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Evaluation of two feeding programs on
productive traits and foot injuries in commercial
turkeys

Evaluación de dos programas de alimentación
sobre el comportamiento productivo y lesiones
en patas de pavos comerciales

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Resumen

Introducción: Varios factores afectan la ganancia de peso y el rendimiento de canal en las aves. Entre estos, los programas de alimentación, el sexo y las enfermedades son los más relevantes. El objetivo de este trabajo fue evaluar el efecto de dos programas de alimentación, uno alto en proteína (AP) y otro bajo en proteína (BP), en pavos de ambos sexos, sobre el peso vivo, rendimiento en canal y lesiones en patas.

Método: El programa de alimentación alto en proteína (AP) consistió en dietas con mayor contenido de proteína que las utilizadas en el programa de alimentación bajo en proteína (BP), sin embargo, el nivel de energía metabolizable en las dietas fue similar en ambos programas. Se evaluó la ganancia diaria de peso, rendimiento de canal y lesiones en patas. Se utilizó un diseño completamente al azar con arreglo factorial con 128 repeticiones por tratamiento. El análisis estadístico incluyó los efectos del programa de alimentación, sexo y la interacción.

Resultados: Los pavos del programa AP fueron más pesados ($P<0.05$) que los pavos del programa BP a las 15 y 19 semanas de edad (10.0 vs. 9.1 y 13.1 vs. 11.9 kg, respectivamente). Los pavos machos fueron más pesados ($P<0.05$) que las hembras a esas edades (10.6 vs. 8.4; 14.7 vs. 10.4 y 17.4 vs. 11.8 kg, respectivamente). El rendimiento en canal fue significativamente mayor ($P<0.05$) en los machos, en comparación con las hembras a las 19 y 23 semanas de edad (78.8 % vs. 77.6 % y 78.2 % vs. 77.5 %, respectivamente). Las lesiones en patas grado 2 (>1.5 cm de diámetro) fueron más frecuentes ($P<0.06$) en los pavos alimentados con el programa AP (28.3%) vs. BP (18.1%) y en los machos (31.9%) vs. hembras (14.9%; $P<0.05$). Adicionalmente, conforme los pavos incrementaron de edad las lesiones grado 2 en patas fueron más frecuentes (34.9, 37.8 y 60.2% a las 15, 19 y 23 semanas de edad, respectivamente).

Conclusión: Los resultados indican que los pavos criados con un programa AP fueron más pesados, mientras que los pavos machos fueron más pesados y rindieron más en canal que las hembras. La frecuencia y severidad de las lesiones en las patas de las aves fueron mayores en los pavos machos y de mayor edad.

Palabras Clave: pavos; rendimiento en canal; lesiones en patas; programa de alimentación; peso vivo.

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Abstract

Introduction: Many factors affect live weight gain and carcass yield in poultry. Among those, feeding program, sex and diseases are the most relevant. The aim of this study was to evaluate the effect of a high protein (HP) and a low protein (LP) feeding programs in male and female turkeys on liveweight, carcass yield and foot injuries.

Method: The high protein (HP) program consisted in diets with a higher content of crude protein than those of the low protein (LP) program, although the metabolizable energy was similar in both programs. Liveweight gain, carcass yield and foot injuries were evaluated. A complete randomized design with factorial arrangement and 128 replicates per treatment were used. The statistical analysis included the effects of the feeding program, sex and the interaction.

Results: The turkeys from the HP program were heavier ($P<0.05$) than those from the LP program at 15 and 19 weeks of age (10.0 vs 9.1 and 13.1 vs 11.9 kg, respectively). The male turkeys were heavier ($P<0.05$) than the females at those ages (10.6 vs 8.4; 14.7 vs 10.4 and 17.4 vs 11.8 kg, respectively). Carcass yield was also significantly greater ($P<0.05$) for males than for females at 19 and 23 weeks of age (78.8 % vs 77.6 % and 78.2 % vs 77.5 %, respectively). Foot injuries grade 2 (>1.5 cm of diameter) were more frequent ($P<0.06$) in the HP (28.3%) than in the LP (18.1%) program, and in males ($P<0.05$). Additionally, as turkeys got older, foot injuries grade 2 were more frequent (34.9, 37.8 y 60.2% for turkeys at weeks 15, 19 and 23 of age; $P<0.05$).

Conclusion: The results indicated that turkeys raised in the HP program were heavier, and that males were heavier and yielded more carcass than females. Frequency and severity of foot injuries were highest in HP program, in males and in older turkeys.

Keywords: turkeys; carcass yield; foot injuries; feeding program; liveweight.

