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Horse Meat for Human Consumption in México: Slaughter Performance and Carcass Morphometry

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Abstract: In Mexico, equine use for meat production is not commonly found; the highest percentage of equine meat that can be possibly consumed comes mostly from culled animals. The objective of the present study was to characterize the slaughter performance and test the effect of gender in the incidence of injuries during transportation, in offals and hot carcass yields in twelve creole horses. Results indicate an average live weight of 296 Kg and carcass weight of 175 Kg, equivalent to 60% yield. It is possible that the husbandry method commonly used on pasturing the animals, decreased the thoracic development and increased the corporal length and diameter of the leg. With regard to slaughtering yield, red viscera represented 4.3%, green viscera 30%, skin 6%, limbs 2.8%, head 4.4% and loss at slaughter 1.5% of the total live weight. Average body condition in the horses was poor. No significant differences were observed between genders in the presence of injuries, although there was an influence of the arrival position on the severity of injuries; animals that were facing the direction of travel (rear-facing) showed injury 2 affecting subcutaneous and muscular tissues, whereas animals facing backward did not show injuries or these were not too severe.

Key words: Horses, slaughter performance, Mexico

INTRODUCTION

Currently, horse meat consumption is unusual. However, some European countries, like France, include horse meat in their diets and nowadays they even have to import it in order to meet demand[1]. In Mexico, equine use for meat production is not commonly found; the highest percentage of equine meat that can be possibly consumed comes mostly from culled animals (injured and old donkeys and horses mostly), from different towns, circuses or auctions[2] and is destined to feed dogs or carnivorous animals at zoos. This species is in disadvantage with domestic ruminants for two important reasons. First, Mexicans consider horses as pets, companion and sporting performance animals; they are mostly used as a source of labor and transportation, therefore the habit to consume horse meat is not widely accepted and second, this species have a feed conversion of 10-11 Kg of high quality food to gain 1 Kg of live weight, whereas bovines need 7 Kg of food to produce 1 Kg of live weight; consequently this activity is not profitable. For this reason, horses slaughtered in Mexico for meat production arrive to the abattoir as culled animals, when they have finished their productive life in diverse activities[3]. Horse breeding for slaughtering purposes is not a revenue-yielding business for Mexican cattlemen, since equine meat is much more expensive than bovine, swine or ovine meats, because the latter species show faster growth and better weight gain and carcass yields compared with horses[2].

Several horse breeds are found in Mexico; however, the one that prevails the most (90%) is the creole (serrano) horse, a crossbreed of Andalusian and Arab horses[3] that has adapted to the country's environmental conditions through time. These animals as other species of zootechnic interest have not been raised appropriately in order to obtain their maximum genetic capacity. At the moment there is not enough information available on equine livestock carcass yield in Mexico.

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Transportation to slaughterhouses is still the main cause of injuries, stress and animal bites[4]. In addition, some studies indicate that certain orientation of horses during transportation do possibly cause adverse effects[5]. When facing the direction of travel, Cregier[6] proposed that horses sense an increased vulnerability to head and chest injuries. In fact the mere act of maintaining balance is an additional source of stress in transported horses[7]. The objective of the present study was to characterize the slaughter performance and test the effect of gender in the incidence of injuries during transportation, in offals and hot carcass yields in creole horses.

MATERIALS AND METHODS

The study was carried out at the slaughterhouse located in in Texcoco, State of Mexico, during October and November, 2004.

Animals and groups: Twelve adult horses were used: 6 males (group 1) and 6 females (group 2), they were transported in trucks with a stocking density of 0.86 square meters per animal with a layer of oat straw bedding during 4 hours.

Transportation evaluation: At arrival to the abattoir, breathing frequency was measured in each animal, quantifying the number of aspirations per minute. At the same time rectal temperature was determined using a citizen digital thermometer (CT561C/F).

Also, the orientation of the animals was observed; that is, the orientation of the head with relationship to the direction of travel. Likewise, a detailed examination of the horse's body was carried out in order to identify the presence of injuries. Injury severity was determined using the following classification: injury 1 (t1) affected skin and subcutaneous tissues; injury 2 (t2) affected subcutaneous and muscular tissues and injury 3 (t3) affected subcutaneous, muscular and bone tissues.

Body condition was evaluated according to Henneke *et al.*,[8] method of direct observation. A scale of 1 to 9 was used, where 1 was very thin and 9 obese. Animal's live weight was measured with a platform scale to obtain the carcass yield.

Evaluation of slaughtering, carcass and viscera yields The activities carried out at slaughtering for every animal were:

- Head, skin, limbs, red and green viscera were weighed to determine their percentage yield.
- Age was calculated by Bone's[9] dental formula.
- pH was measured 45 min after slaughtering in the tenth rib of the *Longissimus dorsi* muscle, using a Hanna Instruments potentiometer (Penetration pH electrode, HI8314, pHmeter membrane. 115V/60Hz. Cod. 1.1176).
- The carcass yield was determined dividing the hot carcass weight by the live weight of the animal and multiplying it by 100.

