CARCASS CHARACTERISTICS AND YIELDS OF NELLORE BULLS COMPARED WITH 1/2 AND 1/4 BLOOD MARCHIGIANA-NELLORE BULLS[1]

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ABSTRACT - Four groups totaling 36 young bulls were placed in a dry lot and individually fed a ration of 66% TDN. There were two groups of ten Nellore bulls (Nellore I and Nellore II) and two groups, one of ten one-quarter Marchigiana-Nellore and one of six one-half Marchigiana-Nellore bulls (crossbred I and crossbred II, respectively). Nellore I bulls averaged 689 days of age and the other three groups averaged 613 days of age at the start of the trial. All animals were randomly assigned to three slaughter time groups (1, 2 and 3) and were fed for 119, 152 or 175 days. The crossbred II bulls had heavier ($P < .05$) live weights (513.5 kg) at slaughter than the Nellore I, Nellore II and crossbred I groups (476.0, 464.5 and 479.0 kg respectively). Consequently, crossbred II bulls showed heavier ($P < .05$) hot and chilled carcass weights than the other groups. Also the crossbred II bulls had less ($P < .05$) 12th rib fat cover (3.5 mm) with Nellore II bulls having the thicker 12th rib fat cover (6.1 mm) and Nellore I and crossbred I groups being intermediate (4.7 and 4.6 mm respectively). Loin eye area was larger ($P < .05$) for crossbred II (79.65 cm^2) than for Nellore I, Nellore II and crossbred I groups (70.39, 68.57 and 65.93 cm^2 respectively). A marked advantage was shown for the crossbred II group from the standpoint of producing greater quantities of lean meat without excess waste fat. This group had higher ($P < .05$) proportion of edible portion from the special hindquarter (33.65%), higher ($P < .05$) proportion of total edible portion (76.30%) and lesser amounts of trimmable fat (6.96%).

Index terms: meat, crossbreeding.

CARACTERÍSTICAS E RENDIMENTO DE CARCAÇA DE TOURINHOS NELORE EM COMPARAÇÃO COM TOURINHOS 1/2 E 1/4 DE SANGUE MARCHIGIANA-NELORE

RESUMO - Trinta e seis tourinhos jovens terminados em confinamento, dez nelore (grupo I), com média de idade de 689 dias e dez nelore, dez 1/4 marchigiana-nelore e seis 1/2 marchigiana-nelore (nelore II, cruzado I e cruzado II, respectivamente), com média de 613 dias de idade ao início do confinamento, foram divididos em três grupos e alimentados por 119, 152 ou 175 dias antes do abate. O grupo de cruzados II apresentou maior ($P < .05$) peso vivo (513.5 kg) ao abate do que o nelore I, nelore II e cruzado I (476.0, 464.5 e 479.0 kg, respectivamente). Como conseqüência, o grupo de cruzados II apresentou maiores pesos de carcaça quente e resfriada do que os outros grupos. Também o grupo de cruzados II apresentou a mais fina ($P < .05$) espessura de gordura (3.5 mm), enquanto o grupo nelore II apresentou a camada mais espessa de gordura (6.1 mm), ficando intermediários o nelore I e cruzado I (4.7 e 4.6 mm respectivamente). A área do olho-de-lombo foi significativamente maior para o grupo cruzado II (79.65 cm^2) do que para nelore I, nelore II e cruzado I (70.39, 68.57 e 65.93 cm^2, respectivamente). O grupo de cruzado II também apresentou vantagem do ponto de vista de produção de maiores quantidades de carne magra, sem a produção excessiva e desnecessária de gordura, além de maior percentagem da porção comestível do traseiro especial (33.65%), maior porcentagem da porção comestível total (76.30%) e menor quantidade de gordura aparada (6.96%).

Termos para indexação: carne, cruzamentos.

INTRODUCTION

In order to improve beef production and also to meet the consumer demands for more and leaner meat, breeds such as Charolais, Limousin, Simmental, Chianina and Marchigiana have been introduced in several western hemisphere countries. Faster growing rates, greater feed utilization, larger carcass weights as well as leaner carcasses associated with

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some heterosis effects make the use of these breeds potentially worthwhile.