Introduction

Many factors affect live weight gain, carcass yield and meat quality in poultry (Nestor *et al.* 2005). Among those, season, feeding program, sex and diseases are the most relevant (Mazanowski, 1999; Mazanowski, 2000).

Feeding programs in turkeys involve several diets and they are supplied in different phases during the fattening period. Feeding programs differ in protein, energy or amino acids depending on genetic line, sex, weather and length of fattening period (NRC, 1994; Lamme *et al.* 2006). Therefore, live weight reached at the end of the fattening period depends significantly on the feeding program used.

With respect to sex differences, it is known that in poultry, males grow faster than females since first week until the end of the fattening period (Havenstein *et al.* 2007). Consequently, appropriate feeding programs should be used according to the sex of the turkeys.

On the other hand, many factors affect the presence and severity of foot injuries in turkeys, such as, high stocking rate, weather conditions, inadequate housing design, genetic predisposition, and faster live weight gain. Foot injuries have also been associated to food intake and weight gain (Krautwald-Junghanns *et al.* 2011). It has also been reported a high incidence of foot injuries in male chickens fed high energy diets (Bilgili *et al.* 2006). However, there is no information on the effect of sex on incidence of foot injuries in turkeys under tropical conditions. Furthermore, little information exists on the effect of feeding programs on this pathology in turkeys.

Evaluation of feeding programs in turkeys and its effect on foot injuries incidence is relevant because could provide useful information to be used for planning better feeding programs, particularly under tropical conditions.

The aim of this study was to evaluate the effect of sex and two feeding programs on growth, carcass yield and the manifestation of foot injuries in turkeys.

Method

The study was conducted in a commercial turkey farm in Yucatan, Mexico, under a tropical climate, where annual average temperature is 26 °C (minimum 17 °C and maximum 36 °C) and the average annual precipitation is 1000 mm (INEGI, 2013).

Feeding programs

The feeding programs utilized in this experiment are shown in Table 1. Those feeding programs were designed taken into consideration the nutritional guidelines for turkeys hybrid converter line (Hybrid, 2013).

Table. 1. Chemical composition of high protein (HP) and low protein (LP) feeding programs for turkeys raised under tropical conditions.

Phase	Weeks	HP program				LP program			
		CP1 (%)	ME2 Mcal/kg	M+C3 (%)	L4 (%)	CP1 (%)	ME2 Mcal/kg	M+C3 (%)	L4 (%)
1	0-4	28		1.19	1.83	26	2.83	1.05	1.62
2	5-8	26		1.05	1.62	24	2.89	0.97	1.52
3	9-10	24	2.85	0.97	1.52	22	2.95	0.92	1.42
4	11-12	22	2.83	0.92	1.42	20	2.95	0.81	1.21
			2.89						
5	13-14	20	2.95	0.81	1.21	18	3.00	0.76	1.13
			3.00						
6	15-18	18	2.95	0.76	1.13	16	3.12	0.71	1.00
			3.00						
7	19-24	16	3.12	0.71	1.00	16	3.12	0.71	1.00

¹Crude Protein

²Metabolizable Energy

³Methionine + Cistine

⁴Lysine

The high protein (HP) program consisted in diets with a higher content of crude protein than those of the low protein (LP) program, although the metabolizable energy was similar in both programs. The chemical composition of the diets was calculated from the main ingredients used (Corn, soybean meal and soybean oil), plus vitamins, minerals, growth promoters, lysine and methionine.

Animals and husbandry

Five hundred and twelve turkey broods of one day of age and both sexes from the Hybryd converter genetic line (Hendrix Genetics Company) were used. They were divided in two groups of 256 birds from both sexes (128 males and 128 females). Each group was housed in 7 x 20 m house, equipped with feeders, drinkers and brooders, and they were fed with one of the feeding programs evaluated (HP or LP). All turkeys were vaccinated against avian pox at 1 and 3 weeks of age, and against Newcastle at 2 and 4 weeks. Feeding was *ad libitum* throughout the experiment. The turkeys were reared in a regimen of 16 hours total light daily. Turkeys were wing banded at one day of age and sex was determined by necropsy when they were slaughtered. Thirty turkeys from each group were slaughtered at 15, 19 and 23 weeks of age. Furthermore, carcass yield was evaluated and physical examination of turkey feet was performed to assess the presence of foot injuries. The feet injuries were further classified according to the scale suggested by Nagaraj *et al.* (2007):

Grade 0: Normal feet, without injuries.

Grade 1: Slight injurie (≤ 1.5 cm of diameter).

Grade 2: Severe injurie (> 1.5 cm of diameter).

