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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Productive performance and carcass characteristics of crossbreed (*Bos taurus* × *Bos indicus*) cattle grazing at mexican tropic

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Abstract

A total 37 Holstein (Ho) and Brown Swiss (BS) crossbred with Zebu (Z) bulls reared under a grazing production system were evaluated for the productive performance and carcass characteristics. No significant difference was found in weight and weight gain and carcass characteristics between the two groups. Hot and cold carcass, rib eye area, back fat thickness, kidney, pelvic and heart weight fat, rumen weight, skin weight, carcass length and width and leg parameters increased significantly in cattle weighing more than 450 kg. Genetic groups did not show any significant differences in growth and carcass composition, so both groups can be used for slaughtering. The weight at slaughter is important, since at larger weight, the carcass features improved.

Keywords: Cross breeding; Zebu; grazing; carcass classification; tropic

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Introduction

Beef in Mexico has shown an increase both in the production and price for the last six years (SIAP, 2014). The excessive increase in the cost of inputs requires the generation of alternatives that allows beef producers to retain their place in the market (Zorrilla, 2007). Tropical regions in Mexico comprise 28% of the territory which have the potential to produce meat (Conargen, 1998). A significant number of producers have found important benefits using improved varieties of grasses (Loeza et al., 2005). Although the beef production is common under intensive system in Mexico, however, the local breeds with low productivity are more suitable which are mostly reared on the local grazing system with less cost input. Del Campo et al. (2008) mentioned that extensive production systems are associated with a lower quality of the carcass, however, this strategy does not show significant changes in the meat quality and even increases its tendency (Jaturasitha et al., 2009). Few studies have reported meat production, classification and carcass composition of cattle grazing in the tropics. In the tropical region of the country, no price difference exists in meat prices in beef cattle from grassland or intensive fattening. Therefore, it is necessary to determine the qualities of the grazing production system in order to distinguish it from others (Dan et al., 2009). There is a wide diversity of information related to animal development on grazing production systems, where the weight gain depends on the consumed grass (Garcés, 1999).

The tropical conditions are sometimes extreme, so cattle productivity may be low if a good management is not carried out. Animals available in this environment are mostly kept for dual purpose. The most representative breeds are the Brown Swiss/Zebu (BS/Z) crossbreed in addition to Holstein/Zebu (Ho/Z) and

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Simmental/Zebu crossbreeds (Vilaboa-Arróniz et al., 2009). The aim of this study was to evaluate the productive performance and carcass characteristics of Ho/Z and BS/Z animals and find the appropriate slaughter weight under a grazing system in the tropic.

Materials and Methods

The research was conducted at the Experimental Centre La Posta, INIFAP, located 22.5 km from Veracruz-Córdoba Federal highway, with a geographical location 19º00'49" north latitude and 96 º 08’19” west longitudes at a height of 10 meters above sea level (INEGI, 2009). The region weather is tropical sub-humid type with an average annual rainfall of 1461 mm. Average temperature is 25°C and relative humidity 77% (Vidal, 2005).

37 bulls (n = 25 Ho/Z, n = 12 BS/Z) were weaned at seven months of age (205d) and then transferred to grazing on African star grass (*Cynodon plectostachyus*) and Pará grass (*Brachiaria mutica*). In addition, mineral salt was supplemented during the dry season (December to May). Animals were dewormed with Ivermectin and Amitraz for tick control.

