Intake, milk production and weight change curves for lactating Holstein x Zebu cows under grazing

[*Consumo, curvas de lactação e variação de peso de vacas Holandês x Zebu em pastejo*]

S.A. *Santos*[1], S.C. *Valadares Filho*[1], E. *Detmann*[1], J.R.M. *Ruas*[2], L.F. *Prados*[1], L.D.S. *Mariz*[1]

[1]Universidade Federal de Viçosa – Viçosa, MG
[2]Empresa de Pesquisa Agropecuária de Minas Gerais – Epamig – Felixlândia, MG

ABSTRACT

The purpose of this study was to evaluate feed intake and develop lactation and weight change curves for Holstein x zebu cows under grazing. Eighteen F1 cows were used, divided into three treatments; 6 were Holstein x Gir (HGI), 6 were Holstein x Guzerat (HGU), and another 6 were Holstein x Nelore (HNE), under the feeding conditions of pasture plus concentrate with 22% of crude protein (CP). To estimate individual feed intake at pasture, 2 markers were used: titanium dioxide to estimate fecal dry matter (DM) excretion, and the indigestible acid detergent fiber (iADF) to estimate individual pasture intake. The Wood (1967) model was used to evaluate milk yield and the parameters were estimated for each genetic group, as follows: $HGI = 17.2667 * t^{0.0652} * e^{-0.00424t}$; $HGU = 18.1470 * t^{0.0332} * e^{-0.00408t}$; and $HN = 14.2836 * t^{0.1059} * e^{-0.00552t}$. The NEFA contents varied according to different genetic groups (P<0.001). It was concluded that the estimated peak DMI occurs during the sixth week of lactation, when the DMI by the different genetic groups was stabilized. The HGI cows have greater cumulative production at 305-d.

Keywords: crossbreeding, F1, lactation, tropical grasses

RESUMO

O objetivo deste estudo foi avaliar o consumo de vacas Holandês x Zebu sob pastejo e desenvolver curvas de lactação e variação de peso para elas. Dezoito vacas F1 foram utilizadas, divididas em três tratamentos: seis foram Holandês x Gir (HGI), seis foram Holandês x Guzerá (HGU, e outras seis foram Holandês x Nelore (HNE), sob as mesmas condições de alimentação com pasto e concentrado com 22% de proteína bruta (PB). Para estimar o consumo individual, dois indicadores foram utilizados: dióxido de titânio para estimar a excreção de matéria seca fecal (DM), e fibra em detergente ácido indigestível (FDAi) para estimar a ingestão de pasto. O modelo de Wood (1967) foi utilizado para avaliar a produção de leite, e os parâmetros foram estimados para cada grupo genético, conforme a seguir: $HGI = 17.2667 * t^{0.0652} * e^{-0.00424t}$; $HGU = 18.1470 * t^{0.0332} * e^{-0.00408t}$; e $HN = 14.2836 * t^{0.1059} * e^{-0.00552t}$. O conteúdo de ácidos graxos não esterificados (AGNE) variou de acordo com os diferentes grupos genéticos (P<0,001). Concluiu-se que o pico estimado para CMS ocorre durante a sexta semana de lactação, quando o CMS pelos diferentes grupos genéticos foi estabilizado. As vacas HGI têm maior produção de leite acumulada aos 305-d.

Palavras-chave: cruzamentos, F1, gramíneas tropicais, lactação

INTRODUCTION

Tropical countries, which have high average temperatures throughout the year, face challenges in milk production when using European cattle breeds because these animals suffer from heat stress and metabolic changes. Consequently, there is a decrease in feed intake and efficiency, as well as pregnancy rates.

As a result, it is important to study animals that are better adapted to tropical climates. The

production of F1 crossbred females for dairy farms in this environment normally involves breeding zebu (*Bos indicus*) females with a Holstein bull to exploit the beneficial effects of heterosis. The zebu breeds most often used are Gir and Guzerat, because these animals possess milk-producing characteristics and are more docile than other zebu breeds. However, there is market discount for heifers birthed by Nelore dams because of a fear of aggressive behavior and lower milk production. Therefore, research is needed to characterize the milk production and performance of these different breed combinations.

In general, zebu breeds are adapted to warmer climates because of their short and fine hairs and dark skin covered with melanin, and increased surface area in the ears and dewlap for heat exchange. Its thermal comfort zone is between 10 and 27°C and can be expanded to 5-31°C for *Bos indicus* x *Bos taurus* crosses, clearly demonstrating the effects of heterosis (Pereira, 2005). Studies on the performance of zebu cross cows during lactation under grazing conditions are needed; in addition to these factors, tropical C4 grasses are not highly digestible, which results in a lower efficiency of milk production with specialized animals. The objective of this study was to develop feed intake and weight change curves for F1 crossbred Holstein x zebu cows under grazing systems.