Fat thickness has been observed by many authors to be thinner for continental European cattle and crosses from these breeds. (Damon Junior et al. 1960, Adams et al. 1973, Hedrick et al. 1975, Prior et al. 1977, Robelin 1978, O'Mary et al. 1979, Luchiari Filho et al. 1981). Also the larger loin eye areas obtained for these crosses is described by the findings of many authors as Hedrick et al. (1975), Koch et al. (1976), Koch & Dikeman (1977), O'Mary et al. (1979), and Luchiari Filho et al. (1981). The advantages of these larger framed cattle in producing heavier and leaner carcasses and consequently higher cutability percentages, is well documented and many researchers agree that due to a greater body size, these animals can be slaughtered at heavier weights with minimal fat (Damon Junior et al. 1960, Hedrick et al. 1970, Adams et al. 1973, Hedrick et al. 1975, Robelin 1978, Ferrell et al. 1978, Peacock et al. 1979, O'Mary et al. 1979, Luchiari Filho et al. 1981).

Higher forequarter weights and percentages and lower hindquarter weights and percentages obtained from the Zebu breeds have been described by Carpenter et al. (1961), Norman & Felicio (1981) and Luchiari Filho et al. (1981). These workers have stated that the hump on the Zebu forequarter exerts a great influence on the differences observed between forequarter and hindquarter.

The purpose of this study was to evaluate the effects of breed and time on feed on the carcass characteristics and carcass yields of young bulls of Nellore, 1/2 and 1/4 Marchigiana-Nellore breeding. The experiment was conducted at the Estação Experimental de Zootecnia de Andradina of the Instituto de Zootecnia in São Paulo, Brazil.

MATERIALS AND METHODS

Four groups totaling 36 young bulls were placed in a dry lot and individually fed a ration of 66% TDN. There were 20 Nellore bulls, 10 each in two groups (Nellore I and Nellore II), a third group of 10 one-quarter blood Marchigiana-Nellore bulls and a fouth group of six one-half blood Marchigiana-Nellore bulls (crossbred I and crossbred II respectively). The Nellore I group had a mean-age on test of 689 days and the other three groups all had mean-ages of 613 days. Group mean on test weights were 294.2, 285.8, 286.4 and 278.3 kg respectively. All animals were randomly assigned to three slaughter time groups (1, 2 and 3) which were slaughtered after 119, 152 or 175 days on feed respectively. The range in ages across all animals at slaughter was from 24 to 28.5 months.

At the conclusion of each feeding period, individual off-test weights were recorded following an 18 hour fast (with access to water). Cattle was then transported to a commercial slaughter plant approximately 60 miles from the feedlot. Animals were slaughtered followed a 14 hour resting period (with access to water).

Kidney and pelvic fat weight was recorded as it was removed during the slaughter process. Carcasses were split into sides, throroughly washed with warm water, weighed and side weights were recorded. The carcasses were placed in a chill cooler at 2°C.

Following a 24 - hr chill, carcasses were measured for length (anterior edge of the symphysis pubis to the mid-point of the first rib) and depth of chest (measured at the fifth rib).

Cold side weights were recorded and, to eliminate weight differences due splitting error, alternate right and left sides from each carcass were broken into the Brazilian wholesale cuts special hindquarter, forequarter and "ponta-de-agulha" as described by Corte at al. (1978). Loin eye area and fat cover over the loin eye were measured at the 12th rib level, and loin eye area was expressed per 100 kilograms of carcass weight (LEA/100 kg carcass).

The wholesale cuts were then fabricated into retail cuts in accordance with the retail market cutting procedure common in Brazil, with each cut being trimmed of excess fat to approximately 0.5 cm of fat cover. Trimmed retail cuts represent the total amount of edible meat and will be designated hereafter as edible portion from each quarter and total side. Total bone from each quarter was weighed without scraping.

Data were analyzed using analysis of variance with unequal sample sizes, using the General Linear Model procedure on the SAS Institute (1979). Means were compared by using Duncan's Multiple Comparisons procedure (Snedecor & Cochran 1967).

RESULTS AND DISCUSSION

Live and carcass trait differences

Despite a lower mean on-test weight, the 1/2 Marchigiana-Nellore (Crossbred II) bulls finished with heavier mean slaughter (off-test) weights and hot and chilled carcass weights. These results agree with those observed by Hedrick et al. (1975) who reported that carcass weight was greater for crossbreds than straightbreds.