The animals were weighed every 28 days from birth to slaughter, with a digital scale (Tru-Test ®) having a sensitivity of 100g. To evaluate the animals productive performance, DWG was calculated according to the method proposed by Rodriguez (1988) in four stages: from birth to weaning (205 days), 206 to 365 d, from day 366 to 540 d, and from day 541 to slaughter. The weights were obtained by interpolation of the upper and lower age data set from the monthly sampling. The following formula was used: Weight = (Post Weight – Before Weight) / (Post Age – Age before) * (Age - Previous Age) + Previous weight. Animals were sacrificed at three different weight ranges: <400, 400 to ≤450 and > 450 kg. Animals underwent desensitization through contusion by a captive bolt pistol Brand Cash Special 22 Calibre (Accles and Shelvoke LTD, Model 16965, Birmingham, England). The dieted weight (96% of live weight) was calculated according to NRC Beef Cattle (2000). Variables measured on the hot carcass were: hot carcass weight, perirenal pericardial and pelvic fat (KPH), skin and rumen weight, carcass length and width, plus the subjective carcass variables according to Mexican Bovine Carcasses Classification (NMX-FF-078-SCFI-2002): maturity, conformation (muscularity), distribution of subcutaneous fat, meat and fat color. After cooling the carcasses 24 h, the following variables were determined: cold carcass weight, perimeter, length, width and depth of the leg, rib eye area (REA) between the 12th and 13th rib (Alberti et al., 2008; Barkman et al., 2009) and back fat thickness (BFT) according to Barkman et al. (2009). Finally, meat marbling in the chop was rated according to the Mexican Standard (Supreme, Select, Standard, Commercial and Out of Classification). The carcass measurements were taken according to the reports of Alberti et al. (2005).

Productive characteristics were analyzed in a completely randomized design using initial weight as a covariate. For carcass characteristics a completely randomized design was applied using the genetic group (Ho/Z vs. BS/Z) and slaughter weight range (<400, 400 to ≤450 and >450 kg) as main effects. Comparison of means was performed using Tukey's test (P<0.05), applying the statistical software Minitab 15 (2007) with the GLM (General Linear Model) module.

Results and Discussion

No statistical difference (P>0.05) was found between the two groups in total weight or DWG at the time of birth or different stages (Table 1). In literature review, grazing cattle in tropical regions of Mexico, calves less than 320 kg had a DWG ranged between 0.322-0.569 kg depending on the type of grass (Garcés, 1999). González et al. (1992) reported 0.362-0.429 kg DWG in Ho/Z and BS/Z calves under a grazing system, throughout the year, in humid tropical weather with marked stages of wet and dry seasons. Chirinos et al. (1997) reported similar findings in DWG from birth to weaning in crossbred cattle. Furthermore, in Brahman cattle, Riera-Sigala et al. (2004) published weaning weight 175.4 kg and at 18 months 281.8 kg, higher than those reported in this paper. Additionally, DWG (0.662 kg) at weaning and from weaning to 18 months (0.291kg) was higher which can be explained by the differences in grasses and management. Dominguez et al. (2003) found in Tropicarne a birth weight 35.2 kg similar to that found in the present work, but DWG, the weaning weights, weight at one year of age and at 18 months was 220, 263 and 323 kg respectively. The results of the carcass classification such as the highest level of animals at a certain age (Table 2) showed that most variables from the qualification standard had an average level for both genetic groups. It should be noted that the rest of the carcasses were at a lower level (commercial) except for the maturity variable, where animal age was known (24 to 37 months) and the frequency distribution varied. Therefore, classification ranged from Commercial (12%) to the Supreme (15%). Furthermore, Table 3 indicates slaughter weight classification which indicates that the classification variables had the same response but the frequency in proportion to the maturity variable was distributed differently.

These results differ from the findings of Vazquez et al. (2008) who reported higher carcass compared to the ones evaluated in this work. Also, Alberti et al.

