Phenotypic characterization of the Guajolote (*Meleagris gallopavo gallopavo*) in Mexico

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Summary

The study was conducted to investigate the phenotypic diversity of Guajolote present in small backyard poultry operations. From September 2004 to July 2006, in 54 municipalities in the coastal region of Oaxaca, Mexico 768 "*guajalotes*" growers were visited. Eleven different phenotypes of Guajolote, previously described as turkey varieties, have been identified. The phenotypes identified and their frequency are: Bronze (30.1%), Black (29.0%), Royal Palm (13.4%), Auburn (5.3%), Bourbon Red (5.2%), Narragancet (2.6%), Spotted (2.4%), Brown (2.2%), Slate (1.7%), White (1.5%) and Imperfect Albino (0.2%). The remainder (6.4%) were not identified as a phenotype previously described. This is the first report about the phenotypic differentiation of Guajolote in Mexico.

Résumé

Une étude a été mise en place pour connaître la diversité phénotypique des "*guajalotes*" (une espèce de dinde) dans les petites exploitations avicoles de basse cour. De septembre 2004 à juillet 2006 on a visité 768 producteurs dans 54 municipalités de la côte de la région de Oaxaca (Mexique). On a identifié 11 phénotypes différents de "*guajalotes*" qui avaient été décrits précédemment comme étant des variétés de dinde. Les phénotypes identifiés avec leur présences respectives sont: Bronze (30,1%); Black (29%); Royal Plan (13,4%); Auburn (5,3%); Bourbon Red (5,2%); Narragancet (2,6%); Spotting (2,4%); Brown (2,2%); Slate (1,7%); White (1,5%); et Albinisme imparfait (0,2%), le reste de l'échantillon n'a pas été identifié parmi les phénotypes indiqués ci-dessus. Il s'agit du premier rapport sur la différence phénotypique des "*guajalotes*" au Mexique.

Resumen

Se elaboró un estudio para conocer la diversidad genética de los Guajolotes presentes en las pequeñas explotaciones avícolas de traspatio. De Septiembre de 2004 a Julio de 2006 en 54 municipios de la región costa de Oaxaca, México; se visitaron 768 productores. Hasta el momento se han identificado 11 fenotipos diferentes de Guajolotes descritos anteriormente. Los fenotipos identificados y su frecuencia son: Bronze (30.10%), Black (29.01%), Royal Palm (13.36%), Auburn (5.27%), Bourbon Red (5.24%), Narragancet (2.62%), Spotting (2.41%), Brown (2.19%), Slate (1.74%), White (1.53%) y Albinismo imperfecto (0.21%), el resto de la muestra no fue identificado como algún fenotipo descrito anteriormente. Este es el primer reporte sobre diferenciación fenotípica de Guajolotes para México.

***Key words:** Backyard poultry, Color of feather, Genetics, Turkey, Variety.*

Introduction

Mexico has brought to the world one of the three most important species of domestic birds in current poultry farming: the turkey, (*Meleagris gallopavo*). There is a general agreement that domestication of this bird by one of the Central American cultures took place on actual Mexican territory (Hale *et al.*, 1962; Schorger, 1966; Crawford, 1990; Henson, 1992).

Nowadays, what people know as Guajolote (*M. g. gallopavo*) are domesticated, nondescript native birds whose productive characteristics are unknown. Turkeys, which had been derived from the Mexican subspecies (*M. g. gallopavo*), were brought to northeastern America from Europe from the 16th century, where they interbred with the

eastern subspecies (*M. g. silvestris*) forming the bronze bird that became the foundation for nearly all domestic lines specialized for meat production (Crawford, 1990).

In Mexico, Guajolote breeding is practiced mainly in backyard conditions along with native birds that have not been genetically selected. Such birds exhibit great variability in regard to their size, weight and phenotype (Jerez *et al.*, 1994). In rural communities, they have an important economic, social and cultural value (Diaz, 1976).

