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Apparent Digestibility and Growth in Two Swine Genotypes Kept under Pasturing and Confinement Conditions

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Abstract: The study was carried out with 13 Mexican Hairless (MHP) and 21 York-Landrace (Y-L) fattened pigs, randomly distributed in 4 treatments: 1) MHP under total confinement, 2) MHP in pasturing conditions, 3) Y-L in total confinement and 4) Y-L in pasturing conditions, all four groups were fed *ad libitum*. Morph metric growth in 63 days old pigs showed significant differences ($p<0.0001$) between breeds; however, at the end of the study (175 days old) significant differences were observed ($p<0.05$), both between breeds and between productive systems for the following variables: height at withers, hind- and fore- cane perimeters and snout length; indicating that the feeding system caused some hypertrophies in the organs mostly exercised. Results on the percentage of ileal apparent digestibility showed significant differences ($p<0.001$) between breeds and between productive systems too, whereas in the total apparent digestibility, differences between feeding-productive systems were only significant in the MHP. Results indicate that the MHP is a small size animal with thin limbs, these pigs show a great instinct for forage consumption but are unable to take advantage of this since they can not digest fiber, which ends with the myth that swine autochthonous breeds are able to digest fiber.

Key words: Creole pig, apparent digestibility, morphology measurements

INTRODUCTION

Considering the worldwide inventory of pigs, it is estimated that approximately 25 to 35% belong to local genotypes (FAO, 1994), not well defined but surely resulting from uncertain crossbreeds basically of main species and in a less number, of local breeds not well spread or deficiently characterized, but that undoubtedly constitute a genetic reservoir that should be part of future germoplasm stock. This is essential for crossbreeding programs in order to introduce certain genes important for the swine industry, such as those related with swine stress syndrome, subcutaneous fat rich in unsaturated fatty acids, resistance to diseases and tolerance factors on extreme weather conditions (Lemus *et al*., 1999, 2001; Rubio and Mendez, 2000).

Mexican indigenous pigs are known by the generic names: Mexican Hairless Pigs (MHP) and Cuinos. However, these pigs are not very commercial, they have a very low sale price due to excess of backfat that has to be discarded causing a decrease of 30 to 40% in the market price in comparison with genetically improved breeds (Cenobio, 1993; Lemus *et al*., 1999; Mendez, 1997); nevertheless, it has been proven that the consumption of products from this kind of pig do not cause health problems since its fat is mainly constituted by unsaturated fatty acids (Perez *et al*., 1999; Rubio and Mendez, 2000).

Currently, there has been a genetic absorption of Creole animals by improved breeds endangering their existence, as a consequence of deliberate crossbreeds of females with improved sires of different breeds, supposedly to increase their production in few generations (Chupin, 1994), which has not been accomplished yet under the breeding conditions of the MHP. Indeed, according to FAO (1992) the conservation of animal genetic resources is deemed to be essential in the light of a rapid loss of varieties and breeds through

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dilution and breed replacement. The MHP is a rustic breed, raised with low veterinary, husbandry and feed inputs, foraging being the main daily diet (Cenobio, 1993; Chel *et al*., 1983), forages constitute the only protein source they consume since few grains are administered into the diet (Cárdenas, 1969; Cenobio, 1993). It is hypothesized that Creole pigs have higher capacity to use tough materials in their diet compared to other breeds. The objectives of the present study were to evaluate the morphometric growth through body measurements and to analyze the ileal and faecal apparent digestibility with the addition of Cr_2O_3 in the feed of Mexican Hairless and York-Landrace pigs in pasturing and confinement conditions.

MATERIALS AND METHODS

Two groups of pigs were used in this study, both were brought from the MHP and York-Landrace (Y-L) breeding stocks of the Veterinary Medicine and Zootechnics Faculty of the Autonomous University of Nayarit, located in the 3.5 km of the Compostela-Chapalilla highway of the Municipality of Compostela, Nayarit in Mexico. Female pigs and barrows were used at 63 days of age and were randomly distributed in 4 groups (Table 1).

Feeding systems: Groups of pigs raised under pasturing conditions were taken to a grass (*Brachiaria brizantha*) prairie during approximately 8 h (9:00 to 16:00 h) every day. In order to protect animals from predators and adverse weather conditions, they were housed overnight in corrals located at the prairie, where they were provided with food and water *ad libitum*. The period of treatment lasted 4 months. Two types of balanced feed were used, according to the physiologic requirements of the animals:

- Growing stage: animals were fed with balanced feed with 17% protein content that provided 3,100 kcal; this stage took the first two months, when the animals were 2 months old until they reached 4 months of age.
- Finishing stage: this stage lasted the next two months and concluded after 175 days; food contained 14% protein and provided 3,100 kcal. This balanced feed was based on sorghum and a commercial supplement with 36% protein.