Table 1: Weight and daily weight gain at different ages in the two genetic groups

Variable	Genetic groups			
	Ho/Z n=25	SEM	BS/Z n=12	SEM
Weight at birth (kg)	36.54[a]	1.00	35.33[a]	1.45
Weight at day 205 (kg)	137.41[a]	3.78	145.78[a]	5.45
Weight at day 365 (kg)	176.69[a]	4.16	174.41[a]	6.00
Weight at day 540 (kg)	253.21[a]	6.13	247.43[a]	8.84
DWG at birth until day 205 (kg)	0.492[a]	0.019	0.539[a]	0.027
DWG from day 205 until day 365 (kg)	0.257[a]	0.018	0.164[b]	0.027
DWG from day 365 until day 540 (kg)	0.437[a]	0.030	0.424[a]	0.043
DWG from day 540 to slaughter (kg)	0.459[a]	0.022	0.410[a]	0.032

n= Number of repetitions, Ho= Holstein, BS= Brown Swiss, Z=Zebu, SEM: standard error of the mean, DWG: daily weight gain
[a,b]Different letters between columns from the same row indicate statistical difference ($P<0.05$)

Table 2: Carcass characteristics of two genetic groups

Variable	Genetic groups			
	Ho/Z (25)	%	BS/Z (12)	%
Maturity	Standard	44.0	Standard	58.3
Muscularity	Standard	92.0	Standard	100.0
Subcutaneous fat distribution	Standard	80.0	Standard	83.3
Perennial fat	Standard	88.0	Standard	66.7
Meat colour	Standard	68.0	Standard	66.7
Fat colour	Select	100.0	Select	100.0
Marbling	Unprovided	100.0	Unprovided	100.0

( ): Number of repetitions, %: frequency of carcasses representing the majority, Ho= Holstein, BS= Brown Swiss, Z=Zebu

Table 3: Carcass characteristics at three levels of body weight of two genetic groups

Variable	Weight at slaughter (kg)					
	<400 (13)	%	400<x<450 (14)	%	>450 (10)	%
Maturity	Select	38.5	Standard	50.0	Standard	80.0
Muscularity	Standard	100.0	Standard	92.9	Standard	90.0
Subcutaneous fat distribution	Standard	100.0	Standard	57.1	Standard	90.0
Perennial fat	Standard	84.6	Standard	92.9	Standard	60.0
Meat colour	Standard	61.5	Standard	64.3	Standard	80.0
Fat colour	Select	100.0	Select	100.0	Select	100.0
Marbling	Unprovided	100.0	Unprovided	100.0	Unprovided	100.0

( ): Number of repetitions, %: frequency of carcasses representing the majority

(2005) classified male bovine carcasses of animals fed hay and grain concentrate from different beef breeds applying the European Union standards. According to this study, animals of lower body weight had lower grading than the higher body weight. In this study, no effect was observed at slaughter weight. Similar findings were also reported by McGee et al. (2007).

Regarding meat color, Dunne et al. (2005) mentioned that cattle on grazing have darker muscles when walking daily for their food frequently and when the maturity of cattle increases they tend to have darker meat. Fat colour tends to be yellowish when cattle are under a grazing system, unlike those with a diet high on grains (Kerth et al., 2007). Furthermore, the yellowing colouration is related to forage type and the quality (Barron et al., 2006).

Additionally, Gilbert et al. (1993) observed a slight degree of marbling in beef cattle breeds. Nkrumah et al. (2004) with synthetic breeds originated from meat and dairy breeds, fed a diet containing corn, alfalfa and canola oil, reported higher degree of marbling compared to the present study which may be due to the breeds or the feeding system. Vazquez et al. (2008) observed traces of marbling in feedlot cattle. Ítavo et al. (2008) also observed at an average low marbling in uncastrated steers. Carcasses evaluated by Núñez et al. (2005) observed no marbling in slaughtered animals of an abattoir which were reared on grazing system. Orellana et al. (2009) recorded the same in Criollo Argentino and slightly higher marbling in Bradford cattle grazing in semitropical climate. For these reasons, differences in characteristics when classifying carcasses are due mainly to management in the feeding, even with the use of standards established. Table 4 shows some of the variables of carcass composition in which the analysis did not detect a significant difference ($P>0.05$) between genetic groups, as the animals feeding system was the same; except in the REA, which showed difference ($P<0.05$) between genetic groups with 75.5 and 79.7cm^2 for Ho/Z and BS/Z, respectively. Vazquez et al. (2007) observed a higher yield (55%) in cattle from the same breed. Riera-