Guajolote breeding in backyards is common in rural communities (Saucedo, 1984), peri-urban areas and deprived areas in big cities (Aquino *et al.*, 2003). In rural communities, Guajolotes are mainly kept for domestic use or gifts, a tradition that has lasted through the centuries.

In Mexico, it is recognized that the study of the native Guajolote is an urgent necessity and, as a consequence of the poor production conditions of the backyard system (Aquino *et al.*, 2003), the possibility of extinction in the short term cannot be ruled out (SAGARPA, 2003). Paradoxically, even though the actual turkey descended from the Guajolote, which was domesticated in Mexico, at the present time a native breed has not been reported or characterized in this country (FAO, 2006).

It is important to study the Guajolote and its production potential, because while it is possible to cross it with the turkey, with fertile offspring, there is a resulting loss of very important characteristics like adaptation to different environmental, sanitary and nutritional conditions. The turkey and the Guajolote are not the same; the Guajolote has more genetic variation than the turkey due to genetic isolation and a longer period of genetic adaptation to local environmental conditions, but is less studied than the turkey. In the USA the turkey is characterized in 31 varieties (Sponenberg *et al.*, 2000, 2005). Some of these varieties have phenotypic similarities to the Guajolote. Therefore, this study was conducted for the purpose of evaluating the phenotypic diversity of the Guajolote in backyard poultry farming setings in Mexico, using varieties of turkey as a reference.

Materials and Methods

From September 2004 to July 2006, 768 backyard turkey growers located in different communities distributed in the 54 coastal municipalities of Oaxaca, Mexico were visited.

They lie between coordinates 16° 45′ latitude north and 96° 20′ longitude east, with an altitude range of 0 – 3 000 meters. The prevailing vegetation is diverse: oak trees, pine trees, thorny bushes, dense or medium sub-deciduous jungle, seasonal evergreen forest, low deciduous jungle, medium jungle or low evergreen, mangrove swamps, sterns, palm trees, savanna and pastureland (Torres-Colin, 2004). The predominant climates are: temperate sub-humid C (w1), warm semi-dry Bs1hw, warm sub-humid Aw1, semi-warm sub-humid (A)C(w1) and warm humid Am(f) (Trejo, 2004).

In each backyard operation, photographs were taken to determine the color pattern of each bird. When there was no access to the birds because they were grazing out in the countryside, the information was obtained directly from the producers. The results obtained were analyzed with descriptive statistics (Steel *et al.*, 1997). The comparison of the color pattern of the birds observed with the standard breeds was executed by a direct comparison of the pictures taken, and compared with different photographs and breed descriptions (Platt, 1925; Robertson, 1929; Hutt and Mueller, 1942; Robertson at al., 1943; Marsden and Martin, 1945; Asmundson, 1945, 1950,1955; Nestor and Renner, 1979; Savage, 1990; Savage and Attamangkune,1990; ALBC, 2006; Savage and Zakrzewska, 2006).

Results and Discussion

The most frequent distribution (Table 1) was that of the Guajolote with plumage of the phenotype identified as 'Bronze' (Marsden and Martin, 1945; Savage, 1990; ALBC, 2006; Savage and Zakrzewska, 2006). They were found with a frequency of 30.1%,and were recognizable by their iridescent green feathers on the neck, breast, wings and back; the primary and secondary feathers of the tail and wings are alternatively black and white stripes (Figure 1).

The completely black feathers (Figure 2), belong to the second most common type of coloration (29.0%) and corresponds to the 'Black' phenotype (Platt, 1925; Asmundson, 1945; Savage, 1990; ALBC, 2006; Savage and Zakrzewska, 2006); followed by the pattern of white feathers over all the body with areas of black feathers on the neck, back and wings (Figure 3) that belongs to the 'Royal Palm' or 'Palm' phenotype (Asmundson, 1945; ALBC, 2006; Savage and Zakrzewska, 2006). This phenotype was found with a frequency of 13.4%.