On a slaughter time group basis (Table 1) bulls fed 152 or 175 days had heavier ($P < .05$) slaugh-

ter, hot and chilled carcass weights than those fed 119 days. This would be expected because weight increases with age and increased feeding time.

No differences were noted for hot and chilled dressing percentages by breed or slaughter group (Table 1). These findings disagree with those of Guenther et al. (1965) who observed that dressing percentage increased as the feeding period was increased. Butler et al. (1956) also observed the advantage of higher dressing percentage for crossbred Brahman-Hereford steers than straightbred Hereford steers.

No differences were observed for depth at fifth rib between breeds or slaughter time groups. Carcasses from crossbred I and II groups were longer than those from Nellore I and II (Table 2). These results agree with findings of Gaines et al. (1957) and Butler et al. (1956), who observed longer length of body for crossbred Brahman-Hereford steers than for Hereford steers.

Kidney and pelvic fat (Table 2) expressed as a weight or as a percentage of chilled carcass weight was not different by breed group. This agrees with Luchiari Filho et al. (1981), who found no differences in kidney and pelvic fat weights when comparing Nellore purebred with Chianina and Marchigiana crossbreds. Carrol et al. (1955) and Ferrell et al. (1978) observed lesser fat content for crossbred than straightbreds or small type breeds. Comparing slaughter groups, bulls fed 119 days had less ($P < .05$) kidney and pelvic fat weight than the other slaughter time groups but when this was expressed as a percentage of carcass weight there was no difference by slaughter group. Increased kidney and pelvic fat weight would be expected with increasing live weight, increasing fatness and longer feeding times. This agress with findings of Hedrick et al. (1975), who observed greater amounts of internal fat in long fed steers than short fed steers.

Fat thickness (Table 2) was less ($P < .05$) for the crossbred II group, higher for Nellore and intermediate for Nellore I and crossbred I. These results for fat thickness agree with many authors who have observed thinner fat cover for crossbred animals (Damon Junior et al. 1960, Adams et al. 1973, Hedrick et al. 1975, Prior et al. 1977, Robelin 1978, O'Mary et al. 1979, Luchiari Filho et al. 1981).

Slaughter group 3 had greater ($P < .05$) fat thickness than did groups 1 and 2. The fact that groups 1 and 2 were not different indicates that they were not depositing increasing amounts of fat up through 152 days of feeding. These results agree with Adams et al. (1973) and Hedrick et al. (1975).

Crossbred II animals were observed to have larger ($P < .05$) loin eyes than the other groups (Table 2). These results agree with Gaines et al. (1957), who comparing crossbred and straightbred steers and heifers observed positive evidence of heterosis for loin eye area.

TABLE 1. Breed and time on feed effects on slaughter traits.

Breed groups	N	Live weight at slaughter (kg)	Hot carcass weight (kg)	Hot dressing percentage	Chilled carcass weight (kg)	Chilled dressing percentage
Nellore I	10	476.0[a]	269.78[a]	56.68	266.30[a]	55.92
Nellore II	10	464.5[a]	264.49[a]	56.89	259.11[a]	55.74
Crossbred I	10	479.0[a]	264.42[a]	55.16	260.22[a]	54.29
Crossbred II	6	513.5[b]	291.57[b]	56.77	286.30[b]	56.76
Slaughter groups (Time on feed)						
Group 1	11	450.73[a]	250.44[a]	55.54	245.53[a]	54.45
Group 2	14	481.45[b]	273.92[b]	56.88	269.53[b]	55.97
Group 3	11	501.57[b]	283.46[b]	56.53	279.18[b]	55.67

[abc] Means within breed groups or slaughter groups without a common superscript differ ($P < .05$).

TABLE 2. Breed and time on feed effects on carcass traits.

