Research Note

Growth performance and carcass characteristics of female turkeys as affected by feeding programs

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ABSTRACT A trial was conducted to evaluate the effects of different feeding programs on growth performance and carcass characteristics of Nicholas Large White female turkeys. Three different feeding programs were considered for a 12-wk period: 1) 3 diets fed for 4 wk each (starter 24% CP, grower 20% CP, and finisher diet 16% CP), 2) 2 diets fed for 6 wk each (starter-grower 22% CP and grower-finisher diet 18% CP), and 3) no change of diet for 12 wk (starter-grower-finisher diet 20% CP). From 0 to 4 wk of age, birds were fed an ad libitum common starter diet. Each dietary treatment was replicated 3 times, and feed and water were provided ad libitum. Body weight and feed consumption were measured every 2 wk, whereas carcass characteristics were evaluated at 16 wk of age. Feed intake increased as the frequency of dietary changes decreased, and feed conversion was not different between programs 1 and 3. There were no significant differences in final BW among experimental groups. For a single feeding program, the proportion of neck, bone, and feet decreased, and a greater percentage of edible meat was registered as compared with the other 2 groups. Mean carcass, breast, and thigh weights of turkeys reared under multiple diets were not different compared with other groups. Positive correlations were noted between live weight and weight of carcass, breast, thigh, drumstick, wing, and abdominal fat of turkeys. Thus, a single cycle feeding regimen in Nicholas Large White female turkeys results in similar growth performance and carcass characteristics compared with other conventional feeding programs considered in the present study.

Key words: turkey, feeding program, growth, carcass characteristic

2009 Poultry Science 88:805–810
doi:10.3382/ps.2008-00082

INTRODUCTION

Turkey meat is an excellent protein source and has a good price-quality ratio (Roberson et al., 2003). It is very important to know the factors influencing the productive performance of this species, the yield and quality of the carcass (Nestor et al., 2005). Breed, sex, and slaughtering age influence carcass characteristics of turkeys (Brake et al., 1994; Waldroup et al., 1997; Roberson et al., 2003). However, feeding techniques, and in particular changes of diet during the different stages of growth, have received limited consideration. Diet substitution is a commonly accepted principle of poultry nutrition to meet protein and energy requirements in relation to the different periods of growth (NRC, 1994). Larbier and Leclercq (1994) and the NRC (1994) suggested that diet should be changed every 4 wk to meet more closely the nutrient requirements of turkey. Nevertheless, the effect that such feeding technique produces on the growth performance and carcass characteristics of turkeys remains controversial.

Dunkelgod et al. (1961) and Waibel (1976) reported that the efficiency of diet variations was directly proportional to the frequency of changes. Salmon et al. (1982), working with male and female Large White turkeys, found that the frequency of changes in protein content had little influence on growth rate, feed efficiency, and energy utilization, even though frequent adjustments in the diet improved its protein efficiency. A practical feeding technique should represent a compromise between the nutritional requirement of the animals and management needs, thus balancing poultry performance and economic yield. If meat-type turkeys are fed a single diet of average composition instead of a multiple diet feeding program, then theoretically the protein level of the single diet would be lower than that recommended when the birds are young, and higher than recommended levels as the birds get older. Ideally, growth restriction could be accomplished through the use of fewer diets to reduce early growth and thus metabolic disorders. Therefore, the objective of the

Received February 22, 2008.
Accepted November 20, 2008.
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present study was to determine the effects of 3 different feeding programs on the growth performances and carcass characteristics of female Large White Nicholas turkeys.

MATERIALS AND METHODS

Birds and Management

Forty-five 1-d-old Nicholas Large White female turkey poults were obtained from North Italian commercial hatcheries in the summer of 2007. The birds were raised in battery brooders situated in windowless rooms with temperature maintained at 32°C for the first 7 d with the minimum temperature reduced 2.8°C/wk to 18°C. Incandescent lights supplemented natural daylight to provide 23 h of light daily (0100 to 2400 h). Until the beginning of the experiments at the specified ages, all birds received an ad libitum-fed starter diet that contained 27% CP and 2,990 kcal of ME/kg of diet, designed to satisfy the recommendations of the NRC (1994). At 4 wk of age, poults were identified with numbered tags affixed on the wing web and divided into 3 homogeneous experimental groups of 15 birds with the aid of a computer algorithm equalizing both average BW and variance. At 30 d of age, turkeys were distributed into 3 rooms, each containing 3 pens (5 birds/3.50 m^2).