MATERIALS AND METHODS

The experiment was carried out at the Empresa de Pesquisa Agropecuária de Minas Gerais Research Farm, in Felixlândia-MG-Brazil, between the months of January and May, 2008. The procedures for humane care and handling of the animals followed the recommendations of the Federal University of Viçosa.

In total, there were 18 F1 cows – 6 Holstein x Gir (HGI), 6 Holstein x Guzerat (HGU) and 6 Holstein x Nelore (HNE) – that formed three experimental treatments with six repetitions. The initial body weight was 560.01±6.62 for Holstein x Nelore; 566.87±4.70 for Holstein x Guzerat and 513.36±5.42 for Holstein x Gir. Cows were placed into the experiment by their similar lactation numbers, which was four or five, for all genetic groups. The cows had recently calved and were distributed in simple random samples

under the same feeding conditions, as follows: pasture plus 220g/kg crude protein (CP) supplement.

Every day after milking (7h00), the cows were led to paddocks of *Brachiaria decumbens*, under rotational grazing management. Dry matter intake (DMI) and digestible dry matter (DMd) estimates were obtained for 6 experimental periods, each comprising 21 days, and started during the first week of lactation; milk production and weight change were collected until the end of lactation.

To estimate individual feed intake at pasture, 2 markers were used, during 6 experimental periods of 21 days each, with 14 for adaptation, and 7 for data collection. Titanium dioxide was used as a marker to estimate fecal dry matter (DM) excretion. From the 7th to 18th day of the experimental period, 15g of titanium dioxide was given via an oral catheter to each cow during the afternoon milking at 15h00. There was a total of 11 days of application, being 6 days for stabilization of marker excretion in the feces and 5 days feces collection. Feces were collected twice daily, following each milking. Fecal samples collected were dried, ground and the amount composited proportionately based on the air dry weight per animal. Titanium dioxide concentration was determined using the technique described by Myers *et al.* (2004).

To determine individual pasture intake, indigestible acid detergent fiber (iADF) was used as an internal marker. To estimate the iADF from the pasture, 2 esophageally fistulated steers were used for the collection of esophageal extrusa on the 16th day of each experimental period. To quantify the iADF in the feces, concentrate, and extrusa, the samples were placed in Ankom F57 filter bags and incubated in the rumen of a fistulated animal for 264 hours (Casali *et al.*, 2008). The material remaining after the incubation was washed in water and then subjected to acid detergent extraction. The estimates of individual feed intake were determined according to the equation: DMI (kg/d) = ([[(fecal excretion*iADF concentration in feces) – iADF in concentrate]/iADF concentration in extrusa) + DMI from concentrate.

828

Arq. Bras. Med. Vet. Zootec., v.66, n.3, p.827-836, 2014

Total concentrate (Table 1) was supplied in an individual trough in the milking shed and was supplied according to milk production, providing 1kg of concentrate for each 3kg of milk produced; the initial production needed to be 8kg of milk to receive the initial concentrate. After milking, the feed orts were collected and weighed. The concentrate contained: soybean meal (240g/kg), ground corn (685g/kg), urea (20g/kg), ammonium sulfate (2g/kg), limestone (16g/kg), dicalcium phosphate (23g/kg), sodium chloride (4 g/kg), and a mineral premix (10 g/kg), which contained cobalt sulfate (79.3g/kg), copper sulfate (239g/kg), zinc sulfate (635g/kg), potassium iodide (31.7g/kg) and sodium selenite (15.8g/kg).

Table 1. Bromatological composition of the concentrate, extrusa and pasture allowance throughout the experimental period[1]

Item[2]	21 days		42 days		63 days		84 days		105 days		126 days		
	EXT	ALW	EXT	ALW	EXT	ALW	EXT	ALW	EXT	ALW	EXT	ALW	CONC
ADM	--	3.2	--	4.5	--	6.4	--	6.8	--	6.5	--	10.8	--
DM	--	170.6	--	190.2	--	270.0	--	300.8	--	370.1	--	410.5	870.6
OM	900.4	920.4	900.0	920.1	890.6	920.6	880.9	930.1	900.3	940.2	910.1	930.9	910.9
CP	50.2	30.1	120.3	80.1	90.6	60.9	80.4	40.4	70.6	30.6	60.8	40.3	240.6
NDIN	6.6	4.4	9.7	12.2	8.5	9.2	7.9	6.9	9.1	6.5	10.2	6.1	79.3
EE	21.0	5.80	19.3	9.2	15.1	7.8	19.4	8.8	20.1	15.4	22.7	12.9	28.3
NDFap	600.4	662.4	554.0	616.3	591.3	653.8	623.5	672.0	596.9	711.1	598.0	713.8	95.5
iNDF	208.0	312.9	175.2	311.2	202.5	319.0	243.2	357.2	228.6	377.6	311.1	449.9	25.6
NFC	229.0	224.5	200.4	214.3	185.4	195.2	158.1	205.2	206.6	172.4	220.8	175.7	549.2
ADFap	285.2	352.4	269.0	362.4	324.2	378.6	315.1	374.1	336.5	447.7	273.3	402.9	30.1
LIG	61.7	117.9	42.2	75.8	88.5	140.8	87.4	162.2	102.1	121.5	75.8	112.8	17.5