Breed groups	Carcass length (cm)	Depth at Fifth rib (cm)	Kidney and pelvic fat weight (kg)	Kidney and pelvic fat (%)	Fat thickness at 12th rib level (mm)	Loin eye area (sq cm)	LEA/100 kg of carcass weight (sq cm)
Nellore I	124.13[a]	40.57	7.57	2.81	4.70[ab]	70.39[a]	26.41
Nellore II	123.87[a]	39.94	7.91	3.06	6.10[b]	68.57[a]	26.53
Crossbred I	128.50[b]	41.37	6.93	2.67	4.60[ab]	65.93[a]	25.48
Crossbred II	128.12[b]	40.85	7.60	2.66	3.50[a]	79.65[b]	27.93
Slaughter groups (Time on feed)							
Group 1	124.58[a]	40.44	6.43[a]	2.61	3.36[a]	67.61	27.56[a]
Group 2	–	–	7.90[b]	2.94	3.91[a]	71.93	26.56[ab]
Group 3	126.97[b]	40.84	8.01[b]	2.87	6.78[b]	71.28	25.55[b]

[abc] Means within breed groups or slaughter groups without a common superscript differ ($P < .05$).

Between slaughter time groups, even though loin eye shows a trend to increase with age, the differences were not significant. The larger loin eyes in the crossbred II bulls can partially be explained by their higher average live weight since loin eye area is positively correlated with live weight. The larger loin eyes in the crossbred II groups are supported by the findings of Hedrick et al. (1970, 1975), Koch et al. (1976), Koch & Dikeman (1977), O'Mary et al. (1979) and Luchiari Filho et al. (1981). Hedrick et al. (1975) observed that loin eye area was greater for steers fed longer time periods than for short fed steers.

When loin eye area was expressed per 100 kg of carcass weight, crossbred II bulls had slightly more and crossbred I bulls the least, but differences were not significant. LEA/100 kg of carcass weight was different ($P < .05$) by slaughter time with group 1 having more than group 2 and with group 3 having the least. Berg & Butterfield (1968) reported that *Longissimus dorsi* muscle has an average growth impetus; thus, in later stages of development, weight gain of other carcass tissues surpasses that of *Longissimus dorsi*.

Differences in carcass wholesale cuts

Crossbred II bull carcasses yielded more weight of special hindquarter which would be expected since they had heavier live and carcass weights (Table 3). Slaughter time group 3 had heavier ($P < .05$) special hindquarter weights than group 1 with group 2 being intermediate. This should be expected because hindquarter weight increases with increasing age and weight. When special hindquarter weight was expressed as a percentage of side weight, group 2 and 3 had less ($P < .05$) than group 1. According to Luitingh (1962), because the growth impetus of the hindquarter at later stages of development is lower in bulls than that of the forequarter, when it is expressed as percentage of side weight it should be expected to decrease as the animals get older and heavier.

Slaughter groups 2 and 3 had heavier ($P < .05$) forequarter weights and greater forequarter percentages. Forequarter weights were not significant by breed groups, a tendency was observed for crossbred I bulls to have lighter and crossbred II bulls heavier forequarter weights. When expressed as a percentage of side weight crossbred II bulls had less ($P < .05$) than the Nellore I and II bulls.

The higher forequarter weights and lower hindquarter weights obtained from the Zebu breeds has been well documented and the results agree with findings of Carpenter et al. (1961), Norman & Felicio (1981) and Luchiari Filho et al. (1981). These workers have stated that the hump on the Zebu forequarter exerts a great influence on the weight differences between forequarter and hindquarter. The decrease in special hindquarter pro-

portion and consequent increase in forequarter proportion with age and finish agree with earlier findings of Luitingh (1962), who observed that as the animal gets older an onset of higher growth intensity and fat deposition takes place in the forequarter.

No differences were observed between breed groups for "ponta-de-agulha" expressed as a weight or percentage of side weight (Table 3), but "ponta-de-agulha" weights increased ($P < .05$) as the animals were fed longer, with slaughter time group 1 being lighter than group 3 and group 2 intermediate. This was expected, because ventral parts of the body increase with age, fattening and ration energy level as observed by Luitingh (1962) and Luchiari Filho et al. (1981). When the "ponta-de-agulha" weights were expressed as a percentage of side weight the difference was not significant. These results indicate that these bulls were not accumulating fat in this carcass part more rapidly than other carcass parts up through 175 days on feeding.

From a carcass characteristic standpoint, crossbreeding of Nellore and Marchigiana purebred cattle would be of interest because the crossbreds attained higher gains of the higher priced special hindquarter, and lower gains of the lower priced forequarter and "ponta-de-agulha".

