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Effect of Kitchen Leftovers on Body Measurements and Pork Carcass Quality

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Abstract: The use of kitchen waste or leftovers in animal feeding is limited basically by its high nutritious variability and for sanitary reasons; although it represents an option in the artisan pig raising system, its effect on the carcass quality has not been evaluated yet. In this study 50 hybrid pigs from a family pig farm were evaluated; animals were distributed by sex at random: T1: 15 females and T2: 15 castrated males, both groups fed with left-overs; T3: 10 females and T4: 10 castrated males, fed with balanced commercial food. Tukey test was used to determine significant differences between the treatments'. Pigs fed with leftovers had less height and less corporal length and a high leg development; an increase in the backfat covering and smaller development of the Longissimus dorsi muscle as well. Besides, these animals had carcasses of smaller length, compared with pigs fed with balanced commercial feed, which showed carcasses of better quality, as well as higher values in the viscera. Contrary to what was expected, in barrows fed with kitchen leftovers the backfat deposition was favored in comparison with the females fed in the same way.

Key words: Pig, kitchen leftovers, carcass quality, backfat

INTRODUCTION

In accordance with the Mexican Official Norm NOM-037-200-1995, the term kitchen waste or leftovers corresponds to every food waste or food remains that are used for pig feeding. In Mexico, the use of household swill to feed pigs as a main nutrition source goes back to the beginnings of swine raising during the Colonial period[1]. With the industrialization of the sector, this feeding practice was relegated to the level of self-sufficiency, which has not transcended due, among other factors, to the lack of knowledge on its appropriate use[2]. Some of the main obstacles for its use are the great variability in its chemical composition[2-5] and the sanitary aspect in which the risk of disease transmission is present[6].

According to Restrepo and Phillips[7] and Grande[8], in Mexico City every day more than 90 tons of tortilla and more than 75 tons of bread are wasted. Considering, as these authors estimate, the total waste of other feed like bean and rice is equally enormous, a final estimate of 10% of feed bought in every home in Mexico City is wasted. This is an indicator of the volumes generated from such resources and the importance it would have if it is directed for animal feeding.

At the moment the use of leftovers has been reconsidered in some countries, in some of them it has gained importance due to its considerably low cost (MX $0.20 kg). In the United States, this product has been dehydrated in order to be used for fattening pigs[9] in Latin American countries, nowadays, Cuba has advanced considerably in this area[4,5] and Colombia[10] as well. Evaluations regarding the use of household scraps have also been made in finishing pigs in Mexico[2,8].

The objective of the present study was to evaluate the quality of cold and hot carcasses of hybrid pigs fed with leftovers.

MATERIALS AND METHODS

The study was carried out in a family pig farm for located in the municipality of Amecameca, in the State of Mexico. The slaughterhouse was located in Amecameca, 5 km. from the farm. The leftovers gathered were obtained from a military camp (CABIR), which is a military community that belongs to the municipality of Temamatla,

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State of Mexico, located 24 km from the mentioned municipality. Waste was gathered daily and transported in 200 kg plastic barrels.

Fifty hybrid pigs were used coming from crossbreeding females (Landrace x Hampshire) and Duroc stud. Animals were weighed and the experiments began when they were 90 days old (initial weight). Ten corrals were adapted with 5 pigs each. Males were castrated in the first week of age. All the animals used for the study were distributed by sex at random in the following treatments:

Treatment 1 (T1): 15 Females fed with left-overs (FL).
Treatment 2 (T2): 15 Males fed with left-overs (ML).
Treatment 3 (T3): 10 Females fed with balanced commercial feed (FC).
Treatment 4 (T4): 10 Males fed with balanced commercial feed (MC).

Feed supply was provided *ad libitum* for the 10 corrals and it was weighed every day before the animals consumed it. Animals from corrals 1 to 6 were given leftovers on a humid base *ad libitum* in 3 sessions per day: 6:00, 13:00 and 18:00 hours, whereas animals from corrals 7 to 10, were given commercial feed in a dry base *ad libitum* in 2 sessions, at 6:00 and 18:00 hours.