Dietary Treatments

Dietary treatments were randomly assigned within each of the 3 blocks of replicate pens within each room. Birds were fed different, nearly isocaloric, diets for an experimental period of 12 wk (Table 1). Turkeys of group 1 were fed 3 experimental diets containing decreasing CP level: starter 24% CP, grower 20% CP, and finisher diet 16% CP. These diets were changed every 4 wk. The turkeys of group 2 received 2 experimental diets: the first diet was administered in the first 6 wk and its CP content (22%) was equal to the mean CP levels of starter and grower diets utilized in group 1; the second diet was given in the remaining 6 wk and its CP content (18%) was equal to the mean CP levels of grower and finisher diets of group 1. Finally, a single diet was obtained by the dilution in equal proportions of starter, grower, and finisher diets of group 1, with a CP content of 20%, and was given to group 3 for 12 wk. Experimental diets were provided ad libitum, and water was also provided freely throughout the experimental period. Every 2 wk, from 30 to 114 d of age, individual live BW and feed intake were recorded to calculate live BW gain and feed conversion efficiency. Mortality was recorded as it occurred.

Processing Procedures

At 16 wk of age, birds were taken off feed for 12 h and water for 2 h and a final BW was recorded. The birds were then manually caught and crated in plastic crates such that each crate contained 5 birds. These birds were transported less than 0.2 km to the processing facility. All 15 birds from each dietary treatment were electrically stimulated with a device consisting of conventional shackles suspended above a 1% NaCl solution bath. The device was wired such that, when the turkeys were hung from the shackles and their heads immersed in the salt water, electric current flowed through the birds from head to feet. Birds were stimulated during bleeding with a fixed voltage of 150 V of alternating current intermittently (2 s on, 1 s off) for 1 min. Current during the stimulation phases varied from 115 to 125 mA per bird. Immediately after stunning, the birds were killed by bleeding for approximately 180 s until death from a single unilateral neck cut severing the right carotid artery and jugular vein. After bleeding, turkeys were scalded for 120 s at 63°C in an air-agitated commercial scalder and plucked for 30 s in a commercial inline plucker. After the head, shanks and feet, and feathers were removed, the carcass was eviscerated. Abdominal fat, which consisted of fat surrounding the gizzard, proventriculus, and in the abdominal body cavity, was removed and weighed immediately. The weight of giblet (heart, liver, and gizzard) was also measured. Eviscerated carcass (with neck and the end of wing) without giblet was weighed to determine hot dressed yield. The carcasses were fast-cooled in a tunnel (−2°C/2 $m\cdot s^{-1}$/90% RH) for 2 h and kept in a refrigeration chamber (0°C/85% RH) until deboning (approximately 24 h postmortem). The carcasses were weighed and dissected into the following portions: head, neck, wing, breast, tail back, thigh, drumstick, claws, and abdominal fat. The breast and thigh were further dissected into lean meat, skin, and bone, as described by Jensen (1983).

Meat Cutup

Meat cutup was done after cooling for 24 h at 4°C. The pH 15 min postmortem ($\mathbf{pH_{15}}$) and pH 24 h postmortem ($\mathbf{pH_{24}}$, after carcass deboning) were measured directly on the pectoralis major muscles with a portable pH meter (HI9023, Hanna Instruments, Padova, Italy) equipped with a pH electrode (FC 230B, Hanna Instruments). Samples of breast and thigh meat were analyzed according to AOAC methods (AOAC, 1990) to evaluate their chemical composition.

Statistical Analyses

All data were analyzed by the ANOVA option GLM of SAS/STAT software (SAS Institute, 1999), utilizing the following statistical model: $Y_{ijk} = \mu + A_i + B_{j(i)} + E_{ijk}$, where Y_{ijk} = experimental observation; μ = overall mean; A_i = the fixed effect of the group (i = 1, 2, 3); $B_{j(i)}$ = the fixed effect of diet (j = 1, 2, 3) nested within group; and E_{ijk} = random error. The PDIFF option of least square means (LSMEANS) was used to obtain

Table 1. Composition of experimental diets of turkeys reared under different feeding programs

