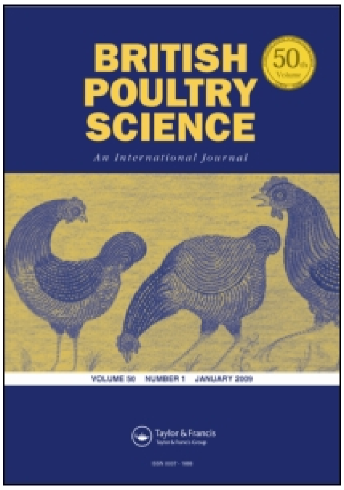

British Poultry Science
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713408216

Growth, slaughter and gastrointestinal tract traits of three turkey genotypes under barn and free-range housing systems

M. Sarica [a]; N. Ocak [a]; N. Karacay [a]; U. Yamak [a]; C. Kop [a]; A. Altop [a]
[a] Department of Animal Science, Ondokuz Mayis University, Faculty of Agriculture, Samsun, Turkey

Online Publication Date: 01 July 2009

To cite this Article Sarica, M., Ocak, N., Karacay, N., Yamak, U., Kop, C. and Altop, A.(2009)'Growth, slaughter and gastrointestinal tract traits of three turkey genotypes under barn and free-range housing systems',British Poultry Science,50:4,487 — 494
To link to this Article: DOI: 10.1080/00071660903110919
URL: http://dx.doi.org/10.1080/00071660903110919

British Poultry Science Volume 50, Number 4 (July 2009), pp. 487–494

Taylor & Francis
Taylor & Francis Group

Growth, slaughter and gastrointestinal tract traits of three turkey genotypes under barn and free-range housing systems

M. SARICA, N. OCAK, N. KARACAY, U. YAMAK, C. KOP AND A. ALTOP

Department of Animal Science, Ondokuz Mayis University, Faculty of Agriculture, Samsun, Turkey

Abstract 1. This study was conducted to assess the impact of genotype and outdoor access (and gender when appropriate) on growth rate and carcass yield.

2. One slow-growing genotype (Bronze; B, $n = 129$), a commercial fast-growing genotype (Hybrid; H, $n = 186$) and a medium-growing genotype (crosses; H × B, $n = 78$) were housed (straight-run) for 21 weeks of age. Each genotype was assigned to 3 pens of 20–23 birds each and raised in indoor floor pens in a curtain-sided house with ventilation fans; the B, H and H × B genotypes were also assigned to 3, 4 and 2 floor pens ($2\,m^2$ approximately) with outdoor access (during daylight hours), respectively. All animals were fed *ad libitum* a commercial diet and birds were commercially processed. After reaching the commercial live weight at 17 and 21 weeks of age, 4 birds (two females and two males) per replicate were slaughtered to determine the yields of carcass, breast, and thigh, abdominal fat and edible inner organs. Gastrointestinal tract characteristics such as length and weight of whole gut were analysed.

3. No significant interaction between genotype and housing systems was observed. Significant differences were found for all traits among genotypes. The live weight was higher in H and H × B genotypes from 7 to 15 weeks and from 7 to 21 weeks of age compared to B genotype, respectively. The live weight of H genotype was higher than that of H × B genotype from 15 to 21 weeks of age. The carcass weight and yield, and the relative weights of the edible inner organs and whole gut, and the relative length of whole gut were significantly affected by genotype and sex of birds. Differences in growth performance, relative weight of breast meat, wings or thighs between birds raised on barn or free-range were negligible. In conclusion, while the development in growth performances was related to strain, the traits at slaughter were related to both strain and sex, and were unaffected by housing system.

INTRODUCTION

The development in organic livestock production can be attributed to an increased consumer interest in organic products while, at the same time, increased farmers' interest in converting to organic production methods-often stimulated by governmental support or subsidies (Sundrum, 2001; Rodenburg *et al.*, 2008). It is important that organic production systems can fulfill the expectations of each of these stakeholders if organic livestock production is to increase further (Rodenburg *et al.*, 2008). In the regulations for organic farming, the aspect of allowing a high degree of natural behaviour of the livestock is, among others, translated in the requirement that livestock, in certain periods of their life or of the year, should be allowed to graze or have access to an outdoor area. The most common outdoor systems for poultry used in intensively managed organic production have some significant drawbacks in relation to environmental impact (risk of N-leaching and ammonia volatilization), animal welfare, high mortality in poultry and workload and management constraints (Hermansen *et al.*, 2004; Von Borell and Sørensen, 2004).

