MEDWELL PUBLISHING
Journal of Animal and Veterinary Advances 8 (2): 202-207, 2009
ISSN: 1680-5593

Studies on Growth of Pelón Mexicano Pigs: Effect of Rearing Conditions on Carcass Traits and Meat Quality

[1]M. Becerril, [2]C. Lemus, [3]J.G. Herrera, [1]M. Huerta,
[4]M. Alonso-Spilsbury, [4]R. Ramírez-Necoechea, [4]D. Mota-Rojas and [5]J. Ly
[1]Unidad Académica de Ingeniería Agrohidráulica,
Benemérita Universidad Autónoma de Puebla, Puebla, México
[2]Facultad de Medicina Veterinaria y Zootecnia,
Universidad Autónoma de Nayarit, Tepic, México
[3]Colegio de Postgraduados, Montecillo, km 36.5 Carretera México-Texcoco,
Estado de México 56230, México
[4]Department of Producción Agrícola y Animal, Universidad Autónoma Metropolitana,
Xochimilco, Distrito Federal, México
[5]Instituto de Investigaciones Porcinas, Carretera del Guatao km 1, Punta Brava. La Habana, Cuba

Abstract: A 2×2 factorial arrangement was used for evaluating carcass traits and meat quality of 22 Yorkshire x Landrace (YL) and 13 Pelón Mexicano (PM) castrate male and female pigs 63 days old which were allotted at random during 16 weeks into 2 rearing systems consisting of total (15 and 7 pigs) or partial confinement (7 and 6 pigs). Partial confinement included rearing animals outdoors in a grass prairie (*Brachiaria brizantha*) from 9-16 h. There were no significant differences ($p<0.05$) for the interaction rearing system x genotype in any measurement conducted throughout this experiment. Highly significant ($p<0.001$) differences between genotypes was encountered for carcass yield and primary cuts adjusted to slaughter weight as covariable. However, carcass yield expressed as percentage of slaughter weight only tended ($p<0.103$) to favour YL pigs. Differences between rearing systems were less marked, with better carcass traits in either totally confined YL animals or partially confined PM pigs. The genotype effect was at least significantly ($p<0.01$) different in all measurements indicating a higher fat content in carcasses of PM pigs, when compared to YL animals. Length of some reservoir digestive organs were significantly ($p<0.001$) higher in PM than in YL pigs. There were no significant differences ($p>0.05$) in meat quality indices, including meat pH, water holding capacity, color and marbling. It is considered that a total or partial confinement, consisting on daily grazing outdoors, rearing system, has less influence on carcass traits in pigs when Pelón Mexicano and Yorkshire x Landrace pigs are compared.

Key words: Pigs, Pelón Mexicano, carcass traits, meat quality, digestive organs, rearing systems

INTRODUCTION

If compared to improved breed of animals imported during the past century to Mexico, Pelón Mexicano pigs has provided very scarce reliable information concerning carcass and meat evaluation (López *et al*., 1999; Lemus and Alonso, 2005). However, it has been claimed that meat sausage and products elaborated from meat of these animals are of better quality, appearance and taste than those from improved breeds. Furthermore, it has been argued that human consumption of this type of fatty meat does not imply any harmful consequence, since its composition in unsaturated fatty acid is high (Pérez *et al*., 1999; López *et al*., 1999).

Nevertheless, it has been said that Pelón Mexicano pigs are not good for marketing its meat as pork, since they have a market price very low, due to the fact that they show a high backfat thickness, which has to be discounted from the original price, which accounts for some 30-40% of lowering of its original monetary value (López *et al*., 1999; Lemus and Alonso, 2005; Lemus *et al*., 2003; Méndez *et al*., 2002; Becerril-Herrera *et al*., 2006).

The objective of the current investigation was to define the possible effects of the rearing regime on carcass traits and meat quality of growing Pelón Mexicano pigs, being compared to an improved pig breed.

Corresponding Author: C. Lemus, Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Nayarit, cdad, de la Cultura Amado Nervo, Tepic, México

MATERIALS AND METHODS

General: Carcass traits and meat quality were studied in an experiment designed as a 2×2 arrangement where 2 groups of 22 Yorkshire x Landrace (YL) and 13 Pelón Mexicano (PM) castrate male and female pigs, were allotted regardless sex, at random into two managing systems consisting of total (15 and 7 pigs) or partial confinement (7 and 6 pigs). Partial confinement consisting on permitting the animals to graze from 9-16 h in parcels covered with *Brachiaria brizantha* grass.