Table 4: Carcass features of males from two different genetic groups

Variable	Genetic groups			
	Ho/Z (25)*	SE	BS/Z (12)*	SE
Hot carcass weight (kg)	217.8^{a}	1.46	217.8^{a}	2.23
Cold carcass weight (kg)	214.1^{a}	1.53	211.0^{a}	2.33
Cold carcass yield (kg)	53.8^{a}	0.38	53.2^{a}	0.58
Rib eye area (cm^2)	75.2^{a}	1.44	79.1^{b}	2.20
Back fat thickness (cm)	0.35^{a}	0.02	0.37^{a}	0.02
KPH fat weight(kg)	1.72^{a}	0.15	1.92^{a}	0.21
Rumen weight (kg)	8.23^{a}	0.13	8.5^{a}	0.18
Skin weight (kg)	26.4^{a}	0.63	27.3^{a}	0.89
Carcass length (cm)	138.7^{a}	0.60	139.5^{a}	0.84
Carcass width (cm)	65.4^{a}	0.45	64.8^{a}	0.64
Leg length (cm)	77.3^{a}	0.44	76.5^{a}	0.63
Leg width (cm)	41.2^{a}	0.35	41.3^{a}	0.49
Leg depth (cm)	21.7^{a}	0.34	21.8^{a}	0.48
Leg perimeter (cm)	104.1^{a}	0.64	103.4^{a}	0.91

( )* Number of repetitions. Ho, Holstein; BS, Brown Swiss; Z, Zebu. SEM: standard error of the mean. KPH: Kidney, pelvic and heart.

Table 5: Carcass features at three weight intervals of crosses

Variable	Weight at Slaughter, kg					
	≤400 (13)	SE	400<x≤450 (14)	SE	>450 (10)	SE
Hot carcass weight (kg)	184.8^{a}	3.23	224.5^{b}	3.23	250.9^{c}	3.68
Cold carcass weight (kg)	181.6^{a}	3.31	220.8^{b}	3.31	244.2^{c}	3.78
Cold carcass yield (kg)	52.9^{a}	0.51	54.3^{a}	0.51	53.5^{a}	0.58
Rib eye area (cm^2)	73.2^{a}	1.98	74.24^{a}	2.36	83.16^{b}	2.69
Back fat thickness (cm)	0.27^{a}	0.03	0.40^{b}	0.03	0.56^{c}	0.03
KPH fat weight (kg)	1.47^{a}	0.20	1.62^{a}	0.20	2.43^{b}	0.22
Rumen weight (kg)	7.4^{a}	0.19	8.5^{b}	0.19	9.3^{c}	0.21
Skin weight (kg)	22.1^{a}	0.89	28.4^{b}	0.89	30.7^{b}	1.01
Carcass length (cm)	131.1^{a}	0.88	141.4^{b}	0.88	146.1^{c}	1.01
Carcass width (cm)	62.0^{a}	0.74	66.1^{b}	0.74	68.3^{b}	0.85
Leg length (cm)	75.0^{a}	0.64	78.0^{b}	0.64	78.5^{b}	0.73
Leg width (cm)	40.2^{a}	0.49	41.6^{ab}	0.49	42.3^{b}	0.56
Leg depth (cm)	20.5^{a}	0.39	21.1^{a}	0.39	24.2^{b}	0.45
Leg perimeter (cm)	100.3^{a}	1.00	105.5^{b}	1.00	106.5^{b}	1.14

( ) Number of repetitions. SEM: standard error of the mean. KPH: Kidney, pelvic and heart. ^{a,b,c} Different letters between columns from the same row indicate statistical difference (P<0.05)

gala et al. (2004) reported hot carcass weights of 266.8 kg and carcass yield of 56.5% on a grazing system with nutritional supplementation in Brahman x *Bos taurus* animals. Piedrafita et al. (2003) and Casas and Cundiff (2006) reported higher carcass percentage in beef breeds under an intensive feeding system. Jaturasitha et al. (2009) highlighted a 54% yield in Zebu cattle reared on pasture. In addition, Orellana et al. (2009) noticed a similar yield in Criollo Argentino cattle compared to Braford cattle in extensive grazing system without any supplementation.