In organic agriculture, poultry are traditionally kept in free-range system, and this system is enrichment for the poultry and provides several advantages for them. However, like organic

Correspondence to: M. Sarica, Ondokuz Mayis Universitesi, Ziraat Fakultesi, Zootekni Bolumu Kurupelit, 55139 Samsun, Turkey. E-mail: msarica@omu.edu.tr

Accepted for publication 14th January 2009.

ISSN 0007–1668(print)/ISSN 1466–1799 (online)/09/040487–8 © 2009 British Poultry Science Ltd
DOI: 10.1080/00071660903110919

production, free-range production does not have a detailed definition, thus the amount and type of outdoor access provided in both organic and free-range production systems varies (Fanatico *et al*., 2005). On the other hand, the increase in use of free-range housing systems is correlated with more infections, losses through predation, local overuse and possibly over-fertilization of pasture (Zeltner and Hirt, 2003). However, bird density in conventional poultry, including turkey housing systems directly affects bird welfare as well as productive indexes (Lima and Naas, 2005; Sarica *et al*., 2007).

Most natural and organic poultry production in most parts of World utilizes the same fast-growing broiler genotype used in conventional production systems (Fanatico *et al*., 2005) although use of slow-growing genotypes, which are suitable for outdoor production and the gourmet market, is an essential requirement in the *Label Rouge* program (Lewis *et al*., 1997; Westgren, 1999; Fanatico *et al*., 2005). However, the suitability of fast-growing poultry, including turkeys or the comparison of fast and slow-growing genotypes for profitable outdoor or free-range production has not been reported. A better understanding of the factors such as growth and performance of specialty birds, including genotype, age, sex, diet, stocking density, environment, exercise, and pasture intake and their interactions (Fanatico *et al*., 2005) will help improve performance in free-range production, in which unpredictable conditions may result in variation in the size of dressed carcasses and parts. Moreover, Fanatico *et al*. (2005) and Horsted *et al*. (2005) reported that substantial growth performance and yield differences exist among broiler genotypes in alternative poultry systems. On the other hand, from experience of such systems, it is argued that there is a need for a radical development of the systems. Also, there is no clear definition of the best housing conditions for free-range production in Turkey. Besides, the productive indexes are rather conflicting when compared to conventional production. Therefore, the objective of this research was to evaluate growth performances, slaughtering yields and gastrointestinal traits of three genotypes of turkeys (Bronze; B, Hybrid; H and crosses; H × B) in two systems of housing: conventional (barn, totally confined) and free-range (partially confined).

MATERIALS AND METHODS

This trial was conducted at the University of Ondokuz Mayis, Agricultural Faculty Research Farm from May to October 2007. All procedures were approved by the local Ethical Committee of Ondokuz Mayis University for Experimental Animals. Three genotypes were compared in this study and were categorized with regard to the approximate time required to reach a market weight of 5–14 kg. The genotypes included slow-growing (Bronze, B), medium-growing (Hybrid × Bronze cross-genotype, H × B), and a commercial fast-growing (Hybrid Converter from Canada, H) genotypes, which were raised to 21 weeks of age. In designing the trial, it was decided that a final live weight (approximating an appropriate live weight for the specialty poultry market) of each genotype was desirable. All genotypes were compared in indoor confinement (Barn) and in outdoor access as free-range (partially confined). All poults were hatched at the University Poultry Research Farm and vaccinated for Marek's disease, infectious bronchitis, TRT and Newcastle disease.

All poults were assigned to randomly 18 floor pens (1·5 × 3·0 m) on wood shavings in an environmentally controlled experimental unit with 23 h fluorescent lighting and 1 h dark. The poults were fed a commercial starter diet based on corn, soybean meal and fish meal (260 g crude protein with 12·1 MJ ME per kg diet) from one day old to 8 weeks of age. Temperature of the experimental unit was maintained at 32 ± 1°C during the first week and gradually decreased to 21°C by third week and the relative humidity was maintained within a range of 60–70%.