Differences in weight and yield of bone

Croossbred II bulls, having heavier slaughter and carcass weights, also had more ($P < .05$) total side bone weight than did the Nellore II bulls. They also had more total side weight of bone than the other two groups but differences were not significant (Table 3). Comparing Hereford and Brahman-Hereford crossbreds, Carrol et al. (1955) observed that crossbred carcasses had more bone than those from straightbreds. From a slaughter time group standpoint, groups 2 and 3 had heavier ($P < .05$) total bone weights than group 1. Expressing total bone weights as a percentage of half carcass weight (Table 3), crossbred I carcasses had higher total bone percentages than the other groups.

Slaughter group 2 had a greater percentage of total bone than did the other two slaughter groups (Table 3). This difference may well have been the result of experimental error resulting from poor carcass splits. Upon reviewing the data, it was observed that the sides from group 2 that were fabricated were consistently heavier in weight than their opposite side which was not the case in slaughter groups 1 and 3. The only plausible explanation for this was the chance selection of those sides with more total bone resulting from poor carcass splits. Comparing groups 1 and 3, although the difference was not statistically significant, it was observed that the percentage of bones decreased slightly with age. It is well documented that bone has a low growth impetus at later stages of development and the proportion of bone in a carcass should decrease as the animal gets older and heavier. These results agree with earlier results reported by Tulloh (1963) and Kempster (1978).

Differences in quarter and side retail cut weights and percentages

The edible portion from special hindquarter expressed as percentage of the side weight was higher ($P < .05$) for the crossbred II bulls than the Nellore I and II bulls but not greater than crossbred I bulls (Table 4). These results agree with results previously reported by Luchiari Filho et al. (1981). This increased percentage of trimmed hindquarter cuts for crossbred II is an obvious advantage of crossbreeding, because these are the high priced cuts which are in greatest consumer demand. On a slaughter time group basis, the weight of the edible portion of the special hindquarter tended to increase with increasing age and weights of each group. Increasing time on feed resulted in decreased percentages of hindquarter total edible portion yields (Table 4). This same pattern was observed in most of the percentage yields for the individual retail cut yields from the hindquarter and should be expected.

Total forequarter edible portion weights increased ($P < .05$) by slaughter group (Table 4). This can be largely attributed to increased fat deposition and muscle growth in the forequarter because the results show a significant increase in weight from slaughter group 1 to slaughter group 2 with slaughter group 3 being heavier than group 2

but not significantly (44.75 vs. 43.17 kg.). Comparing breed groups it was observed that crossbred II bulls had more forequarter or forequarter edible portion yield than crossbred I and Nellore II bulls with Nellore I bulls not being different from any of the other groups. Crossbred I bulls showed the least trimmed edible portion weights which may be desirable due the comparative lower commercial value of these cuts. This lower yield in crossbred I bulls may be due to their not being slaughtered in as advance maturity stages as the other breed groups.

Total edible portion from "ponta-de-agulha" was not different by breed group either on a weight or on a percentage yield basis, but with age and fattening the weight of this cut was significantly higher for group 3 than groups 1 and 2. On a percentage basis, group 2 had less than group 3 with group 1 differing from neither.

Crossbred II bulls yielded more ($P < .05$) total edible portion than the other breed groups (Table 4). This breed group had heavier live and carcass weights. When expressed on a percentage basis, crossbred II bulls had more ($P < .05$) total edible portion than crossbred I and Nellore II bulls but not more than Nellore I (Table 4). This is very desirable because much of this advantage is composed of special hindquarter yield. Because Marchigiana cattle mature later, slaughtering these type animals at an average slaughter weight of the Nellore will bring the advantage of producing leaner and heavier muscled carcasses. The advantages of these larger framed cattle in producing larger and leaner carcasses is well documented and many researchers agree that due to a greater body size, these animals can be slaughtered at heavier weights and still have minimal amounts of fat deposition (Hedrick et al. 1970, Damon Junior et al. 1960, Adams et al. 1973, Hedrick et al. 1975, Robelin 1978, Ferrell et al. 1978, Peacock et al. 1979, O'Mary et al. 1979, Luchiari Filho et al. 1981).