On carcasses of specialized breeds for meat production, Casas and Cundiff (2006) obtained REA and BFT 82.6 cm^2 and 1.02 cm respectively. Gilbert et al. (1993) found 80 cm^2 REA and 0.73 cm BFT. Greiner et al. (2003) recorded an REA of 78.1 cm^2, BFT 1.09 cm and KPH 2.96%. Nkrumah et al. (2004) obtained carcasses of 293 kg having REA 76.3 cm^2 and BFT 1.03 cm. In different Angus crossed cattle under grazing, Kerth et al. (2007) observed a BFT 0.64 cm and REA 67.7 cm^2, similar to those obtained in this investigation.

Orellana et al. (2009) recorded an average REA of 86 cm^2 and 0.29 cm BFT from a Criollo Argentino and Bradfor breeds on grazing without any supplementation. Perry and Fox (1997) reported REA 78.4cm^2, BFT 1.05 cm and an estimated 2.24% KPH. Piedrafita et al. (2003) observed that the KPH fat represents 1 to 2.9% in beef cattle breeds. Therefore, it is clear that the discussed characteristics are highly variable; however, these are affected by the type of breed and the feeding system. McGee et al. (2007) reported carcass length and width, length, width and depth of leg 134, 52, 74, 46 and 29 cm, respectively in dairy cattle in an extensive system. So these are shorter and narrower carcasses, but with larger leg measures in contrast with our result. Such differences are due to the nutritional supplementation and castration.

However, analyzing the effect of slaughter weight on the carcass features mentioned in Table 5, it was found that there is significant difference ($P<0.05$) between the different weight ranges. The weight of the hot and cold carcass increases between intervals because of slaughtering weight is larger ($P<0.05$), however, cold carcass yield was unaffected among them ($P>0.05$). The increase in the REA was only evident after 450 kg unlike back fat thickness, which increased with the increase in slaughter weight. Although the weight of the KPH fat, rumen and skin increased as slaughter weight was higher, no significant difference ($P>0.05$) was found. According to the measurements of the carcass, the carcass length increased ($P<0.05$) in each weight range; however, the carcass width and length did not increase after 450 kg of weight, suggesting that the animals continue to grow longitudinally without increasing the height. In addition, the width of leg grows slowly, being more related to the leg's bone, but muscle development measured by the depth of the leg is better in the last weight interval. Moreover, it appears that the leg circumference is influenced by both measures, which would be useless for further investigation, since the former data provide better animal growth performance and muscle development. Blanco et al. (2008) obtained an average slaughter weight of 453 kg, hot carcass weight 237 kg and cold carcass yield 52.4% in Ho cattle, similar to the values reported in this work. Furthermore, Vazquez et al. (2007) reported higher values than those reported in Tables 4 and 5 for feedlot Ho/Z and BS/Z. Concerning the REA, Vazquez et al. (2007) found values between 81 and 93cm^2, but found no significant difference ($P>0.05$) between genotypes or slaughter weights, suggesting that there is more influence from the feeding system. On the other hand, Torres (2002) reported 76.6 cm^2 in Ho/Z crossed which is similar to our finding (75.25 cm^2).

Conclusions

Genetic groups did not show significant differences between the features of growth and carcass composition, so both groups can be used in dual-purpose systems for slaughtering purpose if reared on grazing system. The weight at slaughter is important, since having a larger weight, the deposition of muscle and fat increases.