A total of 393 poults (mixed-sex) were allocated randomly into 6 experimental groups according to a 2 × 3 factorial arrangement for two housing systems (barn and free-range) and three turkey genotypes (B, H and H × B). Each genotype was represented in 3 replicate indoor pens, and the B, H and H × B genotypes were also assigned to 3, 4 and 2 replicate pens with outdoor access respectively, containing 20–23 poults each (129, 186 and 78 poults per B, H and H × B genotype, respectively). The facility was a curtain-sided house with a concrete floor and was equipped with fans for ventilation and cooling. A thermostatically controlled heater was used, and gas brooders along the length of the house provided additional heat during brooding. Indoor pens measured 3·5 × 3·5 m and contained one waterer and two hanging tube feeder. For free-range treatments, outdoor access from these pens was provided after 7 weeks of age during daylight hours through a single doorway measuring 50 × 90 cm. The outdoor pens each measured 14 × 3·5 m. Birds were confined to indoor pens at night. Indoor pens and pens with outdoor access were interspersed in the same building with pens randomly assigned. All pens contained new pine wood shavings, and 23, 20 and 16 h of light was provided to 7, 12 and 21 weeks of age, respectively. All birds were fed the same

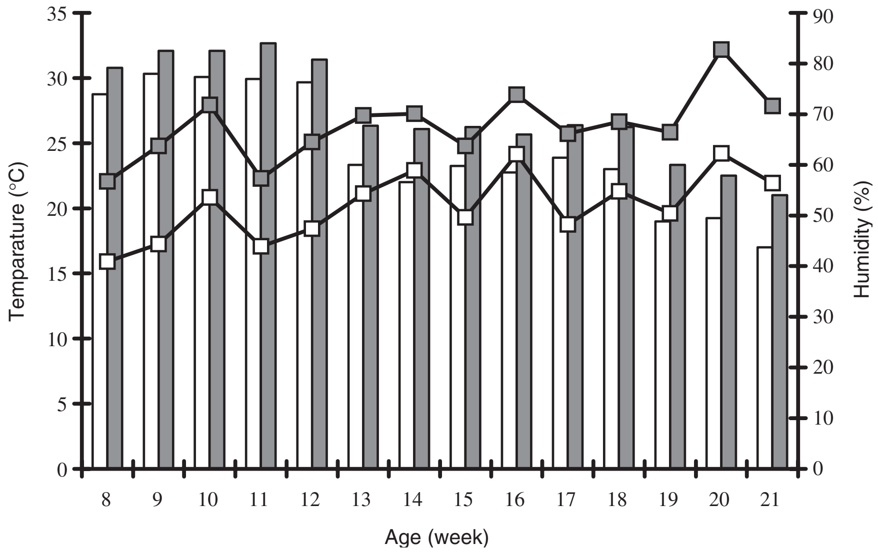

Figure 1. *Average weekly environmental readings during the experiment. The bars show temperature (□) outdoors and (■) indoors, while the lines show humidity (□) outdoors and (■) indoors.*

commercial diets based on corn and soybean meal with 190 g CP and 13·0 MJ ME and 140 g CP and 13·4 MJ ME per kg diet from 8 to 12 weeks of age and from 13 to 21 weeks of age, respectively. Access to feed and water was freely available, and all diets were formulated to contain adequate nutrient levels as defined by the NRC (1994). Average weekly temperature and humidity outdoor and indoor during the experiment are presented in Figure 1.

Turkeys and feed were weighed at 9, 11, 17 and 21th weeks for determination of weight gain, feed intake, and feed efficiency. Weight gain and feed efficiency were adjusted for mortality and birds slaughtered at 17 and 21 weeks of age. The analysis of weight, weight gain and efficiency did not include the effect of gender because the poults were fed as mixed sex groups. All birds were commercially processed at the slaughterhouse of Agricultural Faculty. Feed was withheld for 10 h before slaughter, and turkeys were weighed individually at the plant, where they were identified as male or female. Automated equipment was used for scalding, picking, vent opening, and evisceration. Birds were scalded at 53°C for 120 s. Carcasses were prechilled at 12°C for 15 min and chilled (immersion) at 1°C for 45 min. After being chilled, the carcasses were aged on ice for 6 h, and chilled weight was recorded and separated for their components parts. Yields of carcass, breast, back, wings, legs (thighs and drumstick) were recorded (Hahn and Spindler, 2002). The gastrointestinal tract, from the oesophagus to the anus, and organs were carefully excised. Any digesta remaining in the whole tract were emptied by gentle pressure. Empty weights of the proventriculus and gizzard, and the weight of pancreas, heart and liver and also, edible inner organs (heart + liver + gizzard) were recorded. Weight and length of the whole tract was recorded. Carcass yield (dressing percentage), weight and length of the digestive tract, and weight of edible inner organs were expressed as a percentage of live weight (LW) just before slaughter (g/100 g LW), and carcass parts were expressed as a percentage of the chilled carcass weight (CW) without giblets (g/100 g CW).