Carcass morphometry: The following measurements were performed in each carcass:

- Length of the leg: distance between the ischiatic tuberosity and the hock joints.
- Carcass length: distance between the mid section of the anterior border (fore-border) of the first rib to the ischiatic-pubic symphysis.
- Thorax depth: distance between the inferior parts of the breastbone to the mid dorsum.

Morphometric measurements were determined using a flexible three meters metric tape.

Statistical analysis : The PROC UNIVARIATE command of the SAS program (version 8.1) (2002) was used for all measured variables.

Variable results at slaughtering were analyzed at random using the following mathematical model:

$$Y_{ij} = \mu + \iota_i + \xi_{ij}$$

I = Groups 1, 2 j = 1, 2, 3.... Repetitions

Where:

Yij = Variable result
μ = General mean
ι_I = Effect of the group (sex)
ξ_{ij} = Random error

The Tukey test was used ($p<0.05$) to determine significant differences between groups. SAS V 6.12 (1997) was used for the analysis of the groups' effect on the different traits. The results were analyzed according to the proposed model and by means of the following procedure: for the specific cases of the variables: body condition, rectal temperature at arrival, breathing (respiratory) frequency and meat pH, a test was used. For comparisons of meat pH values between groups, a Mann-Whitney U test was performed.

RESULTS AND DISCUSSION

The injury incidence in the monitored horses is shown in Table 1. No significant differences were found

Table 1: Number and percentage of injured horses on their arrival at the abbatoir according to the sex

	Number (%)	
Type of injury	Goup 1 (Females) n = 6	Group 2 (Males) n = 6
0	4 (66.66)	4 (66.66)
1	0 (0)	2 (33.33)
2	2 (33.33)	0 (0)
3	0 (0)	0 (0)

No significant differences with x^2 test

Table 2: Mean and standard deviation of physiological traits and body condition of the horses on arrival at the abattoir and according to the sex

	Mean ± standard deviation	
Traits	Group 1 (Females) n = 6	Group 2 (Males) n = 6
Rectal temperature (°C)	39.08±0.37	38.83±0.25
Respiratory rate (per min)	34.50±6.89	30.00±8.71
Body condition	2.83±0.98	3.00±0.44

No significant differences with x^2 test

between genders, although in this variable the orientation of the horses at arrival did influence the severity of injure. Animals that were facing the direction of travel (rear-facing) had injury type 2, whereas animals facing backward, did not show injuries or were not too severe. Waran *et al.*,[10] concluded that horses seemed to find transportation less physically stressful when they are facing backward than when they are facing forward. Our results agree with these findings. The rear facing orientation in small trailers thus leads to fewer side and total impacts and losses of balance during trailering[11].

Results on physiologic variables and body condition shown by horses at arrival at the slaughterhouse are provided in Table 2. For physiologic constants the measured values were above the normal range for this species, indicating stress maybe due to transportation time, space provided and hierarchical arrangement, as well as to food and water restriction[4]. The highest injure scores were monitored in the mares. For body condition, the average for all the horses was poor.

Table 3 shows the descriptive statistics of the variables measured during the slaughtering of equine livestock. Due to the fact that horses monitored in this study were culled animals they showed an average weight of 296 Kg and a carcass weight of 175 Kg, which was equivalent to a 60% yield.

It is important to emphasize that the husbandry system employed which consisted in pasturing the animals, decreased the thoracic development in these horses and increased their body length and diameter of the leg. With regard to the pH variable, the observed value was 7.19, which is within the normal range for this species[3]. The variation found in all measured variables was from 6.56 to 24.57, which is considered as moderate.

The descriptive statistics for viscera and offals yield obtained from equine carcasses are shown in Table 4. Red viscera corresponded to 4.3%; green viscera, 30%; skin, 6%; hinds, 2.8%; head, 4.4% and loss at slaughter, 1.5% with regard to the total live weight. Weight loss got the highest variation coefficient, which means that this variable depends on transportation time, rest time before slaughtering and body condition, in other words, the higher they are, the higher the loss of corporal liquids and waste (feces, hair, blood and tail). With regard to the other variation coefficients, these showed moderate deviations.

In order to determine the effect of sex in the variables evaluated at slaughtering, the slaughter yields were analyzed (Table 5), viscera and offals were weighed (Table 6). No significant differences were observed between genders in either case.

Horses in Mexico are not raised for meat production purposes, this is the main reason why the animals under study presented different body conditions and different carcass yields as well, since there is no consensus in weight standards as it is in pigs for instance. Abadía and Fúnez[3] and Domínguez[12], reported carcass yields of 48 to 52%; which are below the percentage obtained in this study (59.25%); although it is necessary to highlight that live weight and carcass yield were inversely proportional; more live weight, less carcass yield. In another study, Lacharetz *et al.*,[13] slaughtered 93 three year-old foals, obtaining a carcass yield of 68.3 ± 4.4%.