References

Alberti, P., Panea, B., Sañudo, C., Olleta, J.L., Ripoll, G., Ertbjerg, P., Christensen, M., Gigli, S., Failla, S., Concetti, S., Hocquette, J.F., Jailler, R., Rudel, S., Renand, G., Nute, G.R., Richardson, R.I. and Williams, J.L. 2008. Live weight, body size and carcass characteristics of young bulls of fifteen European breeds. *Livestock science*, 114:19-30.

Albertí, P., Ripoll, G., Goyache, F., Lahoz, F., Olleta, J.L., Panea, B. and Sañudo, C. 2005. Carcass characterization of seven Spanish beef breeds slaughtered at two commercial weights. *Journal of Meat Science*, 71:514-521.

Barkman, S., Forrest, J., Berg, E.P. and Sheiss. E.B. 2009. Indiana 4-H/FFA Meat Evaluation and identification contest. Coach guide. [Online] http://ag. ansc. purdue. edu/meat_quality/4-H%20718-Meats%20Eval%20Book. [Consulted on June 10 of 2009]

Barron, G. S., Mora, I.O., Castaño M.V. y Shimada, M.A. 2006. La pigmentación amarilla del tejido adiposo de bovinos finalizados en pastoreo y su relación con su concentración de carotenoides y el perfil de ácidos grasos. *Tecnica Pecuaria en México*, 44:231-240.

Blanco, R.N., Huba, J., Hetényi, L. y Oravcová, A. 2008. Estimación *in vivo* de la composición de la canal de bovinos utilizado mediciones ultrasonográficas. *Universitas*, 1(2):58-63 online http://universitas.unanleon.edu.ni/pdf/2do/Arto8vol2.pdf. [Consulted on June 10 of 2009].

Casas, E. and Cundiff. L.V. 2006. Postweaning growth and carcass traits in crossbred cattle from Herford, Angus, Norwegian Red, Swedish Red and White, Friesian and Wagyu maternal grandsires. *Journal of Animal Science*, 84:305-310.

Chirinos, Z., Rincón, E., Madrid-Bury, N. y González-Stagnaro, C. 1997. Crecimiento predestete de becerros mestizos *Bos Taurus* x *Bos Indicus*. *Archivos Latinoamericanos de Producción Animal,* 5:497-499.

CONARGEN. 1998. El Informe sobre la Situación de los Recursos Genéticos Pecuarios (RGP) de México. Programa Nacional de Recursos Genéticos. Marco de referencia. Regiones agroecológica-ganaderas de la república mexicana. SAGARPA. Dirección General de ganadería. *Confederación Nacional Ganadera*, México. DF. Pp: 4-7.

Dan, S.H., Goodson, K. and. Savell, J.W. 2009. Beef Quality and Yield Grades. http://meat. tamu. edu/beefgrading.html. Online http://meat.tamu.edu/beefgrading.html. [Consulted on August 22 of 2014].

Del Campo, M., Brito, G., Soares de Lima, J.M., Vaz Martins, D., Sañudo, C., San Julián, R., Hernández, P. and Montossi, F. 2008. Effects of feeding strategies including different proportion of pasture and concentrate, on carcass and meat quality traits in Uruguayan steers. *Journal of Meat Science*, 80:753-760.

Dominguez, V.J., Núñez, D.R., Ramírez, V.R. y Ruiz, F.A. 2003. Influencias ambientales e índice de constancia para características de crecimiento en ganado bovino Tropicarne. *Técnica Pecuaria en México*, 41:1-18.

Dunne, P.G., O'Mara, F.P., Monahan, F.J., French, P. and Moloney, A.P. 2005. Color of muscle from 18-month-old steers given long-term daily exercise. *Journal of Meat Science*, 71:219-229.