When the animals were 240 days old, different body measurements were carried out according to Cardenas[11], Flores[12], Becerril[13,14] and Mendez *et al.*[15] methodology. Backfat coverage was determined in the following places: 1 (third thoracic vertebra), 2 (tenth thoracic vertebra) and 3 (first lumbar vertebra) and the pork chop eye area using the ultrasonic Renco Pregnat-Alert®. Next, animals were weighed before being transferred to the slaughterhouse (slaughtering weight), in order to determine the average of the hot carcass yield or slaughtering yield.

At the abattoir pigs were identified with cards so it would be easier to determine the corral where they belonged and their own number inside each corral. Animals were slaughtered under the Mexican Official Norm 034[16]. After evisceration, the procedure was the weighing-in of the tongue, trachea, heart, lungs, heart (with blood and clots), stomach (with content), liver, spleen and abdominal viscera (with feces). Next, the following measurements were obtained: stomach's great curvature, length of the small and large intestine, cecum and the spleen as well.

In the carcass, a reglet was used to measure the backfat. The carcass length, depth of the thorax and length and roundness of the ham were measured using the methodology settled by the United States Department of Agriculture[17]. Once the carcass dressing was concluded, then the weighing-in was carried out in hot carcasses.

The results obtained were analyzed totally at random using a design with a covariable and factorial arrangement 2^2, with the following model:

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

i = 1,2
j = 1,2
Where:

Yijk = Variable result (body measurements, carcass yield, etc.)
μ = General mean
Ai = Effect of factor A at i level (feed type)
Bj = Effect of factor B at j level (sex)
(AB)ij = Effect of the interaction AB at the i,j level
β = Regression coefficient
Xi = Covariable (final weight, weight at slaughter)
$\bar{x}$ = General mean of the covariable
Eijk = Random error in repetition k, level j of B and level i of A.

Tukey test was used in order to determine significant differences between the treatment means. The significance level considered for the statistical tests was $p<0.05$.

The SAS program (version 6.12), was used for the analyses of the effects of the treatments on the variables[18].

RESULTS AND DISCUSSION

Table 1 shows the results of the three proximal chemical analyses carried out on three samples of leftovers, in terms of the mean and the standard error of the mean. According to Domínguez[4,5] the great humidity content in the leftovers from human consumption causes nutrients to be diluted, for this reason low values of dry matter are obtained. This effect was presented in the swills used in this study. However, the variability that is mentioned in other works in the scraps[3,5,19-21], was found only in some fractions of the analyzed resource (dry matter, ethereal extract); uniformity was present in the rest.

Just like other authors[2,3], high levels of ethereal extract were found in the leftovers, which indicates a high level of fat (oil) used in the preparation of food for human consumption.

The nutritional content of the commercial balanced feed used during the experiment is shown in Table 2. If the nutritional supply of the two types of feed used in this study is compared, it can be pointed out that practically all the nutrients of leftovers are beneath the ones reported in the commercial product. Nevertheless, since this kind of food for animal nutrition has gained importance, the

Table1: Proximal chemical analyses of kitchen leftovers in humid base (Mean±standard error of the mean)

	In humid base (%)			
Nutrients	Sample 1	Sample 2	Sample 3	Media±SME
Dry matter	15.20	18.91	29.8	21.30±4.38
Total protein	3.09	2.01	4.9	3.33±0.84
Ethereal extract	2.78	1.7	12.5	5.66±3.43
Crude fiber	0.91	0.87-	0.8	0.86±0.03
Minimum niitrogen free extract (NFE)	7.32	12.8	10.6	10.24±1.59
Ashes	1.26	1.31	1.87	1.48±0.19

Table 2: Nutritional content of commercial balanced feed

Nutrient	Persentage
Maximum humidity	12
Maximum ashes	10
Maximum fiber	6
Minimum protein	11
Minimum fat	2
Minimum nitrogen free extract (NFE)	59.9

differences observed in the content of total protein and NFE can be highlighted.

The mean and the standard error of the mean are indicated for the variables evaluated in the body measurements, in this case the covariable final weight was significant, only for the perimeter of the thorax. As it can be appreciated, there are significant differences between the pigs fed with commercial balanced feed and those fed with leftovers. In the second group a statistical difference between sexes is more evident; the castrated males are more affected, since in most of the evaluated variables this group showed the lowest mean, nonetheless without statistical differences regarding females.

