

EFFECT OF GENOTYPE AND TIME ON FEED ON COLOR, MARBLING AND SHEAR FORCE OF MEXICAN BEEF

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Abstract - The aim of this study was to evaluate the effect of time on feed and the influence of *Bos indicus* genotype crosses on color, marbling and Warner-Bratzler shear force (WBSF) of Mexican beef. Samples from 586 young bulls slaughtered in northern, central and southern Mexico were randomly collected. Data was analyzed according to time on feed (< 100 days, 100-150 days and >150 days) and *Bos indicus* influence (50% *Bos indicus*, 75% *Bos indicus* and 100% *Bos indicus*). The increase of feeding time (>150 days) improved the meat color (P<0.05) from all genotypes. Meat marbling and WBSF from 100% *Bos indicus* animals were also enhanced with longer feeding time (>150 days). Minor modifications on cattle production procedures as the increase in feeding time can significantly improve beef quality, particularly in animals >75% *Bos indicus* genotype.

Key words: Mexican beef quality, *Bos indicus*, time on feed.

I. INTRODUCTION

A study published in 2009 by FAO [1] reported that Latin America and Caribbean are the largest bovine production regions in the world, with 15.14 million metric tons (MT), closely followed by North America with 12.72 million tons. The American continent is responsible for 44.74% of the world's beef production, while Asia and Europe are responsible for 25.02% and 18.63%, respectively. In Latin America, as well as in other continental regions where tropical climate is predominant, beef production is mostly represented by *Bos indicus* breeds which are preferred because of their tolerance to heat and

resistance to ecto and endoparasites [2]. Because of this condition, in beef exporting tropical countries like Brazil, *Bos indicus* and *Bos taurus* crosses account for almost all beef production. However, these animals have limitations in terms of reproductive traits, carcass composition, and especially, meat quality [2]. Mexican cattle production is determined by the climate conditions in the different regions of the country [3,4]. Therefore, Mexican cattle production experience might serve as a model for other countries with similar climate conditions. Previous studies in Mexico indicated that 90% of bovine cattle for beef production have *Bos indicus* influence [5]. Tenderness is a beef quality parameter influenced by genotype [6]. Warner-Bratzler shear force (WBSF) values of *Bos indicus*-*Bos taurus* crosses are generally higher than those of *Bos taurus* breeds [6,7,8]. Furthermore, WBSF values increase as the percentage of *Bos indicus* increases [8,9]. As *Bos indicus* is the most common bovine genotype in Mexico and in other tropical countries, and the quality of its meat needs to be improved, the objective of this study was to evaluate the influence of time on feed and *Bos indicus* percentage on meat color, marbling and shear force.

II. MATERIALS AND METHODS

A random sampling of the national cattle slaughtered in Mexico was performed. A total of 586 young bulls slaughtered in northern, central and southern Mexico were selected for this study. Animals were gathered into 3 groups according to the feeding time: 1) < 100 days, 2) 100-150 days and 3) >150 days; and 3 groups according to the

breed crosses: 1) 50% *Bos indicus*, 2) 75% *Bos indicus* and 3) 100% *Bos indicus* (Table 1). As the collection of the samples was randomly performed, not all of the feeding time groups had breed crosses group's representatives. Information about breed crosses and time on feed was obtained interviewing cattle owners.

Table 1. Number of animals gathered in the time on feed x *Bos indicus* crosses groups.

Time on Feed	<i>Bos indicus</i> crosses		
	50%	75%	100%
< 100 days	17	20	54
100-150 days	85	242	-
>150 days	71	55	34

Animals were processed under similar conditions in Federal Inspected slaughterhouses. Trained personnel evaluated marbling and color grades at the 12th-13th rib on the *Longissimus dorsi* muscle after 24 hours at 0-4 °C. Marbling was evaluated according to the following grading scale: 0 to 0.9 (devoid), 1-1.9 (traces), 2-2.9 (slight), 3-3.9 (small), 4-4.9 (modest), 5-5.9 (moderate) and 6-6.9 (slightly abundant). Meat color categories were: 1) dark red, 2) bright red and 3) pale red (Figure 1).

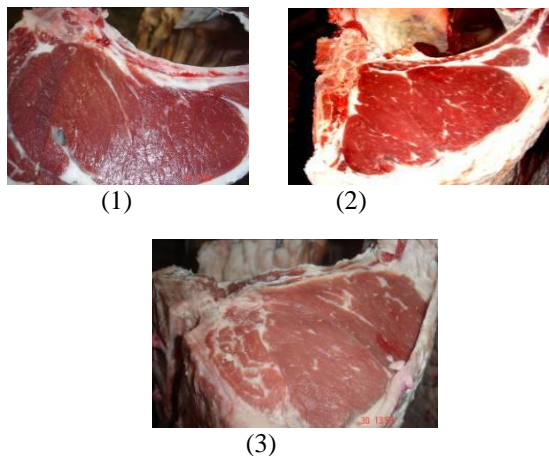


Figure 1. Color grading scale used to evaluate meat color. (1) dark red (2) bright red (3) pale red

A 2 inch steak (*Longissimus dorsi*; 13th rib) was removed from 20% of the measured carcasses. Steaks were aged for 14 days and subjected to WBSF (kg/cm^2) analysis according to the AMSA standard procedures [10]. Results were analyzed by General Linear Models using STATGRAPHICS® Centurion ($P=0.05$). In the

statistical model used, genotype and time on feed were considered as independent variables, and marbling, color and WBSF values as dependent variables. When significant interactions between independent variables were found, the principal effects were not presented.

III. RESULTS AND DISCUSSION

The effects of time on feed and *Bos indicus* crosses on the meat color are shown in Figure 2.