Comparing slaughter time groups, groups 2 and 3 had heavier total edible portion (Table 4) than group 3, which should be expected due to their increased weight. When yields were expressed as a percentage of side weight, they were not statisti-

TABLE 3. Breed and time on feed effects on wholesale cut weights and percentages and bone weight and percentage.

Breed groups	Special hindquarter weight (kg)	Special hindquarter (%)	Forequarter weight (kg)	Forequarter (%)	Ponta-de-agulha weight (kg)	Ponta-de-agulha (%)	Total bone weight (kg)	Total bone (%)
Nellore I	60.22^{a}	45.60^{a}	54.94	41.52^{a}	17.38	13.13	22.74^{ab}	17.25^{a}
Nellore II	59.31^{a}	46.03^{ab}	53.08	41.13^{a}	16.73	12.95	21.67^{a}	16.85^{a}
Crossbred I	60.77^{a}	46.97^{b}	52.38	40.45^{ab}	16.74	12.94	23.60^{b}	18.25^{b}
Crossbred II	67.58^{b}	47.37^{b}	56.82	39.73^{b}	18.03	12.60	23.87^{b}	16.74^{a}
Slaughter groups (Time on feed)								
Group 1	58.24^{a}	47.46^{a}	48.76^{a}	39.71^{a}	15.85^{a}	12.90	21.05^{a}	17.17^{a}
Group 2	61.14^{ab}	45.81^{b}	55.41^{b}	41.61^{b}	17.04^{ab}	12.81	24.25^{b}	18.24^{b}
Group 3	63.95^{b}	46.02^{b}	57.07^{b}	41.06^{b}	18.18^{b}	13.07	23.22^{b}	16.74^{a}

^{abc} Means within breed groups or slaughter groups without a common superscript differ ($P < .05$).

TABLE 4. Breed and time on feed effects on total edible portion from sides and wholesale cuts.

Breed groups	Edible portion from special hindquarter (kg)	Edible portion from special hindquarter (%)	Edible portion from forequarter (kg)	Edible portion from forequarter (%)	Edible portion from ponta-de-agulha (kg)	Edible portion from ponta-de-agulha (%)	Total side edible portion (kg)	Total side edible portion (%)	Total fat trimmings (kg)	Total fat trimmings (%)
Nellore I	41.98^{a}	32.26^{a}	42.90^{ab}	32.42	13.81	10.42	97.76^{a}	75.03^{ab}	9.96	7.63^{ab}
Nellore II	41.04^{a}	31.89^{a}	41.00^{a}	31.75	13.63	10.60	95.71^{a}	74.24^{b}	11.57	8.91
Crossbred I	42.54^{a}	32.87^{ab}	39.97^{a}	30.84	13.24	10.23	95.75^{a}	73.94^{b}	10.07	7.81^{ab}
Crossbred II	47.95^{b}	33.65^{b}	46.27^{b}	32.32	14.80	10.33	109.02^{b}	76.30^{a}	9.97	6.96^{b}
Slaughter groups (Time on feed)										
Group 1	41.93	34.16^{a}	37.72^{a}	30.69^{a}	12.80^{a}	10.42^{ab}	92.45^{a}	75.27	9.27^{a}	7.55
Group 2	42.24	31.63^{b}	43.17^{b}	32.39^{b}	13.43^{a}	10.07^{a}	98.84^{b}	74.10	10.23^{ab}	7.66
Group 3	44.26	32.02^{b}	44.75^{b}	32.15^{b}	14.82^{b}	10.65^{b}	103.41^{b}	74.75	11.64^{b}	8.49

^{abc} Means within breed groups or slaughter groups without a common superscript differ ($P < .05$).

cally different (Table 4), but they did decrease slightly with age of slaughter group. This agrees with other worker findings who have observed that with increased age and finishing, percentage yields of edible portion decline (Cole et al. 1962, Brungardt & Bray 1963, 1962, Allen et al. 1968).

Total weight of trimmings from sides were not different between breeds, but when expressed as a percentage of side weight were lower ($P < .05$) for crossbred II than Nellore II bulls (Table 4). Nellore II bulls had heavier kidney and pelvic fat weights as well as thicker external fat cover. On a slaughter time group basis, weight of trimmings increased with age and finishing mainly due to the higher impetus of fat growth at later stages of development. When expressed on a percentage basis, the differences were not significant.

