Effects of season-of-lambing, stage-of-lactation and ewe-age on milk volume and composition of machine-milked Dorset ewes

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ABSTRACT

Dorset ewes from the Flock House sheep milking flock were used to investigate the effects of season-of-lambing, stage-of-lactation and ewe-age on milk yield and composition. Lambs were removed 4 days after birth and ewes machine milked twice a day. Age of ewe effects were significant ($P<0.05$) for total and daily milk yield, duration of lactation and concentration of milk solids. Total milk yield increased from two (77 ± 4 L/ewe) to four years (108 ± 3 L/ewe) of age and declined in ewes five years and older (78 ± 4 L/ewe). The concentration of milk solids was highest for ewes five years and older. Ewes lambing in Spring and Winter had higher ($P<0.05$) total milk yields, durations of lactation and daily yields of milk solids, but lower daily concentrations of milk fat and total milk solids, than Summer and Autumn lambing ewes. Average concentrations of milk fat, milk protein and total milk solids increased as lactation progressed, while lactose concentration, daily milk yield and yield of milk solids decreased. Milk yield, milk solids concentration and milk solids yield can be modified by ewe-age, season-of-lambing and stage-of-lactation.

Keywords: sheep milking; season-of-lambing; age-of-ewe; stage-of-lactation; milk composition.

INTRODUCTION

While harvesting ewes milk for human consumption is a relatively new concept in New Zealand, it has been practiced for many years in other parts of the world. It is envisaged that a sheep milking industry in New Zealand will be based on exported products and it is likely that a year-round supply of milk will be required to ensure continuity of supply of certain products. Because Dorset ewes generally have a short duration of lactation, a number of lambing periods could be required to supply milk year-round to manufacturers.

In both cows and sheep, milk composition changes with stage-of-lactation which can have an effect on the processing characteristics of the milk. However stage-of-lactation is often confounded with season and the aim of this experiment was to investigate the effects of stage-of-lactation, season-of-lambing and ewe-age on the volume and composition of machine-milked Dorset ewes.

MATERIALS AND METHODS

Between 30 and 50 ewes were lambed at monthly intervals for 13 consecutive months. Lambs were removed 4-7 days after birth and artificially reared, while the ewes entered the milking flock. Pregnant ewes were run together until shearing 3-4 weeks prior to lambing and once lambed, ewes were machine milked twice daily until lactation was terminated when production fell below 250 ml per day. Ewes grazed ryegrass/white clover pastures, supplemented with silage in April/May and turnips in July/August.

Daily milk yield was measured twice monthly for each ewe throughout their lactation using in-line milk meters (Tru-Test Ltd, Auckland). Once per month a milk sample from each ewe in milk was preserved with potassium dichromate and analysed for concentrations of milk fat, milk protein and lactose using an infra-red milk analyser (Milkoscan 605, Foss Electric Denmark). The milkoscan was calibrated for sheep-milk before analysis of samples. Concentrations of total milk solids per sample were calculated as the sum of concentrations of fat, protein and lactose plus a further 0.7 % mineral concentration, (Knight and Gosling, 1995). The yield of milk solid components on each sample day was calculated by multiplying milk volume with the concentration of milk solid components.

Results were pooled into 4 season-of-lambing groups, i.e. ewes lambing in September, October and November were classified as Spring lambing ewes, December, January and February lambing ewes as Summer lambing ewes, March, April and May lambing ewes as Autumn lambing ewes and June, July and August lambing ewes as Winter lambing ewes.

Statistical analyses were carried out using generalised linear models procedures (SAS, 1987). Analysis of variance (ANOVA) was used to compare the effects of season-of-lambing and age-of-ewe on total milk yield, duration of lactation and daily milk yield. In the ANOVA for milk composition and yield the effects of ewe-age, season-of-lambing, stage-of-lactation and the interaction between season-of-lambing and stage-of-lactation were included in the model as factors. Once animal numbers per group on any particular sampling day fell below 6, data was discarded.