Data were analyzed using the GLM procedure (SPSS Inc. 1999, Release 10·0). Live weight, feed intake, feed conversion ratio and carcass characteristics were studied by analysis of variance, including the effects of housing system and genotype and their interaction. Therefore, data were analysed in a randomized blocks design as factorial arrangements of treatments. When the F-test was significant, treatment means were compared using Duncan's multiple range tests. Single df contrasts were used to test overall effects of gender or age (when appropriate). While the gender number within each treatment was used as covariates in the statistical analysis of live weight, it was used as a factor in that of carcass and gastrointestinal tract characteristics. When the interaction effects of factors (housing system, genotype, gender and age) on any of the studied parameters were not significant, these were not shown in the tables and vice versa. All percentage data were transformed by taking arcsine square roots prior to analysis. Mortality was analyzed by chi-square. The level at which differences were considered significant was $P < 0{\cdot}05$.

RESULTS AND DISCUSSION

Effect of genotype

In speciality turkey production, as in conventional production, market live weights (kg) of

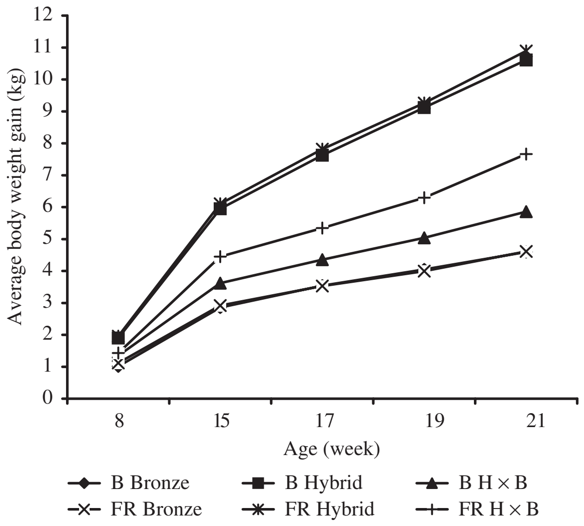

Figure 2. *Average cumulative live weight gains of three turkey genotypes under barn (B) and free-range (FR) housing systems*

hybrid and bronze genotypes respectively are typically 16 (F female) to 19 (M male) and 7 (F) to 12 (M), which result in 11 (F) to 14 (M) and 4 (F) to 8 kg (M) dressed birds. Fast-growing turkeys have been selected for rapid early growth and reach this market weight in about 14–16 weeks, whereas slow-growing turkeys usually take 20 to 22 weeks to reach market weight depending on their diets (Clayton *et al*., 1994; Turkoglu *et al*., 2005). The present study was conducted as a first effort to characterize strains of medium-growing turkeys as a potential meat birds in alternative systems. The growth rates of genotypes studied under the conditions of the present experiment were accurately estimated: the B, H and H × B birds did not reach a very similar market weight in 17 or 21 weeks, respectively (Figure 2). From 8 to 21 weeks of age, H genotype grew faster ($P < 0{\cdot}05$) than B and H × B genotypes, and H × B genotype grew faster ($P < 0{\cdot}05$) than B birds (50·6 vs. 118.3 and 75·2·0 g/day, respectively). Therefore, differences in feed intake and feed efficiency were associated with the growing rate (Table 1). The B and H genotypes had the highest and lowest ($P < 0{\cdot}05$) feed intakes and, consequently, the lowest and highest ($P < 0{\cdot}05$) feed efficiencies, respectively. These results are similar to those reported by Fanatico *et al*. (2005), Horsted *et al*. (2005) and Santos *et al*. (2005) who noted that in both the conventional production system and the system with outdoor access, the fast growing broilers have more efficient growth and feed efficiency.

Mortality can have a large impact on profitability. Previous work has shown higher mortality in fast-growing birds compared with slow-growing birds (Lewis *et al*. 1997; Castellini *et al*., 2002*a*). In the present study, all treatments had less than 5% mortality although the H × B birds (4·55%) had a higher mortality compared to the B genotype (0·00%), but not the H genotype (3·08%).