	Feeding program[1]					
	1			2		3
Item	30 to 58 d	59 to 86 d	87 to 114 d	30 to 72 d	73 to 114 d	30 to 114 d
Ingredients	%					
Ground maize	50.00	61.50	73.00	55.75	67.25	61.50
Soybean meal (48% CP)	31.50	27.00	22.50	29.25	24.75	27.00
Extruded soyabean	8.00	4.00	0.00	6.00	2.00	4.00
Corn gluten	4.00	2.00	0.00	3.00	1.00	2.00
Dicalcium phosphate	2.00	2.00	2.00	2.00	2.00	2.00
Soybean oil	1.50	0.75	0.00	1.13	0.38	0.75
Monocalcium phosphate	1.00	0.70	0.40	0.85	0.55	0.70
Calcium carbonate	0.90	0.90	0.90	0.90	0.90	0.90
Vitamin-mineral premix[2]	0.50	0.50	0.50	0.50	0.50	0.50
Sodium chloride	0.20	0.23	0.25	0.21	0.24	0.23
DL-Met	0.18	0.12	0.06	0.15	0.09	0.12
L-Lys HCl	0.02	0.08	0.14	0.05	0.11	0.08
Coccidiostat	0.05	0.05	0.05	0.05	0.05	0.05
Chemical analysis						
CP, %	24.03	22.03	16.19	21.97	18.06	20.03
Crude fat, %	6.25	4.66	3.59	5.41	4.34	4.66
Crude fiber, %	3.26	3.14	2.90	3.32	3.03	3.14
Ash, %	7.78	6.42	5.70	7.04	6.41	6.42
Calculated analysis						
ME (kcal/kg of diet)	3,003	3,002	3,001	3,002	3,001	3,002
Lys, %	1.42	1.18	0.95	1.30	1.07	1.18
Met, %	0.58	0.46	0.34	0.52	0.40	0.46
Met + Cys, %	0.90	0.78	0.66	0.84	0.72	0.78
Ca, %	1.32	1.16	1.00	1.24	1.08	1.16
Available P, %	0.63	0.56	0.48	0.59	0.52	0.56

[1]Feeding programs: 1 = 3 changes of the diet; 2 = 2 changes of the diet; 3 = no change of the diet.

[2]Supplied per kilogram of diet: vitamin A, 12,500 IU; vitamin D_3, 4,000 IU; vitamin E, 40 mg; vitamin B_1, 2 mg; vitamin B_2, 5 mg; vitamin B_6, 4 mg; vitamin B_{12}, 0.02 mg; vitamin PP, 40 mg; vitamin K_3, 4 mg; folic acid, 0.7 mg ; pantothenic acid, 11 mg; biotin, 0.1 mg; choline chloride, 800 mg; $MnSO_4$, 150 mg; $FeSO_4$, 50 mg; $ZnSO_3$, 60 mg; $CuSO_4$, 35 mg; KI, 1.25 mg; $CoSO_4$, 0.2 mg; Na_2SeO_3, 0.2 mg.

t-tests for mean comparison (SAS Institute, 1999). Significant differences were based on $P < 0.05$ and $P < 0.01$.

RESULTS AND DISCUSSION

The present study showed that changes in dietary patterns produce a final live BW (about 7.5 kg) that is typical for marketing demand but that differences among them were nonsignificant, which is similar to other reports (Salmon et al., 1982). The daily feed and nutrient intake of turkeys on varying feeding programs are presented in Table 2. No case of mortality occurred during the experimental period. A nonsignificant increase ($P = 0.08$) in feed consumption was associated with a decrease in the number of feeding program and dietary CP levels. In particular, birds receiving 22 and 18% CP diets (group 2) tend to consume more feed than those of only 20% CP diets (group 3) and 24, 20, or 16% CP (group 1) diets. The greater feed intake for birds with higher-CP diets was found by Sengar (1987) but opposite to the report of Waldroup et al. (1990) in which low-CP diets significantly depressed appetite.

Mean daily BW gain of turkeys reared under different feeding programs is presented in Table 2. The decrease in the diet changes was associated with an increase ($P < 0.05$) in daily BW gain of turkeys. However, BW gain of birds fed on different feeding programs was not significantly different between groups 1 and 3 ($P = 0.13$). Decreasing the change of diets from 3 to 1 did not improve BW gain of birds throughout the experimental periods. In another study, Schutte (1987) reported that the decrease in performance of birds fed the 16% CP diet was minimal when supplements of all essential amino acids, at levels equivalent to that present in the 20% CP diet, were provided.

Average feed conversion ratio of turkeys was lower ($P < 0.01$) in birds of groups 1 and 3 than in those of group 2. The average feed conversion of birds from 30 to 114 d of age is in agreement with Havenstein et al. (2007), who compared the performance of 1966- vs. 2003-type turkeys when fed representative diets.

Mean carcass characteristics and associated traits of Nicholas Large White female turkeys reared under different feeding programs are presented in Table 3. Although eviscerated carcass weights of birds of experimental groups 1 vs. 3 were not different, the carcass weight of group 2 was significantly ($P < 0.05$) greater than the other 2 groups. Relative breast weight (as percentage of the chilled carcass weight) of birds reared under the 3 different feeding programs was not different.