CONCLUSIONS

1. The crossbred II group had higher ($P < .05$) live weight at slaughter (513.5 kg) than Nellore I, Nellore II and crossbred I (476.0, 464.5 and 479.0 respectively). Consequently, crossbred II had higher ($P < .05$) hot and chilled carcass weights than the other groups.

2. Crossbred II bulls also had a thinner ($P < .05$) 12th rib fat cover (3.5 mm) with Nellore II bulls having the thicker 12th rib fat cover (6.1 mm) and Nellore I and crossbred I being intermediate (4.7 and 4.6 mm respectively).

3. Loin eye area was larger ($P < .05$) for crossbred II (79.65 cm) than for Nellore I, Nellore II and crossbred I groups (70.39, 68.57 and 65.93 cm respectively).

4. A higher ($P < .05$) special hindquarter weight was also observed for crossbred II (67.58 kg) than for Nellore I, Nellore II and crossbred I (60.22, 59.31 and 60.77 kg respectively). Special hindquarter percentage was higher ($P < .05$) for crossbred I and II (46.97 and 47.37% respectively) than Nellore I (45.60%) with Nellore II (46.03%) being intermediate. On the other hand, as expected, crossbred II had a lower forequarter percentage.

5. A very desirable characteristic was also observed for crossbred II from the standpoint of producing higher percentage ($P < .05$) of total edible portion (76.30%), higher percentage of edible portion from the special hindquarter (33.65%) and less amount of trimmable fat (6.96%).

REFERENCES

ADAMS, N.J.; GARRET, W.N.; ELINGS, J.T. Performance and carcass characteristics of crosses from imported breeds. **J. Anim. Sci.**, 37:623-8, 1973.

ALLEN, D.M.; MERKEL, R.A.; MAGEE, S.T.; NELSON, R.H. Variation in some beef carcass compositional characteristics within and between selected weight and fat thickness ranges. **J. Anim. Sci.**, 27:1239-46, 1968.

BERG, R.T. & BUTTERFIELD, R.M. Growth patterns of bovine muscle, fat and bone. **J. Anim. Sci.**, 27:611-9, 1968.

BRUNGARDT, V.H. & BRAY, R.W. Estimate of retail yield of the four major cuts in the beef carcass. **J. Anim. Sci.**, 22:177-82, 1963.

BUTLER, O.D.; WARWICK, B.L.; CARTWRIGHT, T.C. Slaughter and carcass characteristics of shortfed yearling Hereford and Brahman-Hereford steers. **J. Anim. Sci.**, 15:93-6, 1956.

CARPENTER, J.W.; PALMER, A.Z.; KIRK, W.G.; PEACOCK, F.M.; KOGER, M. Slaughter and carcass characteristics of Brahman and Brahman-Shorthorn crossbred steers. **J. Anim. Sci.**, 20:336-40, 1961.

CARROL, F.D.; ROLLINS, W.C.; ITTNER, N.R. Brahman-Hereford crossbreds and Hereford gains, carcass yields and carcass differences. **J. Anim. Sci.**, 14:218-23, 1955.

COLE, J.W.; RAMSEY, C.B.; EPLEY, R.H. Simplified method for predicting pounds of lean in beef carcasses. **J. Anim. Sci.**, 21:355-61, 1962.

CORTE, O.O.; CIA, G.; FELICIO, P.E. de; LUCHIARI FILHO, A. Meat quality and quantity of Nellore, Chianina-Nellore and Marchigiana-Nellore young bulls. In: EUROPEAN MEETING OF MEAT RESEARCH WORKERS, Kulmbach, 1978. **Abstract.** Kulmbach, K.O. Honikel, 1978. p.A1:3-A1:6.

DAMON JUNIOR, R.A.; CROWN, R.M.; SINGLETARY, C.B.; MCCRAINE, S.E. Carcass characteristics of purebred and crossbred beef steers in the Gulf Coast Region. **J. Anim. Sci.**, 19:820-44, 1960.

FERRELL, C.L.; KOHLMEIR, R.H.; CROUSE, J.D.; GLIMP, H. Influence of dietary energy, protein and biological type of steer upon rate of gain and carcass characteristics. **J. Anim. Sci.**, 46:255-70, 1978.