Morph metric traits: Morph metric measurements were performed when pigs were 63 days old (at the beginning of the experiment) and at 175 days of age (close to slaughter age), in order to characterize the MHP as well as the Y-L crossbreed; the obtained measurements were: snout length, height at withers, height of the rump, body length (up to the back), thoracic perimeter, hind- and fore-cane perimeters. All these measurements were carried out according to the methodology described by Cárdenas (1969), Flores (1992), Becerril (1999, 2003) and Méndez *et al.* (2002).

Apparent ileal and faecal digestibility: Five days before slaughter, food was added with chromic oxide (Cr_2O_3) as a non-digestible and non-absorbable marker. The used dose was 0.25% in a powder presentation, according to Stein *et al.* (1999).

After slaughter, samples of intestinal content from the final part of the small intestine (ileum) and the final part of the large intestine (rectum) were gathered; the chromic oxide concentration was quantified and was compared with the dose in food. Ileal digestibility was determined with the following model:

$$DI_a = [(D_{Cr} - F_{Cr}) / (D_{Cr})] * 100$$

Where:
DI_a = Ileal apparent digestibility.
D_{cr} = Chromic oxide concentration in ileal digest (mg kg^{-1}).
F_{Cr} = Chromic oxide concentration in food (mg kg^{-1}).

Faecal apparent digestibility was determined with the following model:

$$DF_a = [(DI_a - DFE_a) / (DI_a)] * 100$$

Where:
Df_a = Faecal apparent digestibility.
Di_a = Chromic oxide concentration in faecal digest (mg kg^{-1}).
DFE_a = Chromic oxide concentration in food (mg kg^{-1}).

A *Varian Spectr AA 50 spectrophotometer was used to determine the chromic oxide concentration in feed and in intestinal content according to the atomic absorption technique.

Table 1: Experimental design

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
No. of animals and breed	7 Mexican hairless pigs	6 Mexican hairless pigs	14 York-landrace pigs	7 York-landrace pigs
Housing and feeding system	Total confinement and *ad libitum* balanced diet	Pasture and *ad libitum* balanced diet	Total confinement and *ad libitum* balanced diet	Pasture and *ad libitum* balanced diet

Statistical analysis: Results obtained were analyzed totally at random using a design with a covariable and factorial arrangement 2^2 and the procedures used were as follows:

- An Analysis of Variance (ANOVA) was elaborated according to the model, including the co-variable.
- An analysis of variance by stages was run in morph metric measurements, using the initial weight as co-variable in each stage.

The statistical model employed was:

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \beta (X_i - \bar{x}) + Eijk$$
$$i = 1,2$$
$$j = 1,2$$

Where:

Y_{ijk} = Response variable
μ = General mean
A_i = Effect of factor A at i level (food type)
B_j = Effect of factor B at j level (sex)
$(AB)_{ij}$ = Effect of interaction AB at i,j level.
β = Regression coefficient
X_i = Co-variable (live weight)
$\bar{x}$ = General mean of the co-variable
E_{ijk} = Random error on the k repetition, 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. SAS version 6.12 (1996) was used for statistical analyses.

RESULTS AND DISCUSSION

Results on the morph metric measurements of pigs at 63 days of age are summarized in Table 2. Y-L pigs under confinement and pasturing conditions showed highest values compared with MHP; high significant differences were found between breeds ($p<0.0001$), but not within breeds. This can be explained because when the animals were 63 days old, they were under different treatments and the feeding system was not yet detected in the productive performance of the animals. Even in some variables such as snout length, there were no significant differences between breeds and evaluated feeding schemes.

After almost 4 months under different feeding systems, morph metric measurements were carried out; these are shown in Table 3. Y-L pigs under pasturing conditions showed the best growth rate and the highest values in the evaluated variables except for the thoracic perimeter, which had the lowest figure. On the contrary, MHP in confinement had the highest figures, which were quite similar to MHP in pasture and Y-L in confinement. In Y-L pigs in confinement this can be explained because animals at this age increase significantly their backfat deposition, which also causes an increase in the thorax circumference. It is worth mentioning that these animals at the end were the ones with the highest live weights; maybe due to fatty tissue deposition, rather than to the increase of bone tissue and muscular masses.

Hind limbs from Y-L animals were higher than their forelimbs ($p<0.05$); on the contrary in MHP, forelimbs were higher than hind limbs.

Snout length in animals kept under pasturing conditions was bigger ($p<0.05$), than that of animals of the same breeds but under confinement conditions.

With regard to cane perimeters, animals under pasturing conditions registered the highest figures ($p<0.05$). MHP in pasture canes´ measurements did not exceed those obtained by their counterparts in confinement, but taking into account the difference in live weight, certainly there was a hypertrophy of the canes in MHP under pasturing conditions. Therefore, the feeding system caused some hypertrophies in the organs that worked the most.