The trial length was for 112 days and started when the pig live weight was on average 9.5 and 16.9 kg, respectively. All pigs were fed *ad libitum* a commercial, balanced concentrate feed composed of ground sorghum grain mixed with a supplement to contain either 17 or 14% crude protein (N×6.25) during the 1st and last 8 weeks of trial, in that order.

Measurements: The pigs were weighed at the end of the performance trial and then were fasted during 24 h prior to sacrifice; during this period animals were supplied with water *ad libitun*. Pig sacrifice was conducted following the Mexican established procedure in municipal abattoirs (NOM-033-ZOO-1995, cited by Mota-Rojas *et al*., 2006). After slaughtering, the pigs were eviscerated and then liver, lung and heart fresh weight was determined. Besides, the length of the small and large intestine, caecum and major curvature of the stomach were determined after their separation from any mesenteric tissue. All length measurements were conducted with a flexible metallic ruler. Major curvature was the external length of the stomach from pylorus to cardias. Carcass dissection was carried out following the procedure cited by Méndez *et al*. (2002). In summary, carcass was weighed being hot, 45 min after slaughtering, then dissected after 24 h of refrigeration, by separating the skin and subcutaneous fat from primary cuts, after cutting up it from head and legs. Primary cuts were determined as recommended by Lemus and Alonso (2005) and then ham, loin shoulder, upper shoulder, belly and ribs were obtained from the cold left half carcass. All carcass components were weighed and expressed in either absolute weight or as percentage of carcass weight.

Several indices of meat quality were determined in samples from the right side of pig carcass. A penetration pH electrode attached to a digital pHmeter was employed to determine pH values of meat from loin and leg 45 min *postmortem,* according to the procedure described by Mota-Rojas *et al.* (2006). Water holding capacity of meat was determined 48 and 96 h after sacrifice from samples obtained by a cut in loin and estimated at 4°C (Lemus and Alonso, 2005). In the case of meat color and marbling, the technique based on Lemus and Alonso (2005) recommendations was used. In summary, meat color classification was based in a scale of 5 colors: pale, slight rose, gray rose, light red and dark red. Marbling was determined in *Longissimus dorsi* between the 10th and 11th ribs, according to a subjective scale: None, light, moderate, much and very much. Muscle scoring was determined following proper standards as described previously by Méndez *et al*. (2002). Briefly, three types of muscle were considered: Rank 1, thin, carcass shape angular, with legs and shoulder with a very lean appearance; muscle to bone ratio small; rank 2, intermediary appearance between extreme types of carcass, representing the average score; rank 3, thick, carcass appearance bulky in appearance, showing thick shoulders and legs, as a result of more meat than fat, convex shape exhibiting a high muscle to bone ratio.

Statistical analysis: All data were subjected to analysis of variance following Steel *et al.* (1997) including slaughter weight as co-variable, using the least squares General Linear Model (GLM) procedure of SAS. The statistical model employed was:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \beta(X_i - \chi) + E_{ijk}$$

Where:

- Y_{ijk} = Response variable
- μ = General mean
- A_i = Effect of factor A at i level (rearing system)
- B_j = Effect of factor B at j level (genotype)
- $(AB)_{ij}$ = Effect of interaction AB at ij level
- β = Regression coefficient
- X_i = Co-variable (slaughter weight)
- χ = General mean of the co-variable
- E_{ijk} = Random error on the k replica, level j of B and level i of A

Orthogonal contrasts were used to determine statistical differences in the means of the treatments of the evaluated variables. In some cases, when differences in treatment means were significant at the probability level of p<0.05 the means were compared using the Tukey test. In the case of certain meat quality indices, corresponding to color, marbling and muscle score. The statistical analyses were conducted by means of the χ^2-test (Steel *et al*., 1997).