GAINES, J.A.; RICHARDSON, G.V.; MCLURE, W.H.; VOGT, D.W.; CARTER, R.C. Heterosis from crosses among British breeds of beef cattle; carcass characteristics. **J. Anim. Sci.**, 26:1217-25, 1957.

GUENTHER, J.J.; BUSHMAN, D.H.; POPE, L.S.; MORRISON, R.D. Growth and development of the major carcass tissues in beef calves from weaning to slaugh-

ter weight, with reference to the effect of plane of nutrition. J. Anim. Sci., 24:1184-91, 1965.

HEDRICK, H.B.; KRAUSE, G.F.; LASLEY, J.F.; SIBBIT, B.; LANGFORD, L.; DYER, A.J. Quantitative and qualitative carcass characteristics of straightbred and reciprocally crossed Angus, Charolais and Hereford steers. J. Anim. Sci., 41:1581-91, 1975.

HEDRICK, H.B.; LASLEY, J.F.; JAIN, J.P.; KRAUSE, G.F.; SIBBIT, B.; LANGFORD, L; COMFORT, J.E.; DYER, J. Quantitative carcass characteristics of reciprocally crossed Angus, Charolais and Hereford heifers. J. Anim. Sci., 31:633-41, 1970.

KEMPSTER, A.J. Bone growth and development with particular reference to breed differences in carcass shape and lean to bone ratio. In: DE BOER, H. & J. MARTION, J., ed. Patterns of growth and development in cattle. The Hague, M. Nijhoff, 1978. p.149--66.

KOCH, M. & DIKEMAN, M. Characterization of biological types of cattle. V. Carcass wholesale cut composition. J. Anim. Sci., 45:48-62, 1977.

KOCK, R.M.; DIKEMAN, M.E.; ALLEN, D.M.; MAY, M.; CROUSE, J.D.; CHAMPION, D.R. Characterization of biological types of cattle. III. Carcass composition, quality and palatability. J. Anim. Sci., 43:48-62, 1976.

LUCHIARI FILHO, A.; BOIN, C.; CESAR, S.M.; CORTE, O.O. Estudo comparativo das características quantitativas de carcaças de tourinhos Nelore, meio sangue Marchigiana-Nelore e meio sangue Chianina-Nelore. B. Indústr. anim., 38:9-17, 1981.

LUITINGH, H.C. Development changes in beef steers as influenced by fattening, age and type of ration. J. Anim. Sci., 58:1-7, 1962.

NORMAN, G.A. & FELICIO, P.E. de. Effect of breed and nutrition on the productive traits of Zebu, Charolais and crossbred beef cattle in South East Brazil. I. Body and gross carcase composition. Meat Sci., 5:425-9, 1981.

O'MARY, C.C.; MARTIN, E.L.; ANDERSON, D.C. Production and carcass characteristics of Angus and Charolais-Angus steers. J. Anim. Sci., 48:239-45, 1979.

PEACOCK, F.M.; PALMER, A.Z.; CARPENTER, J.W.; KOGER, M. Breed and heterosis effects on carcass characteristics of Angus, Brahman, Charolais and crossbred steers. J. Anim. Sci., 49:391-5, 1979.

PRIOR, R.L.; KOHLMEIR, R.H.; CUNDIFF, L.V.; DIKEMAN, M.E.; CROUSE, J.D. Influence of dietary energy and protein on growth and carcass composition in different biological types of cattle. J. Anim. Sci., 45:132, 1977.

ROBELIN, J. Development with age of the anatomical composition of the carcass of bulls. In: DE BOER, H. & MARTIN, J., ed. Patterns of growth and development in cattle. The Hague, M. Nijhoff, 1978. p.47--56.

SAS INSTITUTE, Raleigh, EUA. SAS user's guide. Raleigh, 1979. 494p.

SNEDECOR, G.W. & COCHRAN, W.G. Statistical methods. 6.ed. Ames, Iowa State University Press, 1967.

TULLOH, N.M. The carcase composition of sheep, cattle and pigs as functions of body weight. In: TRIBE, D.E., ed. Carcase composition and appraisal of meat animals. East Melbourne, CSIRO, 1963. v.5, p.1-16.