Figure 1. Guajolote of Bronze phenotype.

Figure 2. Guajolote of Black phenotype.

Figure 3. Guajolote of Royal Palm phenotype.

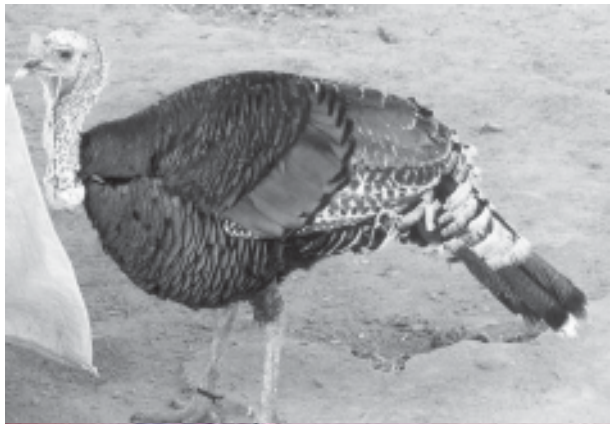

Figure 4. Guajolote of Auburn phenotype.

Figure 5. Guajolote of Bourbon Red phenotype.

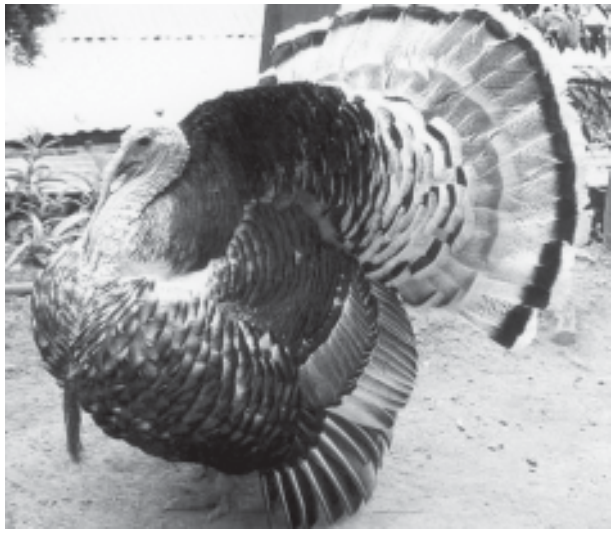

Figure 6. Guajolote of Narragancet phenotype.

Table 1. Frequency of color phenotypes observed in guajolotes of the coast of Oaxaca, Mexico.

Color	%
Bronze	30.1
Black	29.0
Royal Palm / Palm	13.4
Auburn	5.3
Bourbon, Bourbon Red, Red	5.2
Narragancet	2.6
Spotting	2.4
Brown	2.2
Slate	1.7
White	1.5
Imperfect Albino	0.2
Not characterized[1]	6.3

[1]Phenotype do not meet the previously described characteristics.

Figure 7. Guajolote of Spotting phenotype.

Figure 8. Guajolote of Brown phenotype.

In black Guajolotes where the characteristic bronze pattern is substituted by a reddish brown color, the feathers of the tail are reddish brown with black and white stripes (Figure 4) and occurred with a frequency of 5.4%. They were identified as the 'Auburn' phenotype (Asmundson, 1950; Savage and Zakrzewska, 2006); and birds with a reddish brown color with white feathers on the wings (Figure 5) were recognized as the 'Bourbon', 'Bourbon Red' or 'Red' phenotype (Robertson, 1929; Savage, 1990; ALBC, 2006) and occurred with a frequency of 5.2%.

The color pattern of the feathers characteristic of the 'Narragansett' phenotype (Robertson, 1929; Savage, 1990; ALBC, 2006; Savage and Zakrzewska, 2006) was identified by their white color with dark gray feathers on the neck, wings and breast; the feathers on the tail of a bronze color also have black and white stripes (Figure 6). This phenotype had a frequency of 2.6%.