Carcass weight and yields of breast, back, wings, thighs and drumsticks are presented in Table 3. In each housing system, the H genotype had the highest overall carcass yield, while B genotype had the lowest overall carcass yield as a percentage of live weight ($P < 0{\cdot}01$). Breast meat is usually of most interest in most part of the world, where it is preferred over dark meat. The H genotype had higher yield of breast meat, but had lower yields of thigh meat and wings compared to the B and H × B birds ($P < 0{\cdot}01$). The breast meat yield of H × B genotype was higher than those of B birds ($P < 0{\cdot}01$). These results confirm findings in the broilers (Fanatico *et al*., 2005). Dark meat or thigh meat yields may also be of interest in poultry niche markets. As reported by Fanatico *et al*. (2005) the whole-bird market is important for specialty birds because consumers may be looking for the cooking experience of roasting the entire bird.

Because a similar statistical trend between carcass and carcass parts was found at each 17 and 21 weeks of age, differences in yield were most likely maximized (Table 3). Sarica *et al*. (2007) found the B and H × B genotypes to be active and moderately active, respectively compared with the inactive H birds in both housing systems. Thus, these findings support ideas that it is clear that genotype has an impact on live conformation and that when weight gain is reduced, breast meat yield suffers more than dark meat yield (Fanatico *et al*., 2005). Such a situation may result in a lower ratio of white to dark meat, which is usually a disadvantage in most part of the world, even if the value of dark meat may be higher in specialty poultry than it is in conventional broilers.

Effect of production system

Production systems with outdoor access have many factors, such as temperature, photoperiod and light intensity, which are not controlled and are inherently variable. Furthermore, broilers raised outdoors have access to pasture and the various forages, insects, and worms, which may be available (Fanatico *et al*., 2005). Free-range housing systems did not have an effect on weight gain, feed intake and feed efficiency. These results are consistent with those reported by Fanatico *et al*. (2005) who noted that outdoor access did not have an effect on weight gain, feed intake and feed efficiency in broilers. It was expected that the performance of birds with outdoor access would be inferior to that of birds in a more controlled environment because the outdoor birds would be exposed to fluctuating

Table 1. *The live weights, feed intakes and feed efficiencies of different turkey genotypes reared at different housing systems*

Housing systems	Genotype	Feed intake (g)		Feed efficiency (g feed:g gain)	
		Age (week)			
		8 to 17	8 to 21	8 to 17	8 to 21
	B	13 481[c]	20 637[c]	3·81	4·49[a]
Barn	H	27 919[a]	44 564[a]	3·63	4·16[b]
	H × B	18 006[b]	26 681[b]	3·96	4·41[a]
	B	13 480[c]	20 536[c]	3·80	4·44[a]
Free-range	H	27 528[a]	42 486[a]	3·52	3·90[b]
	H × B	19 034[b]	29 771[b]	3·59	4·02[b]
SEM		542·5	852·3	0·05	0·04
Main effects					
Housing systems		NS	NS	NS	*
Genotype		**	**	NS	**

[a,b,c]Means within a column lacking a common superscript differ (NS: $P > 0·05$, *$P < 0·05$, **$P < 0·01$). B, Bronze; H, Hybrid; H × B, Hybrid × Bronze cross-genotype; SEM, Standard error of the mean.

Table 2. *The slaughter weights (g), edible inners organs, abdominal fat and gastrointestinal characteristics (g or cm/ 100 g LW) of different turkey genotypes reared at different housing systems*