Statistical Analysis

Liveweight and carcass yield data were analysed using a complete randomized design with factorial arrangement. The statistical model included the effects of the feeding program, sex, their interaction and the error term (STATGRAPHICS, 2000). Means were compared using Tukey's test with 5 % probability.

The severity of the feet injury data were analysed using the Kruskal Wallis test for discrete variables (STATGRAPHICS, 2000). Frequencies of feet injury severity were compared between feeding programs, sexes and ages.

Results

Results of live weight and carcass yield of turkeys recorded at weeks 15, 19 and 23 and fed two feeding programs are shown in Table 2. Males were significantly ($P<0.05$) heavier than females at weeks 15, 19 and 23 (10.7 vs 8.4, 14.7 vs 10.4 and 17.4 vs 11.8 kg, respectively). Turkeys reared with the HP program were heavier ($P<0.05$) than turkeys fed the LP program at weeks 15

and 19 (10.0 vs 9.1 and 13.1 vs 11.9 kg, respectively). However, there was not effect of feeding program on live weight at week 23 of fattening ($P>0.05$).

Table 2. Live weight and carcass yield at 15, 19 and 23 weeks of age of turkeys reared under a high protein (HP) or low protein (LP) feeding program.

	Live weight (kg)			Carcass yield (%)		
	Week			Week		
	15	19	23	15	19	23
Feeding Program						
HP	10.0 ^a	13.1 ^a	14.6 ^a	78.1 ^a	78.4 ^a	78.0 ^a
LP	9.1 ^b	11.9 ^b	14.6 ^a	78.2 ^a	78.0 ^a	77.6 ^a
Sex						
Male	10.7 ^a	14.7 ^a	17.4 ^a	78.0 ^a	78.8 ^a	78.2 ^a
Female	8.4 ^b	10.4 ^b	11.8 ^b	78.3 ^a	77.6 ^b	77.5 ^b
Standard Error of the Mean	0.064	0.074	0.074	0.14	0.43	0.21
Sources						
Feeding Program	0.000	0.000	0.721	0.591	0.172	0.181
Sex	0.000	0.000	0.000	0.214	0.000	0.027
Feeding Program x Sex	0.001	0.000	0.885	0.003	0.021	0.064

a,b,c,d Means with different letter in the same column are statistically different at $P<0.05$.

Carcass yield was similar ($P>0.05$) in both sexes at week 15 (78.0 vs 78.3% for males and females, respectively), but at weeks 19 and 23 of age, carcasses of males were heavier ($P<0.05$) than those for females (78.8 vs 77.6 and 78.2 vs 77.5%, respectively). Feeding programs evaluated in this study did not affect carcass yield at any week of fattening ($P>0.05$). A significant sex x feeding program interaction effect ($P<0.05$) on live weight at weeks 15 and 19 was observed (Figure 1). With respect to carcass yield interaction sex x feeding program was significant ($P<0.05$) at all evaluated ages (Figure 2).