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RESULTS

Ewe-age

Between 2 and 4 years of age, total milk and milk solids yield increased before declining for older ewes (Table 1). Duration of lactation was longest (P<0.05) for 3 and 4 year olds ewes, but daily milk yield was highest for 4 year-olds ewes. Ewes five years and older had the highest (P<0.05) concentration of milk fat, milk protein and total milk solids and 2 and 3 year olds the highest concentration of lactose.

Season-of-lambing

Ewes lambing in Winter and Spring produced higher (P<0.05) total milk yields and had longer (P<0.05) durations of lactation than ewes lambing in Summer or Autumn. Mean daily milk yields were highest (P<0.05) for Spring lambing ewes and lowest (P<0.05) for Autumn lambing ewes. Peak daily milk production was highest for Spring lambing ewes (P<0.05), followed by Summer, Winter and Autumn lambing ewes. But by the fifth month after lambing, Winter lambing ewes had higher (P<0.05) daily milk yields than other lambing groups.

The concentration of milk fat was highest (P<0.05) for Summer and Autumn lambing ewes (Table 2), while milk protein was highest (P<0.05) for Autumn lambing ewes. Total milk solids concentration was highest in Autumn lambing ewes, followed by Summer, Winter and Spring lambing ewes.

Stage-of-lactation

On average, daily yield of milk and milk solids declined as lactation progressed while concentrations of milk fat, milk protein and total milk solids increased (Table 3). The decline in yield of milk and milk solids occurred more rapidly (P<0.05) in ewes lambing in Spring and Summer.

Stage-of-lactation, season-of-lambing and the interaction between stage-of-lactation and season-of-lambing had significant (P<0.001) effects on daily milk volume and daily concentration and yield of individual milk solids. However mean squares indicated that stage-of-lactation had a greater effect than season-of-lambing or their interaction on daily milk yield, yield of individual milk solids and daily concentration of milk protein and lactose. Conversly mean squares indicated daily fat concentration was influenced more by season-of-lambing than stage-of-lactation.

TABLE 1: Least square means (± SEM) for total and daily milk volume, duration of lactation and daily yield and concentration of milk solids for age- of- ewe classes.

	Ewe-age (years)			
	2	3	4	5+
Total lactation				
Total volume (L/ewe)	77 [a] (4)	97 [b] (5)	108 [c] (3)	78 [a] (4)
Duration (days)	125 [a] (4)	151 [b] (5)	144 [b] (3)	123 [a] (4)
Daily volume (L/ewe/d)	0.60 [a] (0.02)	0.64 [a] (0.02)	0.74 [b] (0.01)	0.61 [a] (0.02)
Composition of milk (%)				
Fat	8.03 [a] (0.07)	8.40 [b] (0.08)	8.28 [b] (0.05)	8.71 c (0.06)
Protein	6.59 [a] (0.03)	6.59 [a] (0.04)	6.53 [a] (0.02)	6.79 b (0.04)
Lactose	5.02 [a] (0.01)	5.01 [a] (0.02)	4.99 [b] (0.01)	4.90 [c] (0.01)
Total milk solids	19.78 [a] (0.09)	20.13 [b] (0.10)	19.94 [b] (0.06)	20.54 [c] (0.09)
Yield of milk solids (g/ewe/d)				
Fat	36.8 [a] (1.2)	45.2 b (1.3)	49.6 [c] (0.8)	41.2 [d] (1.2)
Protein	30.8 [a] (0.9)	35.9 [b] (1.0)	39.3 [c] (0.6)	32.3 [a] (0.9)
Lactose	25.6 [a] (0.9)	29.3 [b] (0.9)	32.9 [c] (0.6)	24.0 [a] (0.9)
Total milk solids	93.9 [a] (3.0)	111.2 [b] (3.1)	122.6 [c] (2.1)	98.8 [a] (2.9)
Number of records	270	211	680	296

Means with the same subscript do not differ significantly at the P<0.05 level.