The established range for stocking density during horses' transportation to the slaughterhouse elsewhere is 1.40 to 1.54 square meters[14]. Some livestock haulers maintain that animals transported at high density are better able to sustain their balance and less likely to be injured because they hold each other up. Reece *et al.*,[15] measured a density of 2.3 square meters and observed that injury rates increased, also increasing severity of injuries. In this research horses were transported at low density (0.86 square meters) during 4 hours. Our findings agree with those of Collins *et al.*,[16] who found a low proportion of horses that fell in low-density compared to high density group, in our study there was not a significant difference in the average severity of injuries too. Nevertheless, acute stress during transportation increased respiratory rate and rectal temperature in these animals, indicating a physiologic response of the animal to adapt to adverse conditions[17].

Abadía and Fúnez[3], observed that mares showed greater carcass weight (0.5 Kg) than males, registering a carcass yield difference of 1.04 Kg., which was also greater in the females. Therefore, sex did not have any effect on weight, but it did on carcass yield ($p<0.02$). In our study females registered higher carcasses weights

Table 3: Means and standard error of the means of the slaughter performance in twelve horses

Statistics	LWA	CY	HCW 1	HCW 2	TCW	CL	TD	LD	pH
Mean	296.41	59.25	83.91	91.16	175.08	128.25	40.25	82.75	7.19
Mode	255	54.1	80	86	166	110	43	70	6.99
Standard deviation	67.34	3.89	20.62	21.46	41.85	22.77	6.21	12.43	0.36
Minimum	185	54.1	46	54	100	96	29	65	6.4
Maximum	400	65	117	130	247	180	48	104	7.85
Variation coefficient	22.72	6.56	24.57	23.54	23.90	17.75	15.42	15.02	5.01

LWA: Live Weight at Arrival, CY Carcass Yield (%), HCW: Hot Carcass Weight; TCW: Total Carcass Weight (2 half carcasses); CL: Carcass Length; TD: Thorax Depth; LD: Leg Diameter; pH: pH at 45 min postmortem

Table 4: Means and standard error of the means of the offal yield in twelve slaughtered horses

Statistics	RVW	GVW	SW	TLW	HW	LW	TVW	TOW
Mean	13.83	62.58	18.37	8.53	13.23	4.77	116.55	121.33
Mode	10	45	15	9.8	12	7.2	83.8	85
Standard deviation	4.716	21.77	4.20	0.99	1.77	2.92	29.22	30.11
Minimum	8.5	40	12	7.2	10.3	0.6	83.8	85
Maximum	22	102	27.5	9.8	16	9.5	169.5	179
Variation coefficient	34.09	34.79	22.88	11.63	13.38	61.33	25.073	24.82

RVW: Red Viscera Weight; GVW: Green Viscera Weight; SW: Skin Weight; TLW: Total Limb Weight; HW: Head Weight; LW: Losses Weight; TVW: Total Viscera Weight; TOW: Total Offal Weight

Table 5: Mean and standard deviation of slaughter performance according to the sex of the horses

	Mean ± standard deviation	
Variables	Group 1 (Females) n = 6	Group 2 (Males) n = 6
Live weight on arrival (Kg)	315.00±89.10	277.83±34.78
Carcass yield (%)	59.30±4.41	59.21±3.71
Hot carcass weight 1 (Kg)	89.33±26.75	78.50±12.27
Hot carcass weight 2 (Kg)	97.83±28.08	84.50±10.87
Total hot carcass weight (Kg)	187.16±54.80	163.00±22.36
Carcass length (cm)	126.66±21.66	129.83±25.80
Thorax depth (cm)	43.66±3.82	36.83±6.49
Leg diameter (cm)	86.33±11.30	79.16±13.46
pH	7.02±0.35	7.37±0.29

No significant differences with x^2 test

Table 6: Mean and standard deviation of offals´ yields according to the sex

	Mean±Standard deviation	
Variables	Group 1 (Females) n = 6	Group 2 (Males) n = 6
Red viscera weight (Kg)	14.16±5.78	13.50±3.89
Green viscera weight (Kg)	70.50±27.36	54.66±12.11
Skin weight (Kg)	16.16±2.65	20.58±4.48
Limbs´ weight (Kg)	8.86±0.90	8.20±1.04
Head weight (Kg.)	13.91±1.98	12.55±1.35
Losses weight (Kg)	4.2167±3.67	5.33±2.15
Total viscera weight (Kg)	123.61±37.30	109.50±19.17
Total offal weight (Kg)	127.83±38.77	114.83±19.76

No significant differences with x^2 test

than males (24 Kg more); nevertheless, carcass yields were only 0.84 higher in the mares compared with the males, although no significant differences were observed in both variables.

CONCLUSION

Equine breeding for meat is rarely practiced in Mexico; horses for slaughtering are mainly culled animals, their yields are not very flattering. The following averages were observed: live weight of 296 Kg and carcass weight of 175 Kg, equivalent to 60% yield. It is possible that the feeding scheme on pasturing decreased the thoracic development, and increased the corporal length and diameter of the leg. With regard to slaughtering yield, red viscera represented 4.3%, green viscera 30%, skin 6%, limbs 2.8%, head 4.4%, and loss at slaughter 1.5% of the total live weight.

No significant differences were observed between genders in the presence of injuries, although there was an influence of the arrival position on the severity of injuries; animals that were facing the direction of travel (rear-facing) showed type 2, whereas animals facing backward did not show injuries or these were not too severe.

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