LACTATIONAL PERFORMANCE OF STRAIGHTBRED ANGUS COWS AND THREE ANGUS-DAIRY-CROSS GENOTYPES

F.J. Roca Fraga, R.E. Hickson, N. Lopez-Villalobos, P.R. Kenyon and S.T. Morris

Massey University, Private Bag 11222, Palmerston North 4442, New Zealand.

SUMMARY

The objective of this study was to determine the milk yield and lactation curves of 117 three-year-old Angus (AA), Angus×Friesian (AF), Angus×Jersey (AJ) and Angus×Kiwi-Cross (AK) cows, rearing singleton calves sired by either Angus or Simmental bulls. Milk yield was estimated using the weigh-suckle-weigh technique (WSW) recorded at day 32, 49, 80, 120 and 160 days postpartum (dpp). A third-order Legendre polynomial was fitted to lactation data using random regression. Cows from AF, AJ and AK groups reached peak lactation at a similar ($P>0.05$) stage of lactation (71 ± 7, 74 ± 6 and 82 ± 9 days, respectively), but later ($P<0.05$) than AA cows (46 ± 6 days). Peak milk yield was the greatest ($P<0.05$) for AF cows (12.1 ± 0.4 kg) followed by AK and AJ cows (11.4 ± 0.5 kg 10.9 ± 0.3 kg, respectively). Cows from AJ and AK groups produced more milk at peak lactation ($P<0.05$) than AA cows (9.8 ± 0.31 kg). Overall, AF cows produced more ($P<0.05$) milk from day 32 to day 160 (1337.3 ± 22.3 kg) than AJ and AA cows (1244.5 ± 19.9 kg and 1017.5 ± 19.99 kg, respectively), although their milk production did not differ ($P>0.05$) from AK cows (1307.8 ± 31.6 kg). Angus×Friesian, AJ and AK cows produced more milk throughout lactation than AA cows.

INTRODUCTION

Maternal milk production is one of the most important factors affecting the weaning weight of calves and the production costs associated with the maternal metabolisable energy requirements (Montano Bermudez *et al*. 1990). Therefore, the profitability of the cow-calf producer is directly affected by changes in the lactational performance of beef cows. Introduction of dairy genetics into a beef cattle herd can result in higher milk yields in cows (Deutscher andWhiteman 1971), higher calf growth rates and better biological and economic efficiencies regarding beef production (Morris 2008). Morris (2008) suggested that both Friesian- and Jersey-cross cows are highly adapted to New Zealand's pastoral conditions and consequently have high potential for use as suckler cows. The objective of this study was to identify how the inclusion of dairy genetics into a straightbred Angus herd may have affected the characteristics of lactations curves of the beef × dairy cows compared to the straightbred Angus cows.

MATERIAL AND METHODS

One hundred and seventeen 3-year-old Angus (AA; n=43), Angus×Friesian (AF; n=32), Angus×Jersey (AJ; n=40) and Angus×Kiwi-Cross (AK; n=21) cows (Hickson *et al*. 2012) rearing calves sired by Angus (n=4) or Simmental (n=4) bulls were used in this study. Cows with single calves were allocated into one of three groups based on their calving date, i.e. early (E), mid- (M) and late (L) calving cows, respectively. Cows were grazed under pastoral conditions to an average post-grazing cover of 1534 kg DM/ha at Massey University's Tuapaka Farm. Calves remained with their dams until weaning at an average 148 ± 19 days of age. The milk production of cows was estimated using the weigh-suckle-weigh technique (WSW) on 5 occasions for groups E and M at an average 32, 49, 80, 120 and 148 days postpartum (dpp) and on 4 occasions for group L at an average 49, 80, 120 and 148 dpp.

Statistical analyses were carried out using the Statistical Analysis System (SAS version 9.2, SAS Institute Inc., Cary, NC, USA, 2009). Third-order Legendre polynomials (standardized for units of time) were fitted to lactation data using a random regression to obtain an average lactation curve for the population and for each cow using the following model:
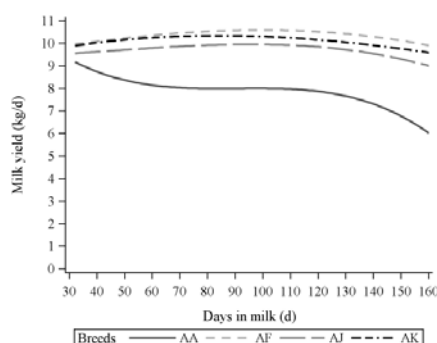
$$y_{tm} = \sum_{i=0}^{3} b_i \, P(x)_t^i + \sum_{i=1}^{3} \alpha_{im} P(x)_{tm}^i + e_{tm}$$

where y_{tm} is the observation at time t in cow m for daily milk yield, b_i are fixed regression coefficients of days in milk on variable y (b_0 = intercept, b_1 = linear effect, b_2 = quadratic effect and b_3 = cubic effect); α_{im} are random regression coefficients of days in milk on variable y in cow m (α_{0m} = intercept, α_{1m}=linear effect, α_{2m}= quadratic effect and α_{3m} = cubic effect), x_{tm}^i is the observation of standardized days in milk at time t in cow m at the power 0, 1, 2, and 3; e_{tm} is the residual error associated with observation y_{tm}.