Garcés, Y.P. 1999. Productividad del ganado bovino en clima tropical. Memorias de la Décima Segunda Reunión Científica Tecnológica Veracruz´99. Veracruz. México. Pp. 170-175

Gilbert, R.P., Bailey, D.R. and Shannon, N.H. 1993. Body dimensions and carcass measurements of cattle selected for post weaning gain fed two different diets. *Journal of Animal Science*, 71:1688-1698.

González, P.M.A., Ortega, S.J.A. y Ávila, C.J.M. 1992. Producción de carne en pastoreo y suplementación en el sur de Tamaulipas. I Utilización del forraje henificado de la misma pradera mas melaza-urea. *Técnica Pecuaria en México*, 30:172-175.

Greiner, S.P., Rouse, G.H., Wilson, D.E., Cundiff, L.V. and Wheeler, T. L. 2003. Prediction of retail product weight and percentage using ultrasound and carcass measurements in beef cattle. *Journal of Animal Science,* 81:1736-1742.

INEGI (Instituto Nacional de Estadística y Geografía). 2009. Catálogo de claves de entidades federativas, municipios y localidades. [Online] http:// mapserver. inegi. org. mx/mgn2k/?s=geo&c=1223. [Consulted on July 17 of 2014].

Ítavo, L.C.V., Dias, A.M.C., Ítavo, C.B.F., Euclides, K., Morais, M.G., Silva, F.F., Gomes, R.C. and Silva, J.P.B. 2008. Desempenho produtivo, características de carcaça e avaliação econômica de bovinos cruzados, castrados e não-castrados, terminados em pastagens de *Bracharia decumbens*. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 60(5):115-1165.

Jaturasitha, S., Vearasilp, T., Wicke, M. and Kreuzer, M. 2009. Carcass and meat quality of Thai native cattle fattened on Guinea grass (*Panicum maximum*) or Guinea grass-legume (*Stylosanthes guyanensis*) pastures. *Journal of Meat Science*, 81:155-162.

Kerth, C.R., Braden, K.W., Cox, R., Kerth, L.K. and Rankins, Jr. D.L. 2007. Carcass, sensory, fat color, and consumer acceptance characteristics of Angus-cross steers finished on ryegrass (*Lolium multiflorum*) forage or on a high-concentrate diet. *Journal of Meat Science*, 75:324-331.

Loeza, L.R., Ángeles, M.A. y Barradas, L.H. 2005. Caracterización de los sistemas de finalización y calidad de canales de bovinos de carne en el estado de Veracruz. Avances en la Investigación Agrícola, Pecuaria, Forestal y Acuícola en el Trópico Mexicano 2005. Veracruz. México. pp: 271-278.

McGee, M., Keane, M.G., Neilan, R., Moloney, A.P. and Caffrey, P.J. 2007. Body and carcass measurements, carcass conformation and tissue distribution of high dairy genetic merit Holstein, standard dairy genetic merit Friesian and Charolais × Holstein-Friesian male cattle. *Irish Journal of Agricultural and Food Research*, 46:129-147.

MINITAB 15. 2007. Programa estadístico versión 15.1.20.0. Minitab Inc. Pensilvania USA.

Nkrumah, J.D., Basarab, J.A., Price, M.A., Okine, E.K., Ammoura, A., Guercio, S., Hansen, C., Li, C., Benkel, B., Murdoch, B. and Moore, S.S. 2004. Different measures of energetic efficiency and their phenotypic relationships with growth, feed intake and ultrasound and carcass merit in hybrid cattle. *Journal of Animal Science*, 82:2451-2459.

NMX-FF-078-SCFI-2002. 2002. Productos pecuarios - carne de bovino en canal - clasificación (Cancela a la NMX-FF-078-1991). Cattle product - bovine carcasses flesh - Clasification. Clasificación. Secretaría de Economía. Dirección General de Normas. México D.F. Publicado en el Diario Oficial de la federación el 3 de octubre de 2002.

NRC Beef Cattle. 2000. Nutrient Requirements Council of Beef Cattle. Seventh edition. National Academic Press, Washington, D.C.