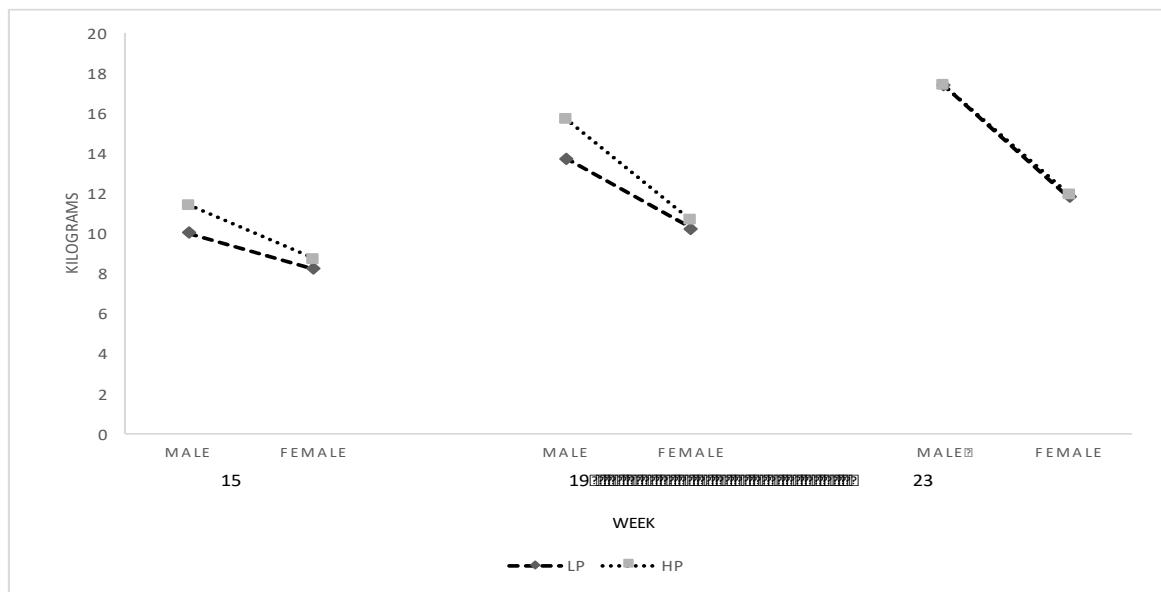


Figure 1. Interaction of sex x feeding program at weeks 15, 19 and 23 of age for liveweight in turkeys.

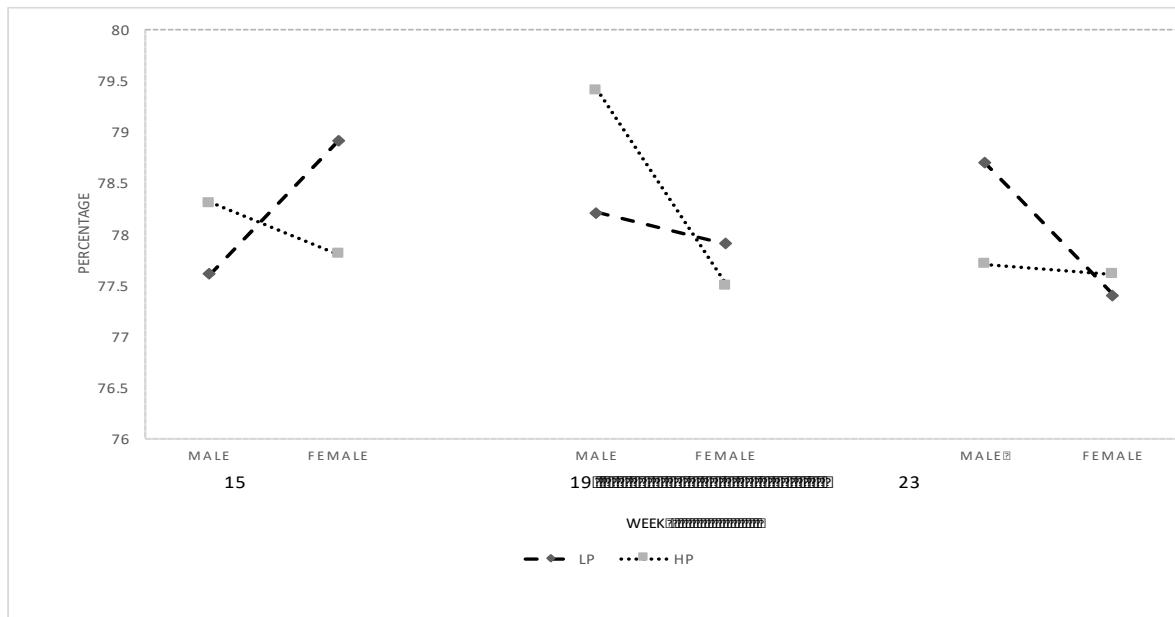


Figure 2. Interaction of sex x feeding program at weeks 15, 19 and 23 of age for carcass yield in turkeys.

The frequencies of the degree of foot injuries found in this study are shown in Table 3. The turkeys in the HP program had more severe foot injuries than turkeys in the LP program ($P<0.06$). Grade 2 injuries were 10% more frequent in turkeys fed the HP program in comparison to turkeys feed the LP program (28.3% vs 18.1%). Grade 2 injuries in males were approximately

twice more frequent ($P<0.05$) than in females (31.9% vs 14.9%, respectively). Grade 2 injuries were almost twice at week 23 (60.2%), in comparison to weeks 15 (34.9%) and 19 (37.8%).

Table 3. Incidence of foot injuries in turkeys reared under two feeding programs.

	Grade of foot injuries (%)			Significance
	0	1	2	
Feeding Program				< 0.06
High protein	2.4	19.3	28.3	
Low protein	4.8	27.1	18.1	
Sex				< 0.05
Male	1.2	16.9	31.9	
Female	6.4	28.7	14.9	
Week				< 0.05
15	8.1	57.1	34.9	
19	15.3	46.9	37.8	
23	2.3	37.5	60.2	

Grade 0: Normal feet, without injuries; Grade 1: Slight injurie (≤ 1.5 cm of diameter); Grade 2: Severe injurie (> 1.5 cm of diameter).