RESULTS

There were not significant differences (p<0.05) for the interaction rearing system x genotype in any measurement conducted throughout this experiment. Highly significant (p<0.001) differences between genotypes was encountered for carcass yield and primary cuts adjusted

Table 1: Carcass traits of pigs as affected by breed and rearing system

	Carcass		Primary cuts			Thorax depth (cm)	Ham length (cm)
	Weight (kg[1])	Yield (%[1])	Length (cm)	Weight (kg[1])	Yield (%[1])		
Yorkshire x Landrace (YL) genotype							
Confinement (C)	73.08±1.66[2]	77.14±1.56	91.89±0.97	54.51±1.40	57.19±1.27	42.64±1.68	44.71±0.79
Grazing (G)	69.70±1.91	73.80±1.80	93.92±1.52	50.71±1.62	53.57±1.47	39.78±0.89	44.28±1.47
Pelón Mexicano (PM) genotype							
Confinement	59.57±2.53	61.01±2.38	63.57±1.46	36.06±2.14	35.34±1.94	29.28±0.42	40.92±1.84
Grazing	61.36±3.13	64.37±2.95	69.40±1.96	38.21±2.65	39.44±2.91	33.40±0.67	40.20±1.32
Orthogonal contrasts	Probability (α)						
PM vs YL	0.001	0.103	0.001	0.001	0.001	0.001	0.007
YL (C) vs YL (G)	0.295	0.079	0.266	0.073	0.032	0.050	0.800
PM (P) vs PM (G)	0.443	0.036	0.015	0.082	0.007	0.027	0.734

[1]Adjusted to slaughter weight as co-variable, [2]Mean and standard error

Table 2: Backfat characteristics of pigs as affected by breed and rearing system

	Back fat thickness (mm)				Loin depth (mm)	Fat and skin (kg[1])	Leg (kg)
	1st rib	10th rib	12th rib	5th lumbar			
Yorkshire x Landrace (YL) genotype							
Confinement (C)	41.7±2,21[2]	28.7±1.50	24.8±1.55	30.6±1.54	63.7±1.85	18.56±0.86	9.33±0.32
Grazing (G)	38.3±2.88	23.53±1.83	16.9±1.29	22.4±2.12	63.5±3.17	18.99±0.99	8.89±0.38
Pelón Mexicano (PM) genotype							
Confinement	51.7±1.05	36.26±1.97	35.4±1.68	37.7±3.89	58.1±3.86	23.51±1.31	4.20±0.10
Grazing	43.1±2.39	31.95±0.86	29.36±1.11	31.0±2.60	47.5±1.98	23.14±1.62	3.69±0.29
Orthogonal contrasts	Probability (α)						
PM vs YL	0.008	0.001	0.001	0.005	0.001	0.001	0.007
YL (C) vs YL (G)	0.298	0.031	0.001	0.017	0.955	0.784	0.800
PM (P) vs PM (G)	0.042	0.153	0.035	0.111	0.026	0.185	0.734

[1]Adjusted to slaughter weight as co-variable, [2]Mean and standard error

Table 3: Head, legs and some internal organ weight of pigs as affected by breed and rearing system (in kg)

	Head [1]	Legs[1]	Liver[1]	Lungs	Heart
Yorkshire x Landrace (YL) genotype					
Confinement (C)	6.61±0.25[2]	1.45±0.04	1.42±0.09	0.25±0.01	0.41±0.02
Grazing (G)	6.94±0.28	1.66±0.05	1.55±0.11	0.32±0.05	0.44±0.02
Pelón Mexicano (PM) genotype					
Confinement	5.51±0.38	1.35±0.07	1.48±0.15	0.14±0.01	0.17±0.01
Grazing	5.01±0.47	1.53±0.09	1.54±0.18	0.12±0.01	0.19±0.01
Orthogonal contrasts	Probability (α)				
PM vs YL	0.001	0.101	0.001	0.001	0.001
YL (C) vs YL (G)	0.258	0.237	0.280	0.066	0.439
PM (C) vs PM (G)	0.045	0.598	0.765	0.559	0.644

[1]Adjusted to slaughter weight as co-variable, [2]Mean and standard error

to slaughter weight as co-variable (Table 1). However, carcass yield expressed as percentage of slaughter weight only tended ($p<0.103$) to favour YL pigs. Differences between rearing systems were less marked, with better carcass traits in either totally confined YL animals or partially confined, outdoors reared PM pigs.