Housing system	Genotype	Sex	Slaughter weight	Carcass yield	Edible organs	Abdominal fat	Gut weight	Gut length
17 weeks of age								
Free-range	B	M	6057	70·5	4·2	0·6	8·3	5·3
		F	4010	69·6	4·7	2·0	9·3	6·9
	H	M	11 468	78·0	2·9	1·7	5·8	3·0
		F	9493	78·2	3·0	3·4	6·0	3·8
	H × B	M	9500	76·7	3·0	1·1	6·4	3·6
		F	5600	74·5	3·9	2·4	7·5	5·7
Barn	B	M	6037	71·6	3·9	0·9	7·2	4·9
		F	4120	72·4	4·4	1·7	8·2	6·7
	H	M	11 650	78·1	3·0	1·5	5·8	3·1
		F	9920	77·5	2·9	3·1	5·8	3·7
	H × B	M	7370	74·6	3·6	1·1	6·7	4·3
		F	6000	74·8	3·5	3·7	6·6	5·3
21 weeks of age								
Free-range	B	M	7690	72·3	3·8	1·7	7·7	4·0
		F	4890	71·1	4·3	3·5	8·4	5·5
	H	M	16 648	80·0	2·3	1·7	4·3	2·2
		F	10 885	77·5	2·6	4·6	5·1	2·8
	H × B	M	11 140	76·9	3·2	1·9	6·3	3·2
		F	7625	75·7	3·7	3·4	6·7	4·0
Barn	B	M	7470	73·7	3·9	1·8	7·3	4·2
		F	5063	73·3	4·0	3·4	7·6	5·2
	H	M	16 558	80·5	2·4	1·6	4·2	2·2
		F	10 675	77·9	2·7	3·8	5·1	3·0
	H × B	M	10 595	77·5	3·1	1·4	5·3	3·2
		F	7845	77·4	3·3	4·4	5·8	3·7
SEM			117·2	0·20	0·04	0·05	0·07	0·04
Main effects								
Age			**	**	**	**	**	**
Housing system			NS	*	NS	**	NS	NS
Genotype			**	**	**	**	**	**
Sex			**	**	**	*	*	*
Age × Genotype			**	NS	NS	**	*	*
Age × Sex			**	NS	NS	*	NS	*
Housing system × Genotype			NS	*	NS	NS	*	NS
Genotype × Sex			**	NS	*	NS	NS	**
Housing system × Genotype × Sex			NS	NS	NS	*	NS	NS
Age × Genotype × Sex			**	NS	NS	NS	NS	*

(NS: $P > 0·05$, *$P < 0·05$, **$P < 0·01$). B, Bronze; H, Hybrid; H × B: Hybrid × Bronze cross-genotype; SEM, Standard error of the mean.

Table 3. *The carcass weight (g) and parts cut-up characteristics (g/100 g CW) of different turkey genotypes reared at different housing systems*

Housing system	Genotype	Sex	Carcass weight	Breast	Back	Wing	Thighs	Drumsticks
17 weeks of age								
Free-range	B	M	4272	28·8	15·20	13·7	16·6	14·2
		F	2792	29·1	15·91	13·3	17·1	13·7
	H	M	8942	35·0	15·65	11·6	16·7	12·3
		F	7428	34·0	15·91	12·3	16·6	12·1
	H × B	M	7286	33·4	14·87	13·1	16·4	13·2
		F	4172	31·7	15·56	12·8	16·9	13·2
Barn	B	M	4324	29·2	15·37	13·6	16·4	13·4
		F	2982	29·3	15·83	13·2	16·6	14·0
	H	M	9094	34·4	15·10	11·9	16·3	13·0
		F	7683	34·6	15·42	11·4	16·7	12·0
	H × B	M	5494	29·4	16·39	14·3	15·9	13·8
		F	4489	29·8	16·66	11·8	17·3	13·2
21 weeks of age								
Free-range	B	M	5557	29·7	15·0	12·1	16·3	13·1
		F	3477	29·7	16·8	12·4	16·5	13·0
	H	M	13 323	38·2	13·8	10·0	15·2	11·7
		F	8438	36·5	16·1	10·6	16·8	11·0
	H × B	M	8571	33·0	14·4	11·4	16·0	13·1
		F	5768	32·7	15·9	11·6	16·4	12·6
Barn	B	M	5507	29·0	14·8	12·7	16·3	13·7
		F	3710	29·0	16·5	12·3	17·1	13·5
	H	M	13 337	37·1	13·9	10·2	15·6	12·5
		F	8312	36·3	15·6	10·6	16·5	11·7
	H × B	M	8210	33·2	12·5	11·6	15·1	12·9
		F	6075	32·4	17·1	10·8	17·0	12·1
SEM			98·2	0·15	0·11	0·11	0·06	0·06
Main effects								
Age			**	**	*	**	**	**
Housing systems			NS	NS	NS	NS	NS	**
Genotype			**	**	NS	**	*	**
Sex			**	NS	**	NS	NS	**
Age × Genotype			**	**	NS	NS	NS	NS
Housing system × Genotype			NS	NS	NS	NS	NS	*
Age × sex			**	NS	**	NS	NS	NS
Genotype × sex			**	NS	NS	NS	NS	*
Age * Genotype × Housing systems			NS	*	NS	NS	NS	NS

(NS: $P>0{\cdot}05$, *$P<0{\cdot}05$, **$P<0{\cdot}01$). B, Bronze; H, Hybrid; H × B, Hybrid × Bronze cross-genotype; SEM, Standard error of the mean.

