 1966-2003. The weights of toms and hens have on the average been increasing by approximately 208 and 140 g per year during that period at an average of 22 wk of age.

Feed efficiency was approximately 20% better in the 2003 tom turkey on the 2003 feed (2.638) than in the RBC2 tom on the 1966 feed (3.278) at 20 weeks of age. Feed efficiency to 25 lbs or 11 kg of body weight in the 2003 toms (2.132 at 98 days of age) was approximately 50% better than in the RBC2 toms (4.208 at 196 days of age). The number of days to reach that weight was halved during this period.

Carcass yield has increased by approximately 6.5% during the 1966 to 2003 period, a change of about 0.18 percent/year.

Total breast yield has improved by an average of 5.35% over this period, which is about 81-82% of the change in total carcass yield.

The yield of the pectoralis major muscle increased by approximately 4.7% during this time frame, indicating that the change in that one muscle alone accounts for about 87% of the change in total breast meat, and about 71% of the overall change in total carcass yield.

Thigh meat yield has increased by only 0.65% during this time period, while the portion of live weight represented by the femur bones has decreased by 0.35% during the 1966-2003 period. Relative leg support has not kept up with the increase in overall body weight, and may be contributing to the increased incidence of leg abnormalities that the industry is experiencing. From this study, the answer one would give as to whether nutrition and nutritional management has improved turkey performance during the past 37 years appeared to be dependent upon the age and ambient temperature under which the study was conducted. Birds on the high energy/low protein modern diets did well early in life, but those on the lower energy/higher protein 1966 diets performed better under the high ambient temperatures that were experienced during the second half of the current study. ■

References available on request