Figure 7 shows a Guajolote type with a frequency of 2.4%, with adult white plumage and a black pigmentation on all the feathers, mainly on the neck, sides and wings, without stripes on the

Figure 9. Guajolote of White phenotype.

Figure 11. Guajolote of Imperfect Albino phenotype.

feathers. These were identified as the 'Spotted' phenotype (Asmundson, 1955; Savage, 1990). Birds with brown plumage (Figure 8) occurred with a frequency of 2.2% and were identified as the 'Brown' phenotype (Savage, 1990; Savage and Attamangkune, 1990; Savage and Zakrzewska, 2006).

Guajolotes of the 'White' phenotype were identified (Figure 9), with completely white plumage (Robertson *et al.*, 1943; Nestor and Renner,

Figure 10. Guajolote of Slate phenotype.

1979; Savage, 1990; Savage and Zakrzewska, 2006) and Guajolotes with ash grey coloring belonging to the 'Slate' phenotype, occurred with a frequency of 1.7% (Figure 10) (Platt, 1925; Savage, 1990; ALBC, 2006). Finally, birds with white feathers but with some kind of pigmentation were identified as the '*Imperfect Albino*' phenotype, which had an observation frequency of 0.2% and are shown on Figure 11 (Hutt and Mueller, 1942; Asmundson, 1945; Savage, 1990).

The rest of the sample (6.3%) are birds whose phenotypes do not meet the previously described characteristics. Figures 12, 13 and 14 show examples of them.

This great diversity of genotypes could be the result of the genetic variation accumulated through centuries of domestication of the species (Crawford, 1990).There is a possibility that in rural communities a hybridization took place between wild turkeys (*M. g. mexicana* and *M. g. intermedia*), that still exist in Mexico, (Hale, *et al.*, 1962; Starker, 1985) and the feral Guajolote or domestic bird (*M. g. gallopavo*). It is important to recognize the Guajolote genetic diversity that still exists in Mexico in order to design and develop rescue and recovery programs for this species, which is used by the agricultural and indigenous communities.

Figure 12. Guajolote without a described phenotype.

Figure 13. Guajolote without a described phenotype.

Figure 14. Guajolote without a described phenotype.

Nevertheless, it is necessary to conduct a detailed investigation in order to determine if there are phenotypes that have not been previously described, and establish a Guajolote classification by genotypes, breeds or varieties using molecular genetics.

List of References

American Livestock Breeds Conservancy. 2006. Turkeys, <*www.albc-usa.org/wtchlist.htmt#turkeys*> Pittsboro, North Carolina. Retrieved May 11, 2006.

Aquino, R.E., A. Arroyo T.H. Glafiro D.D. Riestra F.L. Gallardo & B.A. López. 2003. El Guajolote Criollo (*Meleagris gallopavo L.*) y la Ganadería Familiar en la Zona Centro del Estado de Veracruz. Tec. Pec. Méx. 41(2): 165–173.

Asmundson, V.S. 1945. A triple-allele series and plumage in turkeys. Genetics 30: 305-322.

Asmundson, V.S. 1950. Sex-linkage in the turkey. J. Hered. 41: 205-207.

Asmundson, V.S. 1955. Inheritance of spotting in the plumage of turkeys. J. Hered. 46: 285-288.

Crawford, R.D. 1990. Poultry genetic resources: evolution, diversity, and conservation. In: R.D. Crawford (Ed.), Poultry Breeding and Genetics. Elsevier, The Netherlands, pp. 43-60.

Díaz, G.A. 1976. Programa Nacional de meleagricultura. In: Memoria de la 2ª Reunión Anual. SAG. Dirección General de Avicultura y especies menores. México, DF.

FAO. 2006. Domestic Animal Diversity Information System <*www.fao.org/dad-is*> FAO, Rome, Italy. Retrieved May 11, 2006.

Hale, E.B., W.M. Schleidt & M.W. Schein. 1962. The behaviour of turkeys. In E.S.E. Hafez (Ed.), The behaviour of domestic animals. Baillière, Tindall & Cassell, London, pp. 554-592.