[1]EXT – esophageal extrusa; ALW – pasture allowance; CONC – concentrate
[2]ADM – available dry matter (t/ha); DM – dry matter, g/kg; OM – organic matter, g/kg (dry basis); CP – crude protein, g/kg (dry basis); NDIN – Neutral detergent insoluble nitrogen, g/kg (% NDF); EE – Ether extract, g/kg (dry basis); NDFap – neutral detergent fiber corrected for ash and protein, g/kg (dry basis) ; iNDF – indigestible neutral detergent fiber, g/kg (dry basis) ; NFC – non-fiber carbohydrates, g/kg (dry basis); ADF – acid detergent fiber, g/kg (dry basis) ; LIG – lignin, g/kg (dry basis).

All pre-drying was done in a ventilated oven at 60 °C for 72 h, and grinding was carried out in a mill with 2 mm mesh sieves. The samples were stored in plastic containers for later analyses of dry matter (DM), organic matter (OM) and crude protein (CP) (AOAC, 1997, method number 934.01 for DM; 930.05 for OM and 981.10 for CP). Ether extract (EE) was analyzed by Soxhlet extraction with petroleum ether. The neutral detergent fiber concentrations, corrected for ash and protein (NDFap), and ADFap were determined using the methodology proposed by Mertens (2002) and were analyzed with the addition of thermostable alpha-amylase (Ankom Tech. Corp., Fairport. NY). Lignin was extracted with 72% sulfuric acid. Neutral detergent insoluble nitrogen (NDIN) was evaluated with the Kjeldahl method (Licitra *et al*., 1996). Non-fiber carbohydrates, corrected for ash and protein (NFCap), were calculated as proposed by Detmann and Valadares Filho (2010), where: NFCap = 100 – ([%CP - %CP derived from urea + %urea] + % NDFap + %EE + %ash).

Forage collection, to estimate the pasture allowance, was done on the first day of the experiment and on the last day of each experimental period. Samples were collected by cutting 10 randomly chosen locations from each paddock, within a 0.49m^2 metal frame, as described by McMeniman (1997) (Table 1). The cows were mechanically milked at 7h00 and 14h00, and daily milk production was recorded. To access the BW change, cows were weighed again every 10 days.

Blood samples were collected on 21th day of each experimental period, by coccygeal venipuncture using test tubes with anticoagulants (EDTA), immediately centrifuged at room temperature and 2.800 x *g* for 15 min, and after the removal of the plasma, packed into glass containers and frozen at –15°C, for the subsequent analyses of NEFAs (Non-esterified fatty acids). To determine the NEFAs, a commercial kit (HR Series NEFA-HR(2), Wako Diagnostic, Richmond, VA, USA) was used.

The mathematical model used to fit the lactation curve was: $Y = at^b e^{-ct}$ (Wood, 1967); where Y = milk production (kg/d), t = week of lactation, and a, b, and c = parameters to be estimated. The data collected in this investigation was also used for the validation of the original DMI prediction

Arq. Bras. Med. Vet. Zootec., v.66, n.3, p.827-836, 2014

829

model from the NRC (Nutrient…, 2001), in which the observed and predicted data were compared by the combined intercept test (Mayer *et al*., 1994). In the event the data did not fit the NRC (Nutrient…, 2001) model, the assessment of DMI using the structure of the model proposed by the NRC (Nutrient…, 2001) and its reparametrization was proposed, as follows: DMI (kg/d) = (a*FCM + b *BW$^{0.75}$) + (1 − e$^{(c*[WL+d])}$), where FCM = 4% fat corrected milk, BW = body weight in kg, WL = week of lactation, and a, b, c, and d = parameters to be estimated, using PROC NLIN of SAS (version 9.1).

To obtain the parameters of non-linear regression equations, the iterative process of the Marquardt algorithm and *t* statistics were used to determine confidence intervals for the parameters (1 - α = 0.95). To calculate asymptotic standard-deviation (A-SD), the maximum likelihood estimation method was used. To compare the models between different genetic groups, the test of model identity was used (Regazzi, 1999).