Random coefficients for each cow were obtained using the MIXED procedure assuming an unstructured covariance structure between the variance and covariances of the random regression coefficients of the model. Using the estimated random regression coefficients for each cow, parameters of the lactation curve for each cow were estimated. Analysis of variance for each of these parameters was performed with the MIXED procedure with a linear model that included the fixed effects of breed of the dam, mob, sex of calf, and the interaction between sex of calf and breed of the dam.

RESULTS

Predicted lactation curves from 32 to 160 dpp based on test-day records varied across genotypes and the shapes can be classified into two types according to the pattern of milk production (Figure 1). Type 1 (AA group): from Figure 1 it is evident that the highest milk production from AA cows was likely to have occurred somewhere during the first month of lactation or before 32 dpp, with a slow decrease until 83 dpp, thereafter it remained fairly constant until approximately 115 dpp after which it decreased rapidly towards weaning; Type 2 (AF, AJ and AK groups): milk production increased continuously from the beginning of the lactation period until it reached a peak around 80 dpp and then decreased until the end of the lactation. The effect of birth weight and differing breed proportions in the calf on lactation curve shape were investigated, however, no effect of bull breed (P>0.05), proportion of maternal breed in the calf (P>0.05) or birth weight of the calves (P>0.05) was observed. This indicates that it was primarily the genotype of the cow that determined milk production in this study.

Figure 1. Milk yield from day 32 to day 160 of lactation, of straightbred Angus (AA), Angus×Friesian (AF), Angus×Jersey (AJ) and Angus×Kiwi-Cross (AK) cows.

The corrected least square means and SE for total milk yield from 32 to 160 dpp, milk yield at peak lactation, days in milk at which peak lactation was reached and milk yield at weaning are shown in Table 1. Absolute days at which peak milk yield was reached differed between AF, AJ and AK cows, although differences were not significant (P>0.05). Pure Angus cows differed (P<0.05) from the crossbred groups and reached peak lactation at 46 dpp. Angus×Friesian cows produced more milk (P<0.05) during peak lactation than AJ and AA cows but did not differ (P>0.05) from AK cows. Angus×Jersey and AK cows produced more milk at peak (P<0.05) than AA cows. On average, beef-cross-dairy crossbreds produced approximately 2 kg more milk during peak lactation than AA cows. The sex of calf affected milk production at peak lactation, such that dams nursing female calves (P=0.05) produced less milk (approximately 0.8 kg) than those nursing male calves.

Angus×Friesian cows produced more milk at weaning (P<0.05) than AJ and AA cows but not AK cows. The AA cows had the lowest milk yield at weaning with an average difference compared to the other genotypes of 3.4 kg. The AF, AJ and AK cows produced more (P<0.05) milk from 32 to 160 dpp than the AA cows. The AF cows produced more (P<0.05) milk from 32 to 160 dpp than AJ cows, with AK cows being intermediate and not differing (P>0.05) from either AF or AJ cows. In the present study, as the proportion of Friesian or Jersey in the crossbreds increased from 0 to 50%, an extra 325 kg and 240 kg of milk, respectively, was expected compared with the AA cows. Given that a Kiwi-Cross is a Friesian-Jersey hybrid, AK cows' production was intermediate between AF and AJ cows, and they produced an extra 282.5 kg of milk compared with the AA cows.

Table 1. Least square means and standard error for the lactation curve parameters of Angus (AA), Angus×Friesian (AF), Angus×Jersey (AJ) and Angus×Kiwi Cross (AK) cows.

| Genotypes | Milk yield (kg/d) | | | Day of peak lactation (d) |
	Peak	Weaning 160dpp	Estimated Total[†]	
AA	9.8±0.3[c]	6.1±0.3[c]	1017.5±19.9[c]	46±6[b]
AF	12.1±0.4[a]	9.8±0.3[a]	1337.3±22.3[a]	71±7[a]
AJ	10.9±0.3[b]	8.9±0.3[b]	1244.5±19.9[b]	74±6[a]
AK	11.4±0.5[a,b]	9.5±0.4[ab]	1307.8±31.6[ab]	82±9[a]

[†] Total milk yield from day 32 to day160 postpartum.
[abc] Values within columns with different superscripts differ at the P<0.05 level.