Table 2: Morph metric at 63 days of Mexican hairless and York-Landrace pigs in confinement and pasture, mean and standard error values adjusted to the covariable weight

Variable	Withers height (cm) Mean±SE	Croup height (cm) Mean±SE	Back length (cm) Mean±SE	Forelimb cane Perimeter (cm) Mean±SE	Hind-limb cane perimeter (cm) Mean±SE	Snout length (cm) Mean±SE	Thoracic perimeter (cm) Mean±SE
Y-L in confinement n = 14	41.00±0.42	40.53±0.40	49.89±0.98	10.55±0.10	10.55±0.11	6.68±0.20	54.85±0.62
Y-L in pasture n = 7	39.85±0.70	39.42±0.68	47.40±1.63	10.32±0.16	10.35±0.18	6.55±0.21	54.28±1.04
CPM in confinement n = 7	35.55±0.69	37.33±0.67	45.45±1.61	9.42±0.16	9.67±0.18	6.78±0.34	53.62±1.03
CPM in pasture n = 6	37.65±0.93	38.46±0.90	51.32±2.17	9.63±0.22	9.62±0.24	5.50±0.22	51.26±1.39
Orthogonal contrasts	Probability (α)						
CPM vs. Y-L	0.0001	0.0001	0.0001	0.0001	0.0001	0.2570	0.0001
Y-L pasture vs. Y-L confined	0.1032	0.0956	0.2878	0.1014	0.0745	0.7783	0.0454
MHP pasture vs. MHP confined	0.6834	0.2974	0.5871	0.2708	0.0745	0.0628	0.0074

Y-L: York × Landrace pigs; MHP: Mexican Hairless Pigs

Table 3: Morph metric at 175 days of Mexican hairless and York-Landrace pigs in confinement and pasture, mean and standard error values adjusted to the covariable weight

Variable	Withers height (cm) Mean±SE	Croup height (cm) Mean±SE	Back length (cm) Mean±SE	Forelimb cane Perimeter (cm) Mean±SE	Hind-limb cane perimeter (cm) Mean±SE	Snout length (cm) Mean±SE	Thoracic perimeter (cm) Mean±SE
Y-L in confinement N = 14	67.82±0.92	71.03±0.92	85.34±2.01	16.22±0.24	16.26±0.21	9.80±0.24	101.64±1.04
Y-L in pasture N = 7	71.51±1.08	71.55±1.08	90.13±2.35	17.09±0.28	16.97±0.25	10.69±0.28	101.03±1.22
CPM in confinement N = 7	68.34±1.39	66.55±1.38	82.10±3.01	14.63±0.36	15.56±0.32	10.10±0.36	102.53±1.57
CPM in pasture N = 6	68.14±1.84	66.52±1.84	79.52±4.00	14.01±0.47	14.74±0.43	10.85±0.48	102.66±2.08
Orthogonal contrasts	Probability (α)						
CPM vs. Y-L	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Y-L pasture vs. Y-L confined	0.0318	0.8634	0.1016	0.0236	0.0820	0.0193	0.5945
MHP pasture vs. MHP confined	0.1675	0.2444	0.1003	0.0167	0.0038	0.4869	0.1348

The treatments in the experiment not only reflect differences between breeds, but also, that the used feeding scheme influenced the productive performance of the animals and benefic changes may be obtained (less backfat deposit and limb hypertrophy) in genetically improved pigs without having to sacrifice growth and weight gain matters.

When comparing morph metric measurements in MHP with previous studies carried out by Cárdenas (1969) and Becerril (1999), the following information was obtained: although MHP live weight reported by Cárdenas (1969) is greater (81.530 kg) to the one reached by the pigs in the present study (57.57 kg for MHP in confinement and 45.30 kg for the MHP in pasture), MHP in this investigation had better height at withers and hind- and fore- cane perimeters; but not in the height of the rump, body length and thoracic perimeter, the MHP evaluated by Cárdenas presented higher figures. On the other hand, all figures reported by Becerril (1999) dramatically overcome the ones obtained in the present study. Differences on the animals´ age in the studies may explain the differences obtained. Nevertheless, all agree that it will take more than 6 months a MHP to reach 60 kg. Comparisons show that young animals have more developed limbs, whereas adults have a more developed body and consequently, more fat tissue. Morph metric results indicate that MHP are small and have thin limbs; indicating that current husbandry has been employed to guide these animals to produce enormous amounts of fat.

Table 4 shows the means and standard error of ileal apparent digestibility and total apparent digestibility of the 4 treatments used in the study.