The statistical analyses for the DMI and DMd, as well as NEFAs, were performed using the multiple linear regression model Y = β_0 + $\beta_1 D_1$ + $\beta_2 D_2$ + $\beta_3 t$ + $\beta_4 (t*D_1)$ + $\beta_5 (t*D_2)$ + $\beta_6 t^2$ + $\beta_7 (t^2*D_1)$+ $\beta_8 (t^2*D_2)$ + ϵ; To evaluate BW change throughout lactation, the statistical analyses were done by adjusting the data to the cube root model, modified to include the effect of genetic groups: Y = D_0 + $\beta_1 D_1$ + $\beta_2 D_2$ + $\beta_3 t$ + $\beta_4 (t*D_1)$ +

$\beta_5 (t*D_2)$ + $\beta_6 t^{1/2}$ + $\beta_7 (t^{1/2}*D_1)$+ $\beta_8 (t^{1/2}*D_2)$ + $\beta_9 t^{3/2}$ + $\beta_{10} (t^{3/2}*D_1)$+ $\beta_{11} (t^{3/2}*D_2)$ + ϵ, where D_1 and D_2 are dummy variables corresponding to the effects of the genetic groups, with D_1 = 0 and D_2 = 0 for HNE, D_1 = 1 and D_2 = 0 for HGU, D_1 = 0 and D_2 = 1 for HGI, and t was the variable regarding the effect of time over DMI, DMd, NEFA and BW. This study used 5% as the probability for the type I error. The analysis was carried out using the PROC REG of SAS (version 9.1). To compare the models between different genetic groups, the model identification test was used (Regazzi, 1999).

RESULTS

The genetic groups did not have an effect (P>0.05) on the DMI (kg/d and %BW) and the DMd (Table 2). The regression equation parameters regarding DMI (kg/d) as a function of days in lactation were significant (P<0.001). The model was quadratic (Table 3), with a positive critical point or maxima. DMI as %BW did not have significant linear or quadratic parameters (P>0.05), and this was also true for the DMd.

Since there was no genetic group effect on any DMI parameter, all of the data from the different genetic groups was compiled to develop a DMI equation for F1 cows. The original prediction model from the NRC (Nutrient…, 2001) did not explain DMI under tropical grazing conditions (P<0.001) according to the combined intercept test.

Table 2. Significance level of the genetic group effect (P – value) in multiple linear regression parameters of the days in lactation[1]

Item[2]	Intercept			Linear effect			Quadratic effect		
	HGI x HNE	HGU x HNE	HGI x HGU	HGI x HNE	HGU x HNE	HGI x HGU	HGI x HNE	HGU x HNE	HGI x HGU
DMI, kg	0.949	0.807	0.879	0.596	0.514	0.946	0.467	0.357	0.925
DMI, BW%	0.638	0.797	0.484	0.803	0.631	0.851	0.631	0.489	0.884
DMd, g/kg	0.740	0.859	0.860	0.434	0.583	0.205	0.374	0.312	0.074
NEFA	0.053	0.014	0.808	0.017	0.003	0.756	0.009	0.004	0.899

[1]HGI – F1 Holstein x Gir; HGU – F1 Holstein x Guzerat; HNE – F1 Holstein x Nelore;
[2]DMI – Dry matter intake; DMd – Digestible dry matter; NEFA – Non-esterified fat acids, mmol/d

However, the model, when reparametrized (Figure 1), was adequate to predict the DMI of F1 cows under tropical pasture conditions (P=0.1407). After reparametrization of the model proposed by the NRC (Nutrient…, 2001),

the final equation was obtained, as described: DMI (kg/d) = (0.6089*FCM4% + 0.0244 *BW$^{0.75}$) + (1 − e$^{(-0.2919*[WL+5.5772])}$), where: FCM4%: fat corrected milk; BW: body weight; and WL: week of lactation.

Table 3. Estimated parameters in multiple linear regression models of the days in lactation[1]

Item[2]	Regression parameters			R-SD	R^2	P – value	Critical point	
	Intercept	t	t^2				Position (day)	Expected response
DMI, kg/d	12.9566	0.0215	-0.000267	1.84	0.3499	< 0.0001	40	13.34
NEFA – HNE	0.87797	-0.01326	0.00005658	0.14	0.4381	< 0.0001	117	0.1010
NEFA – HGU	0.54187	-0.00492	0.00001615	0.14	0.4381	< 0.0001	151	0.1671
NEFA – HGI	0.63704	-0.00807	0.00003313	0.14	0.4381	< 0.0001	122	0.1456

[1]t– linear effect of the time; t^2 – quadratic effect of the time; R-SD – residual standard deviation;
[2]NEFA – Non esterified fat acids, mmol/d; HGI – F1 Holstein x Gir; HGU – F1 Holstein x Guzerat; HNE – F1 Holstein x Nelore