Henson, E.L. 1992. *In situ* conservation of livestock and poultry. Food and Agriculture Organization of the United Nations. Rome, Italy.

Hutt, F.B. & C.D. Mueller. 1942. Sex-linked albinism in the turkey *Meleagris gallopavo*. Hered. 33: 69-77.

Jerez, M.P., J.G. Herrera & M.A. Vásquez. 1994. La Gallina Criolla en los valles centrales de Oaxaca. ITAO – CIGA, Oaxaca, México.

Marsden, S.J. & J.H. Martin. 1945. Turkey Management, 3rd Ed. The Interstate Press, Danville, IL, USA.

Nestor, K.E. & P.A. Renner. 1979. Genetics of growth and reproduction in turkey. 6. Influence of plumage patter color genes on mortality, body weight, and egg and semen production. Poultry Sci. 58: 1137-1142.

Platt, F.L. 1925. All Breeds of Poultry, Origin: History: Description, Mating and Characteristics. American Poultry Journal. Chicago, Illinois.

Robertson, W.R.B. 1929. Revised terminology for the chief color factors concerned in crosses among the breeds of the turkey. Anat. Rec. 44 (Abstract) 289.

Robertson, W.R.B., B.B. Bohren & D.C. Warren. 1943. The inheritance of plumage color in the turkey. J. Hered. 34: 246-256.

Saucedo, M.P. 1984. Historia de la Ganadería en México. Universidad Nacional Autónoma de México, México, DF.

Savage, T.F. 1990. Mutations and major variants in turkeys. In: R.D. Crawford (Ed.), Poultry Breeding and Genetics. Elsevier, The Netherlands, pp. 317–331.

Savage, T.F. & S. Attamangkune. 1990. Interaction between the B and E plumage loci in turkeys. Poultry Sci. 69: (Suppl 1) 118.

Savage, T.F. & EI Zakrzewska. 2006. Single Gene Traits of the Turkey. <*http://oregonstate.edu/dept/animal-sciences/poultry/tc.html*>. Oregon State University. Corvallis, Oregon. Retrieved May 11, 2006.

Schorger, A.W. 1966. The wild turkey. Its history and domestication. University of Oklahoma Press, Norman.

Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. 2003. Informe Sobre la Situación de los Recursos Genéticos Pecuarios (RGP) en México. <*www.sagarpa.gob.mx/Dgg/FTP/infofao.pdf*>. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación; México, DF. Retrieved May 12, 2006.

Sponenberg, D.P., M. Bender, P. Johnson, E. Smith, R. Gogal, F.W. Pierson & M.A. Gomez. 2005. La conservación del pavo en los Estados Unidos. Archivos de Zootecnia 54: 177-183.

Sponenberg, D.P., R.O. Hawes, P. Johnson & C.J. Christman. 2000. Turkey conservation in the United States. AGRI 27: 59–66.

Starker, L. 1985. Fauna Silvestre en México. Edit. Pax-México, México, DF.

Steel, R.G.D., J.H. Torrie & D.A. Dickey. 1997. Principles and procedures of statistics a biometrical approach. Third edition. MC Graw-Hill. NY, USA.

Torres-Colin, R. 2004. Tipos de vegetación. In: A.J. García-Mendoza, M.J. Ordoñez & M. Briones-Salas (Eds), Biodiversidad de Oaxaca. Instituto de Biología, UNAM - Fondo Oaxaqueño para la Conservación de la Naturaleza – Word Wildlife Fund, México, pp. 105–117.

Trejo, I. 2004. Clima. In: A.J García-Mendoza, M.J. Ordoñez & M. Briones-Salas (Eds), Biodiversidad de Oaxaca. Instituto de Biología, UNAM - Fondo Oaxaqueño para la Conservación de la Naturaleza – Word Wildlife Fund, México, pp. 67-85.