Reducing the number of diets fed was associated with increased ($P < 0.05$) live, hot carcass, and chilled car-

Table 2. Growth performance and nutrient intake of turkeys reared under different feeding programs

Item	Feeding program[1] 1	2	3	SEM
BW (kg/bird)				
30 d	1.137	1.136	1.127	0.11
44 d	2.029	2.018	1.894	0.20
58 d	3.321[a,A]	3.272[b]	2.983[c,B]	0.28
72 d	4.530[a,A]	4.421[b]	4.122[c,B]	0.31
86 d	5.350	5.550	5.430	0.32
100 d	6.601[b]	6.983[a]	6.622[b]	0.43
114 d	7.511	7.860	7.638	0.44
BW gain (g/d)				
31 to 44 d	64[a]	63[a]	55[b]	0.85
45 to 58 d	92[A]	89[A]	77[B]	0.87
59 to 72 d	86	82	81	0.91
73 to 86 d	56[C]	80[B]	94[A]	0.86
87 to 100 d	89[b]	102[a,A]	85[B]	1.02
101 to 114 d	65	63[b]	73[a]	0.91
31 to 114 d	76[b]	80[a]	77[b]	0.67
Feed conversion (g/g)				
31 to 44 d	2.13[A]	2.06[A]	2.38[B]	0.04
45 to 58 d	2.16	2.18	2.26	0.03
59 to 72 d	2.63[A]	3.43[C]	2.97[B]	0.06
73 to 86 d	3.85[C]	3.06[B]	2.77[A]	0.09
87 to 100 d	3.31[A]	3.42[A]	3.75[B]	0.05
101 to 114 d	3.77[A]	4.26[B]	3.80[A]	0.06
31 to 114 d	2.98[A]	3.07[B]	2.98[A]	0.02
Feed intake (g/d)				
31 to 114 d	222	245	233	27.8
CP intake (g/d)	46.06	49.07	46.67	0.77
Lys intake (g/d)	2.63	2.90	2.75	0.21
Met intake (g/d)	1.02	1.13	1.07	0.09
ME (kcal/d)	666.4	735.5	699.5	18.2

[a–c]Means within a row with no common superscript differ significantly ($P < 0.05$).

[A–C]Means within a row with no common superscript differ significantly ($P < 0.01$).

[1]Feeding programs: 1 = 3 changes of diet; 2 = 2 changes of diet; 3 = no change of diet.

Table 3. Carcass characteristics of turkeys at 16 wk of age reared under different feeding programs

Item	Feeding program[1] 1	2	3	SEM
BW (kg)	7.511	7.860	7.638	0.44
Processing BW (kg)	7.302[b]	7.685[a]	7.429[b]	0.38
Hot carcass weight (kg)	6.203[b]	6.508[a]	6.281[b]	0.31
Chilled carcass weight (kg)	6.028[b]	6.363[a]	6.131[b]	0.29
	% of processing BW			
Blood	2.93	2.67	2.86	0.46
Feathers	5.61	5.53	5.40	0.61
Intestine	3.99	3.97	4.01	0.22
Giblets (gizzard, liver, heart)	3.02[b]	3.05[b]	3.16[a]	0.17
Warm dressing out	84.95	84.68	84.52	0.52
Cooling weight shrink	2.81[a]	2.24[b]	2.38[b]	0.11
Component yields[2] (%)				
Head	1.94	1.90	1.81	0.12
Neck	4.12	4.06	3.92	0.21
Wings	12.06[a]	11.48[b]	11.63[b]	0.39
Breast	33.43	33.59	33.96	1.05
Back	9.54	9.72	9.41	0.59
Thigh	13.91[A]	12.62[B]	13.61[A]	0.72
Drumstick	11.77	11.82	11.68	0.62
Abdominal fat	0.85	0.95	1.05	0.08
pH_{15}[3]	6.73[a]	6.74[a]	6.63[b]	0.15
pH_{24}[3]	6.19[A]	6.12[B]	6.02[C]	0.13

[a,b]Means within a row with no common superscript differ significantly ($P < 0.05$).

[A–C]Means within a row with no common superscript differ significantly ($P < 0.01$).

[1]Feeding programs: 1 = 3 changes of diet; 2 = 2 changes of diet; 3 = no change of diet.

[2]Component yields were calculated as percentage of the chilled carcass weight.

[3]pH_{15} = pH 15 min postmortem; pH_{24} = pH 24 h postmortem.