The parameters of 3 different lactation curves for HGI, HGU and HNE (Table 4) were developed, as follows: HGI = 17.2667*t$^{0.0652}$*e$^{-0.00424t}$; HGU = 18.1470*t$^{0.0332}$*e$^{-0.00408t}$; and HNE =14.2836*t$^{0.1059}$*e$^{-0.00552t}$ (Figure 1). The lactation curve for HGI cows showed that there was a greater milk production during most of lactation, in comparison to the other groups; its peak lactation was discrete and coincided with those of the HGU cows. The HGI cows had peak production on day 15, producing 19.33kg/d, and the HGU cows had peak production on day 8, producing 19.08kg/d. The milk production sustained by HGI cows on day 305, in proportion to peak production, was of 35.58% (6.87kg/d), which was a little higher than that of HGU cows (33.60% and 6.41kg/d). The projected total production on day 305 of lactation for HGI cows was greater (3938kg) than HGU cows (3713kg), because of its lower rate of decline in production.
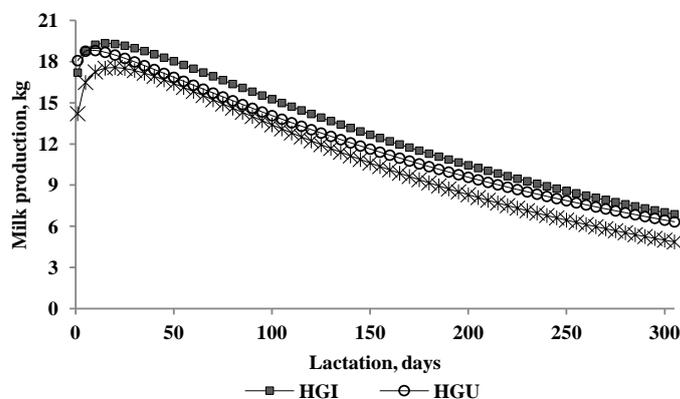

Figure 1. Lactation curves of the F1 Holstein x zebu cows from different genetic groups as follows: HGI – Holstein x Gir: Y = 17.2667*t$^{0.0652}$*e$^{-0.00424t}$; HGU – Holstein x Guzerat: Y = 18.1470*t$^{0.0332}$*e$^{-0.00408t}$ and HNE – Holstein x Nelore: Y = 14.2836*t$^{0.1059}$*e$^{-0.00552t}$

The HNE cows had, in general, lower cumulative milk production than the other groups (3335kg at day 305), with discrete peak lactation on day 19. Its maximum production was 17.56kg/d, and it had the lowest lactation persistence among the three groups, sustaining only 27.68% of peak production on day 305 of lactation. This group also had the lowest initial production, as can be observed when the intercepts of the equations are compared (Table 4). The NEFA content (Table 2) varied with genetic group (P<0.05), presenting 3 different equations (P<0.001) as a function of days in lactation (Table 3). Thus, an equation was developed for each group: HGI = 0.63704 - 0.00807*t + 0.00003313*t^2; HGU = 0.54187 - 0.00492*t + 0.00001615*t^2; and HNE = 0.87797 - 0.01326*t + 0.00005658*t^2. The cows birthed by Nelore dams had greater mobilization of body

Arq. Bras. Med. Vet. Zootec., v.66, n.3, p.827-836, 2014

831

reserves during early lactation, observed by the intercept of the equation. Within 117 days, this group reached a lower level of mobilization compared to the other genetic groups. The cows birthed by Guzerat and Gir dams had lower

NEFA in early lactation and maintained a slower decline in NEFA during lactation, reaching a minimum NEFA at day 151 and 122, respectively. From then on, all of the groups had a resurge of NEFA contents in plasma.

Table 4. Estimated parameters for the Wood (1967) model and descriptive statistics of the observed data

Parameters	Wood (1967) model for genetic groups[1]		
	HGI	HGU	HNE
a	17.2667 ± 2.5145	18.1470 ± 1.2313	14.2836 ± 2.0699
b	0.0652 ± 0.0421	0.0332 ± 0.0209	0.1059 ± 0.0444
c	0.00424 ± 0.0004	0.00408 ± 0.00028	0.00552 ± 0.00057

	Descriptive statistics							
	Average	Median	Mode	Max	Min	SD	CV	n
Days in lactation	121.30	113.0	196	287	1	63.9	52.6	966
Milk Yield, kg	13.35	13.5	15	24	3	3.8	28.8	966

[1]HGI – F1 Holstein x Gir; HGU – F1 Holstein x Guzerat; HNE – F1 Holstein x Nelore; Wood (1967) model: $Y=at^be^{-ct}$

These data may be assessed in combination with those of BW change (Table 5 and Figure 2), because there was a difference in the intercept of the BW change curve for the 3 genetic groups, in addition to describing a second phase of BW loss

after day 150 of lactation, a period that coincided with a reduction in the availability of digestible DM in tropical pasture (after 5 months in pasture).