Núñez, G.F.A., García, M.J.A., Hernández, B.J. and Jiménez, C.J.A. 2005. Caracterización de canales de ganado bovino en los valles centrales de Oaxaca. *Técnica Pecuaria en México*, 43:219-228.

Orellana, C., Peña, F., García, A., Perea, J., Martos, J., Domenech, V. and Acero, R. 2009. Carcass characteristics, fatty acid composition, and meat quality of Criollo Argentino and Braford steers raised on forage in a semi-tropical region of Argentina. *Journal of Meat Science*, 81:57-64.

Perry, T.C. and Fox. D.G. 1997. Predicting carcass composition and individual feed requirement in live cattle widely varying in body size. *Journal of Animal Science*, 75:300-307.

Piedrafita, J., Quintanilla, R., Sañudo, C., Olleta, J.L., Campo, M.M., Panea, B., Renard, G., Turin, F., Jabet, S., Osoro, K., Oliván, M.C, Noval, G., García, P., García, M.D., Oliver, M.A, Gispert, M., Serra, X., Espejo, M., García, S., López, M. and Izquierdo. M. 2003. Carcass quality of 10 beef cattle breeds of the Southwest of Europe in their typical production systems. *Livestock Production Science*, 82:1-13.

Riera-Sigala, T.J., Rodas-González, A., Rodríguez-Matos, C., Avellaneda-Barbarito, J.F. y Huerta-Leidenz, N. 2004. Rasgos de crecimiento y pesos en canal de toros Brahman puros y F1 Brahman x Bos taurus criados y cebados semi-intensivamente en sabana mejorada. *Asociación Latinoamericana de Producción Animal,* 12:66-72.

Rodriguez, G.F. 1988. Proposición de un nuevo sistema para evaluar ganado de carne en pruebas de comportamiento en corral. *Técnica Pecuaria en México*, 26:231-235.

Servicio de Información Agroalimentaria y Pesquera (SIAP), 2014. Producción agropecuaria. Ganadería. Bovinos Resumen Nacional Producción, Precio, Valor, Animales Sacrificados y Peso. SAGARPA. México. D.F. [Online] http://www.siap.gob.mx/ resumen-nacional-pecuario/ [Consulted on august 20 of 2014].

Torres, C.A. 2002. Predicción de la composición de la carcasa en ganado de carne usando el ultrasonido.[Online].http://producción-animal.com. ar/informacion_tecnica/ecografia ultrasonido/30-prediccion_carcasa.htm [consulted on August 17 of 2009].

Vazquez, M.E., Espinoza, C.F., Loeza, L.R., Ángeles, M.A., Vinay V.J.C. y Castañeda. M.O. 2008. Comportamiento productivo y calidad de canales de bovinos machos de diferentes genotipos provenientes de sistemas de doble propósito finalizados en corral. Avances en la Investigación Agrícola, Pecuaria, Forestal y Acuícola en el Trópico Mexicano. Libro Científico N° 5. Veracruz. México. Pp: 281-288.

Vidal, Z.R. 2005. Región 7 Golfo de México. Las regiones climáticas de México. Instituto de Geografía UNAM, México. Pp.121-144

Vilaboa-Arróniz, J., Díaz-Rivera, P., Ruiz-Rosado, O., Platas-Rosado, D.E., González-Muñoz, S. y Juárez-Lagunes, F. 2009. Caracterización socioeconómica y tecnológica de los agroecosistemas con bovinos de doble propósito de la región del Papaloapan, Veracruz, México. *Tropical and Subtropical Agroecosystems*, 10:53-62.

Zorrilla, R. J. 2007. Posibles panoramas de la producción de carne de bovino para México en los próximos cinco años (2007-2012), [Online] http://www.vimifos.com/UserFiles/File/PRODUCCIONBOVINA.pdf [Consulted on August 17 of 2009].