The characteristics of backfat in the evaluated pigs appear in Table 2. The genotype effect was at least significantly ($p<0.01$) different in all measurements, indicating a higher fat content in carcasses of PM pigs, when compared to YL animals. From the point of view of the effect of rearing conditions, this factor affected less pronounced backfat measurements, with lower values in either improved or local pigs subjected to grazing. This effect was very evident for backfat thickness at the 12th rib level, being significantly different in YL ($p<0.001$) and PM ($p<0.035$) genotypes. In the case of backfat thickness located at the fires and 10th rib, the effect was weak in both genotypes. On the other hand, the fat and skin weight was considerable higher ($p<0.001$), on average 23 kg, in PM pigs whereas this same index was on average 18 kg in the improved animals.

Table 3 lists head, leg and some internal organ weight, liver, lung and heart weight of the evaluated pigs, as influenced by breed and rearing system. Overall, there was a clear trend to YL animals to exhibit significantly ($p<0.001$) heavier body parts as those examined in the current investigation. Although a significant effect ($p<0.001$) was found between genotypes for liver weight, this contrast showed a very small numerical value. On the other hand, the rearing factor had practically no influence in head, legs or in liver, lungs and heart weight of the animals.

Table 4: Length of some digestive organs of pigs as affected by breed and rearing system

	Expressed in m		Expressed in cm	
	Small intestine	Large intestine	Caecum[1]	Stomach curvature[1]
Yorkshire x Landrace (YL) genotype				
Confinement (C)	19.30±0.43[2]	4.98±0.16	18.98±1.08	41.28±2.02
Grazing (G)	19.40±0.25	4.91±0.26	17.99±1.25	47.41±2.33
Pelón Mexicano (PM) genotype				
Confinement	11.22±0.37	3.67±0.29	20.51±1.65	46.32±3.09
Grazing	10.85±0.81	3.76±0.19	24.84±2.04	57.97±3.82
Orthogonal contrasts	Probability (α)			
PM vs YL	0.001	0.001	0.004	0.001
YL (C) vs YL (G)	0.883	0.832	0.421	0.022
PM (C) vs PM (G)	0.658	0.821	0.821	0.009

[1]Adjusted to slaughter weight as co-variable, [2]Mean and standard error

Table 5: Meat quality in pigs as affected by breed and rearing system

	pH		Water holding capacity (%)				
	Loin	Leg	48 h	96 h	Color	Marbling	Muscle score
Yorkshire x Landrace (YL) genotype							
Confinement (C)	5.66±0.09[1]	5.70±0.08	93.02±1.09	86.23±1.15	2.42±0.12	1.85±0.20	2.14±0.08
Grazing (G)	5.48±0.12	5.63±0.10	88.95±1.33	83.32±1.46	2.57±0.31	1.57±0.20	2.64±0.09
Pelón Mexicano (PM) genotype							
Confinement	5.84±0.07	5.90±0.08	92.62±2.92	82.77±3.19	2.71±0.18	1.71±0.18	2.00±0.10
Grazing	5.68±0.04	5.75±0.03	89.45±1.96	88.20±1.86	2.90±0.18	1.80±0.20	1.60±0.10

[1]Mean and standard error

It was observed that the length of some reservoir digestive organs, caecum and stomach major curvature were significantly ($p<0.01$) higher in PM than in YL pigs (Table 4), these differences being higher in the stomach ($p<0.001$) than in caecum ($p<0.004$). Rearing system appeared not to have significantly ($p>0.05$) affect intestinal length, except for the stomach curvature, which was significantly longer in YL ($p<0.022$) and PM ($p<0.009$) pigs subjected to daily grazing activities.

The χ^2-test indicated that neither genotype nor rearing system had significant ($p>0.05$) influence in any of the meat quality indices measured in the current study (Table 5).