Table 5. Estimated parameters of the cube root model used to fit the weight variation data throughout days in lactation, different genetic group effects (*P* – value) and descriptive statistics of the observed data

Iten[2]	Regression parameters[1]						
	intercept	t	$t^{1/2}$	$t^{3/2}$	R-SD	R^2	*P* – value
HGI	607.70	3.6957	-32.4659	-0.1352	45.92	0.2379	<0.0001
HGU	664.73	3.6957	-32.4659	-0.1352	45.92	0.2379	<0.0001
HNE	657.42	3.6957	-32.4659	-0.1352	45.92	0.2379	<0.0001
	Genetic group effects (*P* – value)						
	Intercept	t		$t^{1/2}$		$t^{3/2}$	
HGI x HNE	< 0.0001	0.0877		0.0616		0.1230	
HGU x HNE	0.1913	0.0716		0.0716		0.0650	
HGI x HGU	0.0253	0.6214		0.4447		0.8290	
	Descriptive statistics						
	average	median	max	min	SD	CV	n
Days in lactation	137.1	140	280	1	68.3	49.8	205
Body weight, kg	552.0	554	667	441	51.9	9.4	205

[1]t– linear effect; $t^{1/2}$ – cube effect; $t^{3/2}$ – cube root effect; R-SD – residual standard-deviation;

[2]HGI – F1 Holstein x Gir; HGU –F1 Holstein x Guzerat; HNE – F1 Holstein x Nelore;

There was a difference in the initial BW of the 3 genetic groups (Table 5 and Figure 2) and in the degree of mobilization of NEFA. The HGI and HGU cows had a greater preservation of blood NEFA than the HNE group, at week 7 of lactation, which was the week the cows had the lowest BW since the beginning of lactation.

Despite the different intercepts obtained for the BW change curves, it was observed that the remaining parameters were the same for the different groups (Table 5). Thus, an intercept was defined for each group: HGI = 657.42 + 3.6957*t – 32.4659*$t^{1/2}$ – 0.1352*$t^{3/2}$; HGU = 664.73 + 3.6957*t – 32.4659*$t^{1/2}$ – 0.1352*$t^{3/2}$; and HNE = 607.70 + 3.6957*t – 32.4659*$t^{1/2}$ –

832

Arq. Bras. Med. Vet. Zootec., **v.66, n.3, p.827-836, 2014**

$0.1352*t^{3/2}$. This means that all of the genetic groups had the same rate of BW change throughout lactation.

Thus, the HGI cows, with lower initial weights, had the greatest weight loss when compared to their initial weight, losing 15.25% of their total initial BW through week 18 of lactation, in comparison to 14.08% for the HNE and 13.88% for the HGU groups. The HNE cows, although

showing less BW loss in relation to their initial weight, had a high concentration of circulating NEFAs in the first days of lactation, followed by a sharp reduction, reaching a basal level of 0.101 mmol/ml on day 117 of lactation. HNE circulating NEFA reached 88.5% of the initial concentration, whereas the HGU and HGI reached 69.2% and 76.9%, of their initial concentration, respectively.
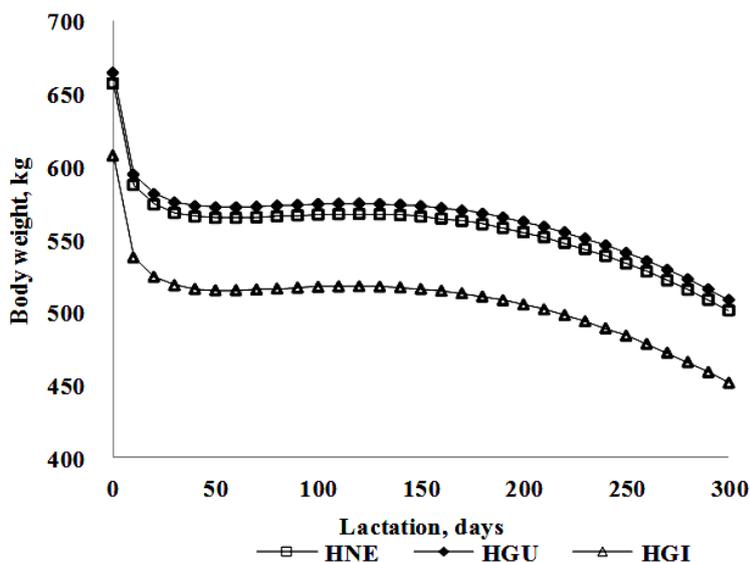

Figure 2. Body weight variation curves of the Holstein x zebu cows from different genetic groups as follows: HGI − Holstein x Gir = $607.70 + 3.6957*t − 32.4659*t^{1/2} − 0.1352*t^{3/2}$; HGU − Holstein x Guzerat = $664.73 + 3.6957*t − 32.4659*t^{1/2} − 0.1352*t^{3/2}$; HNE − Holstein x Nelore = $657.42 + 3.6957*t − 32.4659*t^{1/2} − 0.1352*t^{3/2}$.

DISCUSSION

According to Oldenbroek and Jansen (1978), different breeds or genetic groups together, under grazing systems, have few differences in their grazing behavior. Feeding behavior is intrinsically linked to the nature of the food available. Under a grazing system, food must be searched for and gathered by the cow, which turns feeding into a challenge, and other factors associated with pasture characteristics become key factors in determining intake.

Dry matter intake had a maximum value estimated at 13.34kg at 40 days of lactation, a fact that seems to be closely connected to the characteristics of the pasture available. As shown in Table 1, the pasture had lower NDFap content in the extrusa, around day 42, which coincided

with the peak intake for the cows in this experiment. During this period, the pasture also had greater CP and NFCap content and a lower DM content, despite the lower pasture allowance until day 40 of lactation (Table 1).