In the variables related with the back-sternum diameter and the thoracic perimeter, no statistical differences between the four treatments were observed. At present, results reveal that the type of food was influencing the deposition of back fat in the pigs, since these variables are highly correlated in a positive way with the deposition of backfat. In a general way, it can be stated that the animals fed with balanced commercial feed showed better potential growth, which was reflected in better height, increased corporal length and larger development of extremities, considering that the animals employed in the different treatments had similar genotypes.

On the other hand, when comparing the results that are shown in Table 3, with those obtained by Becerril[14] greater body measurement values are observed, although it is necessary to consider that the hybrid pigs evaluated by Becerril[14] had an average age of 6 months; an age when it is more frequent to send an animal to the abattoir.

When comparing those results with the swine Creole phenotype (Hairless Mexican pig), it is observed that while both breeds presented similar weights, the Pelón Mexicano pigs showed a larger thoracic perimeter and a larger corporal length, although inferior values for the perimeter of the fore and the hind feet were appreciated[13,15].

Table 4 includes the mean and the standard error of the mean for the variables evaluated in the live animals by ultrasound. The results obtained confirm that in castrated males fed with leftovers (T2), the deposit of backfat was favored in comparison with the females that received the same feeding type. The latter is contrary to what Sthaly[22] stated, he indicates that females tend to accumulate more fat, followed by barrows and then by boars. In the case of pigs fed with commercial balanced feed (T3 and T4), there were no statistical differences among them and even in the points P2 and P3, the differences are only numeric in comparison with the males fed with leftovers.

However, regarding the pork chop eye area, results indicate a marked difference between feeding types and even sexes, for the four treatments; T4 (MC) was the one that showed the highest value and on the other hand, T2 (ME) the one with the lowest synthesis of muscular tissue. This can be explained due to the fact that the supply of total protein in pigs fed with leftovers was of 220 grams per day. However, in the NRC charts[23] for pigs, 414 grams per day of assimilable protein are required during growth; this means that they consumed half of their requirement.

In Table 5 the mean and the standard error of the mean are presented for the variables evaluated in the carcasses of the animals, being the significant covariable regarding hot carcass weight and carcass length. Since pigs fed with commercial balanced feed arrived to the slaughterhouse with more weight, this weight is also reflected in the hot carcass. Therefore, the heavier an animal arrives to the abattoir, its carcass will also be heavier. However the animal's age when taken to the slaughterhouse plays a very important role regarding the quantity of backfat and intramuscular accumulated fat. For this reason, the price of the animals is severely punished.

Overall, it can be stated that pigs fed with balanced commercial feed showed better carcass quality, since they developed more muscular and bone tissue as well as less deposit of backfat. This is a very outstanding fact since consumers nowadays prefer lean meat content and animal fat is only used for cooking typical domestic stews.

Once again, the phenomenon that has been mentioned during the experiment is present, kitchen leftovers are influencing the level of backfat accumulation in hogs (castrated males). This group had the highest values and they were statistically different from the other treatments; this definitively was due to the fact that this group of animals consumed a greater quantity of kitchen leftovers.

Table 3: Body measurements in pigs fed with kitchen leftovers and balanced commercial feed (Mean±standard error of the mean)