temperatures and increased exercise in yards. Castellini *et al.* (2002*b*) found lower growth rates and feed efficiencies with outdoor organic treatments than with conventional production systems, while Santos *et al.* (2005) reported that semi-confined birds showed higher growth potential, lower feed intake and better feed to gain ratio than confined birds. These contradictions in the findings might have been due to differences in the experimental approach and the system of production. Indeed in the study of Fanatico *et al.* (2005) and our study, all birds were actually exposed to the same temperature fluctuations because the treatments shared a common research facility, a building that is naturally ventilated. In addition, the trial was conducted in the spring and early summer when the weather was mild and did not fluctuate widely. Although outdoor temperature ranged from 17·0 to 30·3°C during the period that birds had outdoor access, indoor temperatures varied from 21·0 to 32·1°C (Figure 1). Therefore, as reported by Fanatico *et al.* (2005) for broilers, the trial was conducted during an optimal time of year for bird comfort, and additional research for turkeys is also needed during non optimal periods such as very hot or very cold weather. Sarica *et al.* (2007) found that, the tendency of these genotypes for moving to outdoor run was higher in the early hours of the day.

Under free-range conditions the bird's diet is a very mixed one-seeds, herbage and invertebrates. Results on performances of turkeys reared at two different housing systems indicate that under free-range conditions birds are capable of selecting a diet which is adequate for all their requirements. On the other hand, issues in the gut characteristics can result in loss of feed efficiency, live weight and rate of gain. Free-range housing system had a beneficial effect on relative gut weight compared to the barn system (Table 2). Therefore, this effect of free-range housing system on gut weight can result in significant savings. Castellini *et al.* (2002*b*) found that percentages of breast and drumstick meat increased when birds had outdoor access and a lower stocking density in an organic production system. In contrast, although stocking density in the present study was lower (1·8 birds per m^2) in the treatments with outdoor access, there was a deleterious effect of free-range housing system on yields of carcass (Table 2) and drumstick (Table 3).

No significant differences in mortality among the treatment groups (2·34 and 2·42% for the barn and free-range, respectively) were observed. The H × B birds had a higher mortality compared to the B genotype although the H and H × B birds did not venture outdoors as often as the B birds (Sarica *et al.*, 2007). Although free-range housing system had a little impact on growth characteristics and yields in this study, B genotype may become more important in the future in Turkey or elsewhere for natural and organic production, especially if longer growing periods are used. Slow-growing genotypes may also become more important because of animal welfare concerns (Sarica *et al.*, 2007).

Effect of gender

A sex effect on live weight is usually observed in poultry; males are heavier than females. In the present study, the live weights of the males were heavier than the females at the end of the trial (Table 2). In terms of parts yield, the females overall had higher percentages of breast meat yields than males ($P < 0·05$). Males had greater leg yields ($P < 0·05$) except in the conventional H indoor birds. This finding agrees with the study of Young *et al.* (2001) and Brickett *et al.* (2007) who found that females have higher breast meat yields than males, whereas males have higher drumstick yields. Also, Santos *et al.* (2005) reported that males presented higher yields of thigh, drumstick and edible inners organs, while females presented higher breast and abdominal fat yield. In the present study, when comparing genders within each treatment, males and females did not differ in their carcass, breast, wing, and thigh yields ($P > 0·05$; Table 3), confirming the results in the broiler study of Fanatico *et al.* (2005). Because the response in terms of breast and thigh weight can, however, vary depending on the age (Table 3) the age of slaughter should be determined taking into account demands and prices for these carcass components in different markets.

CONCLUSIONS

In this study, there was little impact from the production system; however, it is likely to be dependent on many variables in a production system with outdoor access. In both of the conventional production system and the system with outdoor access, the H birds have more efficient growth, feed efficiency, and meat yield than B or H × B birds. There was a greater impact from the genotypes, which showed a wide range of growth and performance characteristics when housed under the same conditions. With a diverse selection available, producers can choose the genetics most appropriate for their production system, length of grow out, number of flocks per year, and market goals. Specialty production will provide more diversity in the marketplace for consumers who want a differentiated product, and it is necessary to balance the need for efficiency with consumer preferences. However, further research is needed to determine if factors such as consumer preferences, welfare concerns, and dietary restrictions impact the feasibility of housing fast-growing turkeys in alternative systems.

REFERENCES

BRICKETT, K.E., DAHIYA, J.P., CLASSEN, H.L. & GOMIS, S. (2007) Influence of dietary nutrient density, feed form, and lighting on growth and meat yield of broiler chickens. *Poult Science*, **86**: 2172–2181.