Similar to intake, there were no effects of the genetic group on DMd. According to Forbes (1995), the intake level of an animal is among the most important factors that directly affect feed digestibility. This relationship follows an inversely proportional pattern; that is, the lower the intake level, the greater the digestibility of the feed, due in large part to reduction of the rumen passage rate. As there were no effects of the different genetic groups for DMI in this investigation, digestibility would be expected to follow this behavior because the animals were exposed to the same diet.

Arq. Bras. Med. Vet. Zootec., v.66, n.3, p.827-836, 2014

833

With the use of new parameters (a = 0.6089 ± 0.0738; b = 0.0244 ± 0.00764; c = -0.2919 ± 0.3774; d = 5.5772 ± 10.4701) for the model proposed by the NRC (Nutrient…, 2001), DMI curves can be obtained for different periods of lactation for F1 cows with different milk production and BW (Figure 1). There was a peak in the curve at approximately 6 week of lactation, when DMI plateaued, remaining constant until the end of lactation. Peak DMI was similar to that proposed by the NRC (Nutrient…, 2001) for multiparous cows, which showed that the structure of this model was adequate to predict intake based on the inherent characteristics of the animal, just by reparametrizing the model, even with the large differences in the feeding systems to which the animals were subjected.

Using the model by Wood (1967), peaks of lactation were projected for the different genetic groups. According to Keown *et al.* (1986) there is a tendency for delayed peak lactation at higher level of production. Despite the small difference in the number of days, the HGI cows took longer to reach the peak. Nevertheless, this time interval to peak was quite different from that described by Wood (1967), who reported it to be from 5 to 6 weeks, for intensive systems in temperate climates, with Holstein cows that had greater production and greater lactation persistence.

These two crosses also had similar production at the end of lactation, when the milk production was stabilized at the lowest level of production. However, it is possible to affirm that lactation persistence of HGU cows was a little lower than HGI cows. Branton *et al.* (1974) suggested that the lower milk production, in pasture-based systems, is the main factor that affects persistence in lactation; that is, the forage allowance is a limiting factor over the dry season, and it is not exactly a climate factor.

Studies in the literature that show the performance of crossbred HNE are non-existent to date. However, some studies may be found for lactation curves of pure breed Nelore cows, with emphasis on calf performance. Few studies measured milk production during the entire lactation period, showing a linear decrease in milk production and an absence of peak lactation (Alencar, 1988 and Rosado, 1991).

According to Buckley *et al.* (2000), the first stage of increased BW loss around 6 weeks was due to expelling the fetus, placenta and other uterine contents, followed by the gradual decrease in BW because of the mobilization of adipose tissues. For Bauman and Currie (1980), in the first month of lactation, the adipose tissue energy may contribute to approximately 33% of milk production. The catabolism of adipose tissue may support the production of 120 to 550kg of milk during the first weeks of lactation. HGI and HGU cows had greater preservation of circulating NEFAs than cows from the HNE group, even after reaching the minimum value during lactation. Rennó *et al.* (2006), in a review of several studies, observed that higher genetic-merit cows for milk production showed limited response of adipose tissue to the anti-lipolytic agents, resulting in an increased rate of lipolysis.

Regarding the HNE cows, there was a drop in the level of circulating NEFAs to 88.5% of the initial concentration. This was probably due to the temperament of this group of cows postpartum. Mourão *et al.* (1997), evaluating the temperament of different zebu breeds, observed a worse temperament for the Nelore animals. The animals classified as having the worst temperaments are more excitable, ingest less food, are more agitated, do not adapt easily to new situations, and are more difficult to manage (Grandin and Deesing, 1998).

Increased NEFA mobilization at the beginning of lactation, however, was not reflective of greater BW loss. This phenomenon was possible because, as reported by Andrew *et al.* (1994), dairy cows can change body composition in early lactation, mobilizing close to 40% of its tissues, without showing significant changes in BW, due to a rapid increase in DMI in the gastrointestinal tract. In contrast, all of the genetic groups studied had BW loss after 150 days in lactation, associated with a change in circulating NEFAs in the blood. This was probably due to the low quality of pastures found in this stage.

CONCLUSIONS

The peak DMI, estimated by the reparametrized equation from the NRC (2001), occurred during the sixth week of lactation, when there was the stabilization of DMI from pasture. Nonetheless, the cows went through a negative energy balance phase during the seventh week because of the characteristics of the tropical pasture. The HGI group presented the greatest cumulative milk production at 305 days.

REFERENCES

ALENCAR, M.M. Productive Performance of femelas canchim and nelore breed. *Rev. Bras. Zootec.*, v.17, p.411-420, 1988.

ANDREW, S.M.; WALDO, D.R.; ERDMAN, R.A. Direct analysis of body composition of dairy cows at three physiological stages. *J. Dairy Sci.,* v.77, p.3022-3033, 1994.