With regard to ileal apparent digestibility all the contrasts evaluated showed significant differences; there were differences between breeds and between feeding systems ($p<0.0001$). Y-L animals in confinement had the highest numeric values compared with the other treatments. On the other hand, MHP under pasturing conditions presented the lowest figures in ileal digestibility, which is attributed to the fact that these animals spent most of the day pasturing, showing a small increase in size in comparison with the pigs of the same genotype managed in confinement conditions.

MHP under confinement conditions showed the highest total apparent digestibility figures; there were significant differences in almost all orthogonal contrasts ($p<0.0001$), except for Y-L pigs in pasture vs. Y-L pigs in confinement. This reveals that when a genetically improved pig is introduced in a pasturing environment and is also fed with commercial feed, the animal will prefer commercial feed to satisfy its nutritious requirements and grass intake is practically useless. On the other hand, MHP in pasture had the lowest figure, which is justified again due to grass consumption.

There is a common popular belief that Creole pigs still keep the ability of rustic behavior, walking long distances, great ability to root, tolerance to warm weather, ability to look for feed sources and even a preference for feed rich in fiber. Garin *et al*. (2002) reported a greater consumption of fresh forage in Creole pigs of Uruguay in comparison with genetically improved pigs. Nevertheless, results gathered in Table 3 reveal that MHP can not digest feed rich in fiber, although this is mostly preferred. It is important to emphasize that digestive capacity of MHP is not inferior to that of an improved pig; the reason of its slow growth rate is attributable basically to genetic factors.

In order to exemplify Table 3, measured values corresponding to ileal apparent digestibility and total apparent digestibility are depicted in Fig. 1.

Pérez (2006) monitored for 35 days the digestibility of nutrients in diets with 20% of alfalfa flour administered to hybrid breeding pigs and found no effect on the animals performance, in addition he observed that over the time the digestive tract was able to use better the protein and ash contents from the alfalfa flour; the maximum digestibility index was obtained at 21 days and was maintained until the end of the study; however the fiber digestibility index was not improved. In another

Table 4: Ileal and faecal apparent digestibility in Mexican hairless and York-Landrace pigs in confinement and pasture conditions

Variable	Ileal apparent digestibility Mean±SE	Faecal apparent digestibility Mean±SE
Y-L in confinement n = 14	66.58±1.62	73.16±1.22
Y-L in pasture n = 7	57.84±2.01	75.55±2.15
CPM in confinement n = 7	52.38±5.22	80.25±0.87
CPM in pasture n = 6	15.19±1.45	29.88±1.18
Orthogonal contrasts	Probability (α)	
CPM vs. Y-L	0.0001	0.0001
Y-L pasture vs.Y-L confined	0.0096	0.2474
MHP pasture vs. MHP confined	0.0001	0.0001

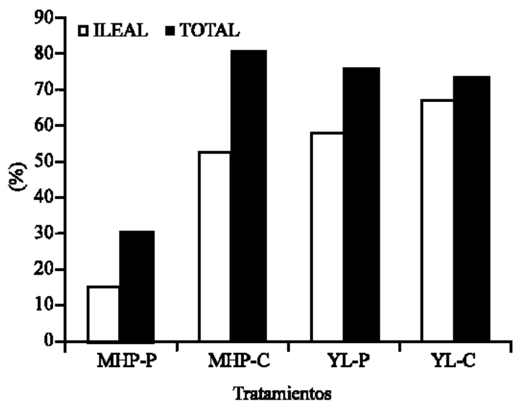

Fig. 1: Ileal apparent digestibility in Mexican hairless and York-Landrace pigs in confinement and Pasture. MPH-P: Mexican Hairless Pig in Pasture; MPH-C: Mexican Hairless Pig in Confinement; Y-L P: York-Landrace in Pasture; Y-L C: York-Landrace in Confinement

study Ly *et al.* (1995) administered 30% of banana residues in Creole pig diets and found the same low pattern for the fiber digestibility index. On the other hand, Arrioja *et al.* (1997) report that pigs are able to assimilate neutral detergent fiber (NDF) up to 54%, as far as there are low lignin levels and fiber may be of good quality. The comparison of the results from the present study with the above mentioned studies, make us conclude that fiber present in the pasture utilized (*Brachiaria brizantha)* was of bad quality and was not digested by MHP or by Y-L pigs. In addition, the nitrogen rate of assimilation was affected with consequences in the muscle mass.

It is worth mentioning that findings in this study do not show differences, but contradict some other studies such as those carried out by Chel *et al.* (1983) who determined that in MHP the capacity to digest alfalfa flour is not high; or studies from Dieguez *et al.* (1995) and Ly *et al.* (1995) who stated that there are no differences between Creole and improved pigs with regard to gastrointestinal tract weight, or in the capacity to digest diets rich in poor quality fiber. MHP shows a great instinct for forages consumption, although they are not able to take any advantage of it. This ends the myth that autochthonous swine breeds are capable to digest fiber.

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