	Treatment 1 FL n = 15	Treatment 2 ML n = 15	Treatment 3 FC n = 10	Treatment 4 MC n = 10
Variable	Med±SEM	Med±SEM	Med±SEM	Med±SEM
Head length (cm)	30.26±1.39^{B}	28.53±0.55^{B}	36.1±0.43^{A}	36.6±0.65^{A}
Snout length (cm)	12.4±0.38^{B}	12.6±0.4^{B}	16.94±0.41^{A}	15.93±0.46^{A}
Height at withers (cm)	76.9±1.09^{BC}	74.86±0.81^{C}	80.2±0.55^{A}	79.4±0.56^{AB}
Height of the rump (cm)	75.0±1.11^{B}	72.76±0.86^{B}	78.7±0.57^{A}	78.5±0.5^{A}
Body length 1 (cm)	89.6±1.48^{C}	94.56±1.01^{B}	102.4±0.63^{A}	101.5±1.20^{A}
Body length 2 (cm)	101.46±1.28^{C}	107.8±1.26^{B}	115.6±0.90^{A}	114.1±0.97^{A}
Dorsum-sternal diameter (cm)	52.26±0.87^{A}	52.7±0.41^{A}	53.7±0.55^{A}	51.9±0.93^{A}
Rib-rib diameter (cm)	24.33±1.05^{BC}	22.7±0.39^{C}	28.4±0.45^{A}	27.0±0.47^{AB}
Rump length (cm)	41.86±1.54^{C}	47.26±1.96^{BC}	51.0±0.85^{AB}	53.2±1.05^{A}
Thoracic perimeter (cm)	112.41±1.39*	109.50±1.12*	107.16±1.51*	109.50±1.95*
Perimeter of the fore feet (cm)	18.16±0.43^{AB}	17.66±0.55^{B}	19.68±0.37^{A}	19.76±0.40^{A}
Perimeter of the hind leg (cm)	17.46±0.29^{A}	17.86±0.55^{A}	19.44±0.40^{A}	19.71±0.34^{A}

^{A,B,C} in the same row are statistically different, Tukey (P<0.05)

* Co-variable corrected values (final weight)

Table 4: Variables evaluated by ultrasound in pigs fed with kitchen leftovers and commercial balanced feed (Mean±standard error of the mean)

	Treatment 1 FL n = 15	Treatment 2 ML n = 15	Treatment 3 FC n = 10	Treatment 4 MC n = 10
Variable	Med ±SEM	Med±SEM	Med±SEM	Med±SEM
Backfat P1 (mm)	28.66±0.64^{C}	35.13±0.67^{A}	30.8±0.59^{BC}	31.9±0.87^{B}
Backfat P2 (mm)	22.66±0.63^{B}	27.4±0.50^{A}	26.0±0.36^{A}	26.7±0.73^{A}
Backfat P3 (mm)	21.6±1.04^{B}	27.4±0.66^{A}	26.9±0.83^{A}	28.8±0.89^{A}
Rib-eye area (mm)	29.6±0.28^{C}	25.06±0.46^{D}	60.5±0.81^{B}	63.9±1.38^{A}

^{A,B,C,D} in the same row are statistically different, Tukey (P<0.05)

Table 5: Variables evaluated in the carcasses of pigs fed with kitchen leftovers and commercial balanced feed (Mean±standard error of the mean)

	Treatment 1 FL n = 15	Treatment 2 ML n = 15	Treatment 3 FC n = 10	Treatment 4 MC n = 10
Variable	Med ±SEM	Med±SEM	Med±SEM	Med±SEM
Carcass weight (kg)	85.27±0.91*	83.60±0.73*	91.84±0.99*	88.71±1.28*
Carcass yield (%)	77.79±0.65^{C}	76.45±0.41^{C}	84.63±0.67^{A}	82.19±0.59^{B}
Carcass length (cm)	92.91±1.50*	94.14±1.20*	88.81±1.62*	78.44±2.10*
Thorax depth (cm)	29.63±0.83^{BC}	28.0±0.75^{C}	31.58±0.61^{AB}	33.29±0.77^{A}
Ham roundness (cm)	62.16±0.98^{B}	64.0±0.97^{B}	72.5±0.73^{A}	73.5±0.95^{A}
Ham length (cm)	41.76±0.44^{B}	42.73±0.33^{B}	47.9±0.76^{A}	48.82±1.05^{A}
Backfat 1 C. (mm)	34.53±1.29^{B}	40.6±0.44^{A}	33.5±0.56^{B}	33.1±1.26^{B}
Backfat 13C (mm)	26.06±0.86^{B}	30.8±0.42^{A}	22.3±0.65^{C}	20.7±0.47^{C}
Backfat 5 L. (mm)	28.4±1.45^{A}	26.2±0.48^{A}	19.2±0.57^{A}	19.9±0.64^{A}

^{A,B,C,} in the same row are statistically different, Tukey (P<0.05)

* Co-variable corrected values (slaughter weight)

Table 6: Viscera weight of pigs fed with kitchen leftovers and commercial balanced feed (Mean±standard error of the mean)