BAUMAN, D.E.; CURRIE, W.B. Partitioning of nutrients during pregnancy and lactation: A review of mechanisms involving homeostasis and homeorhesis. *J. Dairy Sci.,* v.63, p.1514-1529, 1980.

BRANTON, C.; RIOS, G.; EVANS, D.L. *et al.* Genotype-climatic and other interaction effects for productive responses in Holsteins. *J. Dairy Sci.*, v.57, p.833-841, 1974.

BUCKLEY, F.; DILLON, P.; RATH, M. *et al.* The relationship between genetic merit for yield and live weight, condition score, and energy balance of spring calving holstein friesian dairy cows on grass based systems of milk production. *J. Dairy Sci.,* v.83, p.1878-1886, 2000.

CASALI, A.; DETMANN, E.; VALADARES FILHO, S.C. *et al.* Influence of incubation time and particles size on indigestible compounds contents in cattle feeds and feces obtained by *in situ* procedures. *Rev. Bras. Zootec.,* v.37, p.335-342, 2008.

DETMANN, E.; VALADARES FILHO, S.C. *et al.* On the estimation of non-fibrous carbohydrates in feeds and diets. *Arq. Bras. Med. Vet. Zootec.*, v.62, p.980-984, 2010.

FORBES, J.M. *Voluntary food intake and diet selection in farm animals.* Oxon: CAB International, 1995.

GRANDIN, T.; DEESING, D. Behavioral genetics and animal sciences. In: GRANDIN, T. (Ed). *Genetics and behavioral of domestic animals.* San Diego: Acad. Press, 1998. p. 341-356.

KEOWN, J.F.; EVERETT, R.W.; EMPET, N.B. *et al.* Lactation curves. *J. Dairy Sci.*, v.69, p.769-781, 1986.

LICITRA, G.; HERNANDEZ, T.M.; VAN SOEST, P.J. Standardization of procedures for nitrogen fractionation of ruminant feeds. *Anim. Feed Sci. Technol.*, v.57, p.347-358, 1996.

MAYER, D.G.; STUART, M.A.; SWAIN, A.J. Regression of real-world data on model output: An appropriate overall test of validity. *Agric. Syst.*, v.45, p.93-104, 1994.

MCMENIMAN, N.P. Methods of estimating intake of grazing animals. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 34., 1997, Juiz de Fora. *Anais…* Juiz de Fora:1997. p.131-137.

MERTENS, D.R. Gravimetric determination of amylase-treated neutral detergent fiber feeds with refluxing in beakers or crucibles: Collaborative study. *J. AOAC Inst.*, v.85, p.1217-1240, 2002.

MOURÃO, G.B.; BERGMANN, J.A.G.; FERREIRA, M.B.D. Medidas lineares, pelagem e temperamento em fêmeas mestiças F1. *Cad. Tec. Esc. Med. Vet. Zootec.*, v.18, p.61-70, 1997.

MYERS, W.D.; LUDDEN, P.A.; NAYIGIHUGU, V. Technical note: A procedure for the preparation and quantitative analysis of samples for titanium dioxide. *J. Anim. Sci.*, v.82, p.179-183, 2004.

NUTRIENT requirements of Dairy Cattle, 7.ed. Washington: National Academy Press, 2001.

OFFICIAL methods of analysis - AOAC. 15. ed. Washington: Assoc. Off. Anal. Chem., 1990.

OLDENBROEK, J.K.; JANSEN, A.A.M. The effect of the grazing behaviour of a breed on the performance of another breed, when they are grazing together. *Zeit. für Tierzüch. und Züchtungsb.*, v.95, p.132-139, 1978.

PEREIRA., J.C.C. *Fundamentos de bioclimatologia aplicada à produção animal.* Belo Horizonte: FEPMVZ, 2005.

Arq. Bras. Med. Vet. Zootec., v.66, n.3, p.827-836, 2014

835

REGAZZI, A.J. Test for parameter equality in nonlinear regression models. *Rev. Ceres*, v.46, p.383-410, 1999.

RENNÓ, F.P.; PEREIRA, J.C.; SANTOS, A.D.F. *et al*. Effects of body condition at calving on milk yield and composition, lactation curve and body reserve mobilization of Holstein cows. *Arq. Bras. Med. Vet. Zootec*., v.58, p.220-233, 2006.

ROSADO, M.L. *Características reprodutivas, produtivas e biométricas de fêmeas Nelore e F1*

europeu-Nelore. 1991. 55f. Dissertação (Mestrado em Zootecnia) – Departamento de Zootecnia, Universidade Federal de Viçosa, Viçosa.

WOOD, P.D.P. Algebraic model of the lactation curve in cattle. *Nature*. v.216, p.164-165, 1967.

836

Arq. Bras. Med. Vet. Zootec., **v.66, n.3, p.827-836, 2014**