DISCUSSION

This investigation tends to confirm data from others claiming that carcass traits of PM pigs are not comparable to that of other, improved, exotic pigs (López *et al*., 1999; Lemus and Alonso, 2005), when the conventional, standard procedures designed for evaluation those types of animals are applied, in the sense that pigs such as those from the YL cross, which have been systematically selected or crossed for low backfat thickness and high *Longissimus dorsi* area, are utilized for comparative purposes. In fact, results from the current study related to backfat thickness and fat and skin contribution to carcass weight further confirmed observations from others (cited by Lemus and Alonso, 2005; Méndez *et al*., 2002) related to differences in body composition which indeed exists between PM pigs and improved breeds, if it is considered that PM is a genotype with characteristics of fatty animals. These results are otherwise in accordance with other from several countries of the Caribbean basin concerning creole pigs (Rinaldo *et al*., 2003). On the other hand, did not find evidence of differences in carcass traits between female and castrate PM pigs; however, these findings could not be examined in this experiment, since the sex effect was confounded. From the point of view of rearing system of pig production, grazing conditions such as those described in this communication, probably may not contribute in an outstanding manner to a better carcass status in PM and other improved pigs, such as the YL crosses. Obviously, more research must be executed in this direction, if a grazing, rearing system is intended to be applied in PM pig husbandry, at least during the growing and finishing stage of the animal life.

Differences between genotypes for digestive organ length indicated that some digestive indices could be modifying the digestive capacity of PM pigs, since according to Qin *et al.* (1995), the morphometry of the gastrointestinal tract is related to the efficiency of digestion and to the partition of digestion into enzymatic and microbial processes in pigs. In fact, in this experiment it was encountered that large intestine: Small intestine ratio was from 0.253-0.258 in YL pigs, whereas this same length ratio was 0.328-0.347 in the PM animals. There is very few information concerning the morphometry of the alimentary canal in creole pigs, the PM pig included. As illustration (cited by Pérez *et at*., 1999, Méndez *et al*., 2002; Canul *et al*., 2005), reported large intestine:small intestine ratio of 0.972 and 0. 687 in weight for castrate male and female PM pigs from Yucatán, the large intestine accounting for 34.7-41.4% of the total gastrointestinal weight. However, comparison was not made with improved animals. In this connection, Diéguez *et al.* (1995) found that large intestine contributed to some 48.2% of the total gastrointestinal fresh weight in Cuban Creole pigs, whereas this same index was 41.4% in improved pigs, when both genotypes were compared in basis of a similar live weight. However, when Diéguez *et al.* (1995) compared intestinal length in term of length/live weight, the encountered values were similar between the two examined genotypes. It is evident that more research is needed in this direction, together with more information considering the existing relationship, if any, between gastrointestinal morphometry and digestibility indices or even energy requirements for maintenance (Koong *et al*., 1982).

Meat quality appears not be influenced by genotype, if YL pigs are compared to PM animals, according to the present study. These results indicated that, although carcass traits are not comparable when improved animals are contrasted to PM, meat quality with no genotype influence in any case, supports the idea that PM pigs are good meat producer animals. Moreover, Rinaldo *et al.* (2003) have suggested that indigenous pigs of the Caribbean and Latin America areas would be most useful for the production of high quality transformed products from meat, therefore supporting the herein reported findings on PM pigs.

It is considered that a total or partial confinement, consisting on daily grazing outdoors, rearing system, has less influence on carcass traits in pigs when PM and YL pigs are compared. The reverse is true when these same genotypes are compared as such. Nevertheless, meat quality values did not reveal to be affected by both genotypes and rearing system as those assayed in the current study. More investigations should be conducted to further evaluate other factors influencing carcass traits and meal quality indices (Mota-Herrera *et al*., 2006; Becerril-Rojas *et al*., 2008), including digestive system characteristics in PM pigs.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support of SEP-PIFI-2001-UAN. Fondos SAGARPA-Conacyt 2002, Proy. CO1-1472, Mexico.

REFERENCES

Becerril-Herrera, M., C. Lemus-Flores, H.J.G. Herrera, M. Alonso-Spilsbury, R. Ramírez-Necoechea and D. Mota-Rojas, 2006. Apparent digestibility and growth in 2 swine genotypes kept under pasturing and confinement conditions. Pak. J. Biol. Sci., 9 (14): 2630-2635. http://www.ansijournals.com/pjbs/2006/2630-2635.pdf.

Becerril-Herrera, M. *et al*., 2008. CO_2 stunning may compromise swine welfare compared with electrical stunning. Meat Science. DOI: 10.1016/j.meatsci.2008.07.025.