DISCUSSION

The lactation curves for beef × dairy cows are of similar shape and resemble a typical lactation curve seen in dairy cows. The findings in the present study are similar to those of Walker and Pos (1963) in New Zealand, where AF and AJ cows reached peak lactation at an average 74 dpp; and to those reported by Chennete and Frahm (1981) whereby peak lactation in AJ cows was detected at approximately 70 dpp, followed by a steady decrease as lactation progressed. Post peak lactation, milk production levels were maintained until approximately 120 dpp when a decrease in milk production occurred for all three crossbred genotypes. Gaskins and Anderson (1980) reported peak lactation in AJ cows during the first month of lactation, which is earlier than reported in the present study, however, milk yield remained constant until 84 dpp in 2-year-old cows and until 112 dpp in 3-year-old cows. These results suggest lactation curve persistency in beef cows can be greatly improved by the introduction of genes from dairy breeds.

The days in milk at peak lactation reported here for AA cows is earlier compared to the findings of Jenkins and Ferrell (1984) and Hohenboken *et al*. (1992) using the "Jenkins" equation, however, the latter equation has been criticised since it repeatedly produced curves that peaked approximately around 60 and 70 dpp and also underestimated milk yield during the first month of lactation since if forces the curve through the origin (Hohenboken *et al*. 1992).

There is evidence (Oftedal, 1984) that the calf's capacity to withdraw milk may be reduced in early lactation and that the residual milk left in the udder would stimulate mammary involution. An interaction exists between mammary evacuation and milk production, where cows suckled or milked more often produce higher levels of milk than those with infrequent mammary evacuation. Angus cows may be more sensitive to changes in mammary evacuation during early and late-lactation than the beef x dairy crossbred cows. The first drop in production seen in AA cows may be explained by the calf not being physically capable of fully evacuating the udder in the first few days due to physical consumption constraints and consequently, the residual milk left in the udder would stimulate the dam to reduce her milk production (Oftedal 1984). Then, as the calf grows and its ability to suckle increases, milk production stabilises at a level lower than peak to provide nutrients to the calf. Indeed, Blaxter (1961) suggested that milk yield is motivated towards the maximum possible growth rate of the offspring. Thus it is likely that a dams' milk production would respond to the stimulus from her calf, although as a non-dairy animal, AA cows may have limited capacity to produce more milk. Energy requirements increase with increasing age and there is evidence (Baker *et al*. 1976) that if forage availability is adequate, calves receiving less milk during lactation could increase their pasture intake to compensate for the low energy intake from milk. In this study during late-lactation, calves reared by AA cows may have not been receiving enough nutrients from a suckling event; therefore to compensate they reduced their milk consumption in favour of consuming more pasture. This may explain the second drop in milk production observed towards the end of the lactation of AA cows, which is typical in AA cows in other studies (Minick *et al*. 2001).

CONCLUSIONS

Results from this experiment confirmed the hypothesis that increasing the proportion of dairy genetics in the beef herd is accompanied with an increase in milk production. Under non-limiting pasture quality and availability, AF, AJ and AK cows produced more milk throughout lactation than AA cows.

REFERENCES

Baker R.D., Le Du Y.L.P. and Barket J.M. (1976) *J. Agric. Sci*. **87**: 187.
Blaxter K.L. (1961) In 'Milk: the mammary gland and its secretion', pp. 305-361, editors S.K.

Kon and A.T. Cowie, New York Academic Press, New York.

Chenette C.G. and Frahm R.R. (1981) *J. Anim. Sci*. **52**: 483.

Deutscher G.H. and Whiteman J.V. (1971) *J. Anim. Sci*. **33**: 337.

Gaskin C.T. and Anderson D.C. (1980) *J. Anim. Sci*. **50**: 828.

Hickson R.E., Laven R.L., Lopez-Villalobos N., Kenyon P.R. and Morris S.T. (2012) *Anim. Prod. Sci*.**52**: 478.

Hohenboken W.D., Dudley A. and Moody D.E. (1992) *Anim. Prod*. **55**: 23.

Jenkins T.G. and Ferrell C.L. (1984) *Anim. Prod*. **39**: 479

Minick J.A., Buchanan D.S. and Rupert S.D. (2001) *J. Anim. Sci*. **79**: 1386.

Montano Bermudez M., Nielsen M.K. and Deutscher G.H. (1990) *J. Anim. Sci*. **68**: 2279.

Morris S.T. (2008)'Unpublished review'. Meat and Wool. N.Z. pp. 31.

Oftedal O.T. (1984) *Sym. Zool. Soc. Lon*. **51**: 33.

Walker D.E.K. and Pos H.G. (1963) *N.Z. J. Agric*. **107**: 227.