	Treatment 1 FL n = 15	Treatment 2 ML n = 15	Treatment 3 FC n = 10	Treatment 4 MC n = 10
Variable	Med ±SEM	Med±SEM	Med±SEM	Med±SEM
Tongue, trachea, heart and lungs weight (kg)	1.55±0.05^{B}	1.67±0.04^{AB}	1.79±0.04^{A}	1.76±0.04^{A}
Lung weight (kg)	757.0±32.89^{B}	801.66±22.42^{B}	1060.0±30.55^{A}	1035.0±26.92^{A}
Heart weight (gr)	311.66±8.72^{B}	307.6±10.20^{B}	394.0±2.66^{A}	396.0±4^{A}
Stomach weight (kg)	1.71±0.08^{A}	1.82±0.05^{A}	1.58±0.04^{A}	1.66±0.05^{A}
Liver weight (kg)	1.47±0.06^{A}	1.58±0.06^{A}	1.63±0.03^{A}	1.47±0.06^{A}
Spleen weight (gr)	178.66±8.50^{B}	186.53±9.88^{B}	292.0±6.28^{A}	293.0±5.58^{A}
Viscera weight (kg)	9.22±0.36^{B}	10.39±0.21^{A}	7.66±0.14^{C}	7.27±0.15^{C}
Stomach major curvature length (cm)	55.73±1.54^{B}	62.1±1.42^{A}	62.5±0.95^{A}	60.7±0.73^{AB}
Small intestine length (m)	19.32±0.75^{A}	21.18±0.60^{A}	21.65±0.66^{A}	21.81±0.57^{A}
Large intestine length (m)	5.40±0.34^{B}	5.68±0.19^{AB}	6.31±0.18^{AB}	6.44±0.22^{A}
Cecum length (cm)	26.86±0.70^{B}	30.0±0.79^{A}	27.3±0.68^{AB}	27.7±0.86^{AB}
Spleen length (cm)	35.93±1.30^{C}	34.16±1.04^{C}	40.3±0.91^{B}	44.9±0.70^{A}

^{A,B,C,} in the same row are statistically different, Tukey (P<0.05)

When comparing the results mentioned in Table 5 with previous investigations[14], higher values are observed in the carcasses of the animals evaluated in this investigation. The explanation is that these pigs arrived to the slaughterhouse with more weight, therefore a directly proportional ratio is presented between the slaughter weight and the carcass yield. Thus, the heavier a pig is when slaughtered, the heavier and bigger the carcass will be, but with more back and intramuscular fat covering, while the percentage of lean tissue will be diminished.

Table 6 includes the mean and the standard error of the mean, for the group of variables corresponding to the weights and lengths of the abdominal and thoracic viscera. Practically, for all figures regarding abdominal viscera, the pigs that received the commercial balanced feed presented the highest values and they are even statistically different to the values found in the abdominal viscera of the pigs fed with left-overs.

The digestive viscera weight in animals fed with kitchen leftovers is superior in comparison with the one of pigs fed with balanced commercial feed. This is due to the fact that kitchen leftovers have a high percentage of humidity, which in turn influences the viscera weight (it is necessary to consider that all viscera were weighed with content).

Regarding the weight and length of other abdominal viscera, pigs fed with leftovers showed statistically inferior values in comparison with pigs fed with the commercial concentrate.

In general terms, we can state that the type of feed did not affect the digestive physiology between sexes of the pigs, thus, the castrated males and females had a similar performance.

When evaluating the carcass of pigs fed with kitchen leftovers and comparing them with pigs of the same breed fed with a commercial concentrate, we can state that the use of household swills in animal feeding affected the development of the main tissues (bone, muscle and fat), it favored less height, body length and development of extremities. At slaughter pigs fed with leftovers showed an increase in backfat coverage and smaller development of the *Longissimus dorsi* muscle, as well as carcasses of smaller length.

The main advantage of feeding pigs with kitchen leftovers is an economic one, if we consider its low cost in the market ($0.20, kg). Thus, pigs can be fattened with an important cost reduction considering that approximately 70-80% of the total costs of production is spent in feeding[24]. However, it is also necessary to take into account the quality of the product.

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