Discussion

Feeding program

Turkeys of the HP program were heavier than turkeys of LP program at 15 and 19 weeks of age. However, live weight of turkeys at week 23 of age was similar for both feeding programs. According to Huffman *et al.* (2012), these results can be explained by fact that food controls delayed early growth and by patterns of gene expression in turkeys. When the turkeys are fed diets that meet their nutritional requirements, they can express their genetic potential for growth and gain weight; however, as they reach maturity, their nutritional requirements decrease (Laudadio *et al.* 2009).

Carcass yield was not affected by feeding program at any age, so this agrees with the results of Lamme *et al.* (2006), who feeding male turkeys with four different feeding programs showed no difference in carcass yields, except when reduction of protein between feeding

programs was greater than 20%. Similarly, Laudadio *et al.* (2009) found no difference in carcass yield in turkeys reared with two different feeding programs until the 12th week of age. Fanatico *et al.* (2008) found no differences between two feeding programs that differed in 2% of crude protein and 200 MJ of ME. Some studies show that animals with fast growth have lower carcass yield because they have greater abdominal fat deposition compared to animals of slow growth (Nahashon *et al.* 2005); however, that response was not observed in this study.

Sex

The heavier weight and higher carcass yield of male turkeys in comparison to females, observed in this experiment, has been previously reported (Havenstein *et al.* 2003; Segul and Kiraz, 2005; Erbil *et al.* 2006). The difference in live weight between males and females at weeks 15, 19 and 23 agrees with those of Havenstein *et al.* (2007) who found heavier male turkeys from the 2nd until the 28th week of age, in two turkey lines. Those results correspond to the sexual dimorphism that is evident in the majority of the poultry breeds, included turkeys (Juárez and Fraga, 2002; Pérez *et al.* 2013). In this study, females only reached 61% of the weight of males at 23 weeks of age.

The sexual dimorphism for live weight was expected, since males maintain higher levels of growth hormone (GH) from the 2nd week on (Vasilatos *et al.* 1988). Growth hormone improves the nutrient utilization and increases bone and protein tissues synthesis, resulting in an increase in growth and weight gain (Lopez *et al.* 2011). On the other hand, the plasmatic levels of GH in females are reduced in greater extent than in males from the 2nd week of age on (Vasilatos *et al.* 1988). The reduction in plasmatic GH causes a slowdown in weight gain and consequently females are lighter than males at same age.

Carcass yield was similar at 15 weeks of age in both sexes. However, significant differences between males and females ($P<0.05$) at weeks 19 and 23 of age were observed. These results agree with those reported by Lopez *et al.* (2011) in chickens, who found that carcass yield of male chickens was heavier than carcass yield of females at 6 weeks of age. The results of this study agree with the sexual dimorphism effect on tissues synthesis, discussed elsewhere (Juárez and Fraga, 2002; Pérez *et al.* 2013).

The significant interactions of sex x feeding program for liveweight at weeks 15 and 19 and for carcass yield at weeks 15, 19 and 23 of age show that females respond similarly to the LP and HP feeding programs (Figures 1 and 2). However, males respond better to the HP feeding

program. These results suggest that the use of HP program it is not profitable for fed female turkeys. On the other hand, it is suitable the use of HP program in males, because they have more capacity to increase deposition of body protein (Lopez *et al.*, 2011).

Foot injuries

The observation of highest incidence of severe injuries in male turkeys, in this study, is consistent with Bilgili *et al.* (2006) and Nagaraj *et al.* (2007) results, who found higher rates of severe injuries in male chicken. The highest frequency of severe lesions in male turkeys may be related to the body size, because males are heavier than females, so more weight is placed on footpads. This leads to greater contact surface with faeces and wet litter, which results in a high frequency and severity of foot lesions (Nagaraj *et al.* 2007; Kjaer *et al.* 2006).

The frequency of severe injuries was highest in the HP feeding program. This agrees with Nagaraj *et al.* (2007) who reported a higher frequency of severe lesions in chickens fed a diet high in protein. The high frequency of severe injuries in turkeys fed the HP program can be a result of greater live weight gain than in turkeys fed the LP program. As has been explained above, the turkeys in the HP feeding program were heavier, so there was greater pressure at the footpads, which generated more surface of contact with faeces and wet litter, thus increased frequency and severity of foot lesions (Nagaraj *et al.* 2007; Kjaer *et al.* 2006). However, those results do not indicate if frequency and severity of foot injuries affected the live weight gain.

Conclusions

Turkeys in the HP feeding program grew faster, were heavier and had more severe injuries than birds in the LP program. The male turkeys were heavier, yielded more carcass and had more foot injuries than females. The HP feeding program is recommended for male turkeys and the LP feeding program for females.

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