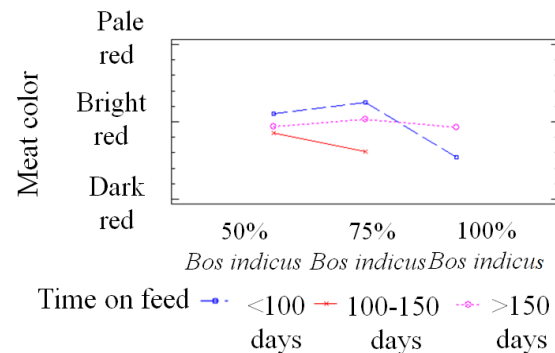


Figure 2. Interaction effect of *Bos indicus* genotype crosses and time on feed on the meat color of young bulls.

According to the interaction effect shown in the figure above, the increase of time on feed above 150 days in animals 100% *Bos indicus* promoted an enhancement on meat color ($P<0.05$), which tended to be less dark (1.69 ± 0.08) than that of animals on less than 100 feeding days (1.35 ± 0.06).

Despite no significant differences in meat color values for 75% *Bos indicus* fed <100 days and >150 days, the increase of time on feed tended to enhance the color of meat of these breed cross animals, which showed brighter red color compared to animals fed <100 days, which presented lighter meat color.

Meat color is affected by factors such as animal diet and marbling level [2]. Shackelford *et al.* [11] reported the effect of breed on the meat color, but did not find significant differences in the percentage of dark cutters of *Bos taurus* and *Bos indicus*. This study shows the increase on the percentage of *Bos indicus* genotype tended to darken the meat color. Boles and Swan [12] also

have observed darker color in *Bos indicus* meat in relation to *Bos taurus* beef.

The effect of time on feed and genotype on meat marbling is shown in Figure 3. The increase of the percentage of *Bos indicus* genotype decreased marbling grade, particularly when time of feed was <100 days ($P<0.05$). Time on feed >150 days tended to decrease differences in marbling grades among the different genotypes. Meat of animals 100% *Bos indicus* on >150 days time on feed increased marbling ($P<0.05$) and decreased WBSF ($P<0.05$), as shown in Figure 4.

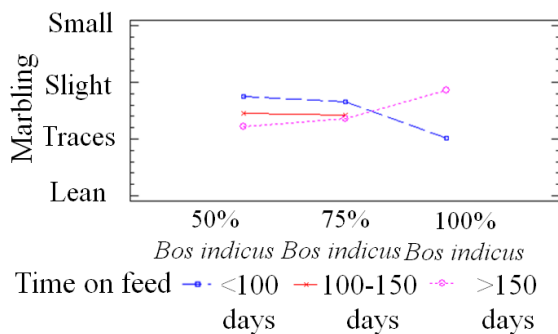


Figure 3. Interaction effect of *Bos indicus* genotype crosses and time on feed on marbling scores of young bulls.

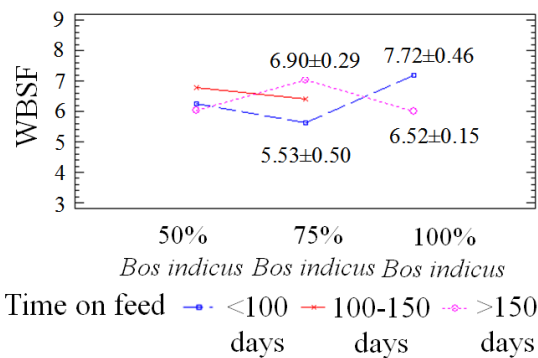


Figure 4. Interaction effect of *Bos indicus* genotype crosses and time on feed on WBSF values of young bulls.

Regardless the percentage of *Bos indicus* and the time on feed, meat of animals of all groups showed marbling scores corresponding to ‘Traces’ or ‘Slight’. Mendez *et al.* [5] reported 93.6% of the bovine cattle slaughtered in México had marbling scores corresponding to the categories ‘Slight’ or

‘Traces’, also stating that *Bos indicus* genotype, which is dominant in Mexican cattle, is well known for its limited ability for fat deposition.

The effect of animal genotype on WBSF was evaluated in many studies and conclusions vary among them [13]. It has been found that increasing *B. indicus* genetic component above 25% [9] or below 50% [14] increases meat toughness. Other studies show that toughness arises with 50% *B. indicus* genetic composition [13]. Finally, some studies show increased toughness only at 75% *B. indicus* genetic component [15] or even at 100% *B. indicus* genetic component [16].

Although the increase in time on feed improved the tenderness of 100% *Bos indicus* beef, meat from Mexican cattle of all *Bos indicus* crosses and time on feed groups showed WBSF average values above the threshold for meat tenderness reported by Strydom [16] of 4.6 and 3.9 kg for retail and food service beef, respectively. According to the category groups for meat tenderness reported by Belew *et al.* [17], meat of Mexican cattle evaluated in this study should be classified into the ‘tough’ group (WBSF > 4.6 Kg). Delgado *et al.* [18] found that WBSF values of Mexican beef varied from 3.6 kg for northern beef to 4.62 kg for central and 4.71 kg for southern beef. The results found in this study for WBSF in Mexican beef were higher than those reported by Delgado *et al.* [18].

IV. CONCLUSION

The increase in time on feed improved color, marbling and WBSF of meat from 100% *Bos indicus* animals. Cattle production procedures in Mexico should include time on feed >150 days which will reduce the negative effects of the inclusion of *Bos indicus* genotype in meat quality. In countries where *Bos indicus*-*Bos taurus* crosses are heterogeneous as in Mexico, the adoption of alternative tools to improve beef quality is highly recommended particularly in >75% *Bos indicus* genotype animals.

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