CASTELLINI, C., MUGNAI, C. & DAL BOSCO, A. (2002*a*) Meat quality of three chicken genotypes reared according to the organic system. *Italian Journal of Food Science*, **14**: 401–412.

CASTELLINI, C., MUGNAI, C. & DAL BOSCO, A. (2002*b*) Effect of organic production system on broiler carcass and meat quality. *Meat Science*, **60**: 219–225.

CLAYTON, G.A., LAKE, K.E., NIXEY, C., JONES, D.R., CHARLES, D.R., HOPKINS, J.R., BINSTEAD, J.A. & PICKET, R. (1994) *Turkey Production: Breeding and Husbandry,* Ministry of Agriculture Fisheries and Food, Reference Book: 242, UK.

FANATICO, A.C., PILLAI, P.B., CAVITT, L.C., OWENS, C.M. & EMMERT, J.L. (2005) Evaluation of slower-growing broiler genotypes grown with and without outdoor access: growth performance and carcass yield. *Poultry Science*, **84**: 1321–1327.

HAHN, G. & SPINDLER, M. (2002) Method of dissection of turkey carcasses. *Word's Poultry Science Journal*, **58**: 179–197.

HERMANSEN, J., STRUDSHOLM, K. & K, Horsted. (2004) Integration of organic animal production into land use with special reference to swine and poultry. *Livestock Production Science*, **90**: 11–26.

HORSTED, K., HENNING, J. & HERMANSEN, J. (2005) Growth and sensory characteristics of organically reared broilers differing in strain, sex and age at slaughter. *Acta Agriculturae Scandinavica, A*, **55**: 149–157.

LEWIS, P.D., PERRY, G.C., FARMER, L.J. & PATTERSON, R.L.S. (1997) Responses of two genotypes of chicken to the diets and stocking densities typical of UK and "Label Rouge" systems: I. Performance, behaviour and carcass composition. *Meat Science*, **45**: 501–516.

LIMA, A.M.C. & NAAS, I.A. (2005) Evaluating two systems of poultry production: conventional and free-range. *Brazilian Journal of Poultry Science*, **7**: 215–220.

NRC (NATIONAL RESEARCH COUNCIL) (1994) *Nutrient Requirements of Poultry*, 9th rev edn., (Washington, DC, National Academy Press).

RODENBURG, T., VAN HARN, B.J., VAN KRIMPEN, M.M., RUIS, M.A.W., VERMEIJ, I. & SPOOLDER, H.A.M. (2008) Comparison of three different diets for organic broilers: effects on performance and body condition. *British Poultry Science*, **49**: 74–80.

SANTOS, A.L., SAKOMURA, N.K., FREITAS, C.M.S. & CARRILHO, E.N.V.M. (2005) Comparison of free range broiler chicken strains raised in confined or semi-confined systems. *Brazilian Journal of Poultry Science*, **7**: 85–92.

SARICA, M., KARAÇAY, N., OCAK, N., KOP, C. & ALTOP, A. (2007) Effects of Barn (intensive) and Free-range systems on some behaviors of different genotypes of domestic turkeys. *Avrupa Uyum Surecinde Turkiye Tavukculugu Sempozyomu*. Ege Univ. Ziraat Fak., 15 Kasim, 172–180, Izmir.

SUNDRUM, A. (2001) Organic livestock farming: a critical review. *Livestock Production Science*, **67**: 207–215.

TURKOGLU, M., SARICA, M. & ELEROGLU, H. (2005) *Turkey Production*, Otak, Samsun, 238 p. (in Turkish).

VON BORELL, E. & SØRENSEN, J. (2004) Organic livestock production in Europe: aims, rules and trends with special emphasis on animal health and welfare. *Livestock Production Science*, **90**: 3–9.

WESTGREN, R.E. (1999) Delivering food safety, food quality, and sustainable production practices: the *Label Rouge* Poultry System in France. *American Journal of Agricultural Economics*, **81**: 1107–1111.

YOUNG, L.L., NORTHCUTT, J.K., BUHR, R.J., LYON, C.E. & WARE, G.O. (2001) Effects of age, sex, and duration of postmortem aging on percentage yield of parts from broiler chicken carcasses. *Poultry Science*, **80**: 376–379.

ZELTNER, E. & HIRT, H. (2003) Effect of artificial structuring on the use of laying hen runs in a free-range system. *British Poultry Science*, **44**: 533–537.