Canul, S.M., V.A. Sierra, M.A. Martínez, O.J. Ortiz, J.V. Delgado, J.L. Vega-Play, G.F. Pérez, 2005. Genetic characterization of the mexican hair-less pig by means of molecular markers. Arch. Zootech., 54: 267-272. http://www.uco.es/organiza/servicios/publica/az/php/img/web/09_13_56_Caracterizacion Canul.pdf.

Diéguez, F.J., J. Ly, I. Maza, F. Savigni and M. Tosar, 1995. Morfometría de los órganos vitales en cerdos criollos y CC21. Livest. Res. Rural Dev., 6: 3. http://www.cipav.org.co/lrrd/6/3/die.html.

Koong, L.J., J.A. Nienaber, J.C. Pekas and J.T. Yen, 1982. Effect of plane of nutrition on organ size and fasting heat production in pigs. J. Nut., 112: 1638-1643. http://jn.nutrition.org/cgi/reprint/113/8/1626.

Lemus, C. and M.L. Alonso, 2005. The Hairless Mexican pigs and other creole pigs. Universidad Autónoma de Nayarit. Tepic, Mayo. Primer tiraje 1000 ejemplares. pp: 251. ISBN 968833064-7.

Lemus, F.C., M.R. Alonso, M. Alonso-Spilsbury and N.R. Ramírez, 2003. Morphologic characteristics in mexican native pigs. Archivos de Zootecnia, 52 (197): 105-108. http://www.uco.es/organiza/servicios/publica/az/php/img/web/30_13_01_15notalemus(morpho).pdf.

López, J.L., G. Salinas and R. Martínez, 1999. Mexican Hairless Pig. Antecedents and Perspective. 1st Edn. El Cerdo Pelón Mexicano. Antecedentes y Perspectivas. Ciencia y Cultura Latinoamericana. México D.F., pp: 78. ISBN: 968-7860-43-X.

Méndez, R.D., M. Becerril, M.S. Rubio and E.J. Delgado, 2002. Carcass traits of Hairless Mexican pigs from Mizantla in the state of Veracruz, Mexico. Vet. Méx., 33: 27-37. http://www.medigraphic.com/espanol/e-htms/e-vetmex/e-vm2002/e-vm02-1/em-vm021c.htm.

Mota-Rojas, D., M. Becerril, C. Lemus, P. Sánchez, M.S.A. González, S.A. Olmos, R. Ramírez and M. Alonso-Spilsbury, 2006. Effects of mid-summer transport duration on pre-and post-slaughter performance and pork quality in Mexico. Meat Sci., 73 (3): 404-412. http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6T9G-4JJ884W-1-2&_cdi=5114&_user=10&_orig=browse&_coverDate=07%2F31%2F2006&_sk=999269996&view=c&wchp=dGLbVlWzSkWz&md5=bfad0db1d09c4f715b401fe0930ce0a7&ie=/sdarticle.pdf.

Pérez, C.L.B., L.M.S. Rubio, M.D. Méndez, K.J. Feldman, Ch. F.A. Iturbe, 1999. Evaluación química y sensorial de morcón de cerdo Pelón Mexicano y cerdo Mejorado. Vet. Méx., 30 (1): 41-48. http://www.fmvz.unam.mx/fmvz/revvetmex/a1999/rvmv30n1/rvm30106.pdf.

Qin, G.X., M.W.A. Verstegen and M.W. Bosch, 1995 Variation of digestive capacity between genetically different pig populations: A review. J. Anim. Physiol. Anim. Nutr., 73: 233-242. http://library.wur.nl/WebQuery/wurpubs/lang/28839.

Rinaldo, D., I. Canope, R. Christon, C. Rico, J. Ly and F. Diéguez, 2003. Creole pigs in Guadeloupe and Cuba: A comparison of reproduction, growth performance and meat quality in relation to dietary and environmental conditions. Pig News Inf., 24: 17N-26N. http://www.inra.fr/compact/nav/externe/en/unites/pages/143.

Steel, R.G.W., J.H. Torrie and M. Dickey, 1997. Principles and Procedures of Statistics: A Biometrical Approach. 2nd Edn. McGraw Hill Book Co. Inco. New York, pp: 666. ISBN: 9780070610286.