Table 4. Breast and thigh composition of turkeys reared under different feeding programs

Item	Feeding program[1] 1	2	3	SEM
Reconstituted breast weight (kg)	2.007	2.025	2.066	0.21
	(% of breast)			
Lean	85.25	84.09	85.66	0.26
Bone	11.72	11.91	10.52	0.22
Skin	3.03[b]	4.00[a]	3.82[a]	0.11
Reconstituted thigh weight (kg)	0.837[a]	0.785[b]	0.854[a]	0.09
	(% of thigh)			
Lean	81.52[A]	77.90[B]	81.68[A]	2.79
Bone	12.77[a]	12.92[a]	11.44[b]	1.67
Skin	5.71[c]	9.18[a]	6.88[b]	2.31

[a–c]Means within a row with no common superscript differ significantly ($P < 0.05$).

[A,B]Means within a row with no common superscript differ significantly ($P < 0.01$).

[1]Feeding programs: 1 = 3 changes of diet; 2 = 2 changes of diet; 3 = no change of diet.

cass weight. Moreover, by increasing the number of diets fed, there was a numerical increase in abdominal fat deposition ($P = 0.09$). This observation is consistent with the report of Marks (1990) that faster-growing birds deposit more fat than their slower-growing counterparts. Wang et al. (1991) reported positive correlations between feed consumption and abdominal fat in broiler sire and dam populations. Other related studies using broiler-type guinea fowl (Nahashon et al., 2005) reported a positive and significant correlation between abdominal fat weight and BW. Feeding program did not affect head, neck, back, or drumstick weights. In contrast, significant differences ($P < 0.05$) were obtained in weight (as percentage of chilled carcass weight) of wings in group 1, which was greater compared with the other groups, and thigh of groups 1 and 3, which showed the greatest yield ($P < 0.01$). The pH_{15} and pH_{24} values in the pectoralis major muscles of turkey carcass sampled are reported in Table 3. The mean internal muscle pH_{15} and pH_{24} were within the range of those observed on pectoralis major by El Rammouz et al. (2004) and Fraqueza et al. (2006).

The mean breast muscle weight did not differ among birds fed multiple diets (Table 4). However, mean breast weight was numerically greater in birds fed on a single diet (group 3) than those of groups 1 and 2. This confirms that changes in breast development can produce transformation in the growth of other muscles as reported by Crouch et al. (2002).

There were no significant differences between the feeding programs for lean breast meat and bone fractions. However, a smaller percentage of skin ($P < 0.05$) was observed in turkeys receiving more frequent diet changes (group 1), which was probably due to more fat associated with the skin. Mean thigh weight of turkeys fed on different feeding programs was different ($P < 0.05$); in particular, thigh weight was greater in birds fed on a single feeding program (group 3). The feeding program with a moderate frequency of diet changes (group 2) produced less lean meat ($P < 0.01$) and more skin ($P < 0.05$) in the thigh compared with the other programs (Table 4). The greatest percentage of lean meat was registered in the breast and thigh of the turkeys of group 3 ($P < 0.01$).

Table 5. Chemical composition of breast and thigh meat

Item	Feeding program[1] 1	2	3	SEM
Breast composition (%)				
Moisture	70.63[A]	70.47[a]	69.37[Bb]	0.98
CP	24.51[C]	25.41[B]	26.67[A]	1.04
Crude fat	1.73	1.65	1.91	0.62
Ash	1.38[A]	1.30[B]	1.22[B]	0.07
N-free extract	0.85	1.17	1.77	0.58
Thigh composition (%)				
Moisture	72.05[a]	70.68[b]	70.96[b]	1.42
CP	20.07[c]	21.04[b]	22.14[a]	1.08
Crude fat	4.77	5.86	5.35	1.37
Ash	1.31[A]	1.27[A]	1.12[B]	0.07
N-free extract	0.81	1.14	1.38	0.70

[a–c]Means within a row with no common superscript differ significantly ($P < 0.05$).

[A–C]Means within a row with no common superscript differ significantly ($P < 0.01$).

[1]Feeding programs: 1 = 3 changes of diet; 2 = 2 changes of diet; 3 = no change of diet.

The chemical analysis on breast and thigh meat composition is presented in Table 5. Birds of group 3 showed the greatest CP content in breast ($P < 0.01$) and thigh ($P < 0.05$) respective to other dietary treatments. More frequent dietary changes led to an increase of breast ($P < 0.01$) and thigh ($P < 0.05$) moisture and to a decrease ($P < 0.01$) of ash muscle content compared with birds fed a single diet.

As a result in this study, the use of a single diet rather than multiple diets does not seem to worsen the growth performance and carcass characteristics in modern turkeys. Therefore, if further large-scale trials confirm these results, there may be reason to further explore the extent of the value of single vs. multiple diets.

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