TABLE 2: Least square means (± SEM) for total and daily milk volume, duration of lactation and daily yield and concentration of milk solids in each season of lambing.

	Season of lambing			
	Spring	Summer	Autumn	Winter
Total lactation				
Total volume (L/ewe)	116 [a] (6)	71 [b] (6)	62 [b] (7)	115 [a] (6)
Duration (days)	147 [a] (6)	109 [b] (7)	123 [b]178 [c] (8)	(7)
Daily volume (L/ewe/d)	0.78 [a] (0.03)	0.65 [b] (0.03)	0.48 [c] (0.03)	0.63 [b] (0.03)
Composition of milk (%)				
Fat	7.73 [a] (0.08)	8.84 [b] (0.11)	9.08 [b] (0.10)	7.80 [a] (0.07)
Protein	6.29 [a] (0.03)	6.52 [b] (0.05)	6.95 [c] (0.04)	6.44 [b] (0.03)
Lactose	4.97 [a] (0.01)	4.95 [a] (0.02)	5.08 [b] (0.02)	5.05 [b] (0.01)
Total milk solids	19.11 [a] (0.09)	20.74 [b] (0.17)	21.55 [c] (0.14)	19.49 d (0.09)
Yield of milk solids (g/ewe/d)				
Fat	49.5 [a] (1.1)	41.2 [b] (1.8)	40.2 [b] (1.5)	48.9 [a] (0.9)
Protein	39.9 [a] (0.8)	30.6 [b] (1.4)	30.6 [b] (1.2)	41.2 [a] (0.7)
Lactose	34.9 [a] (0.8)	26.6 [b] (1.4)	22.2 [c] (1.2)	33.0 [a] (0.7)
Total milk solids	125.2 [a] (2.6)	99.2 [b] (4.4)	93.6 [b] (3.8)	123.9 [a] (2.3)
Number of records	414	353	213	546

Means with the same subscript do not differ significantly at the P<0.05 level.

TABLE 3: Least square means (± SEM) for daily milk volume and daily yield and concentration of milk solids at each stage-of lactation.

	Stage-of-lactation (months from lambing)				
	1	2	3	4	5
Volume (L/ewe/d)	0.93 [a]	0.71 [b]	0.52 [c]	0.36 [d]	0.26 [e]
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Composition of milk (%)					
Fat	7.75 [a]	7.79 [a]	8.43 [b]	9.10 [c]	9.37 [c]
	(0.09)	(0.08)	(0.08)	(0.10)	(0.18)
Protein	5.90 [a]	6.03 [b]	6.59 [c]	7.13 [d]	7.44 [e]
	(0.04)	(0.03)	(0.04)	(0.04)	(0.08)
Lactose	5.22 [a]	5.10 [b]	4.97 [c]	4.83 [d]	4.82 [d]
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Total milk solids	19.01 [a]	19.06 [a]	20.13 [b]	21.22 [c]	21.77 [d]
	(0.11)	(0.10)	(0.10)	(0.12)	(0.23)
Yield of milk solids (g/ewe/d)					
Fat	69.1 [a]	52.7 [b]	42.5 [c]	33.6 [d]	27.8 [e]
	(1.1)	(1.0)	(1.1)	(1.3)	(2.4)
Protein	53.5 [a]	42.0 [b]	34.0 [c]	26.8 [d]	22.3 [e]
	(0.9)	(0.8)	(0.9)	(1.0)	(1.9)
Lactose	49.2 [a]	37.2 [b]	26.6 [c]	18.7 [d]	14.3 [e]
	(0.9)	(0.8)	(0.8)	(1.0)	(1.8)
Total milk solids	173.0 [a]	132.9 [b]	103.8 [c]	79.7 [d]	64.8 [e]
	(2.8)	(2.6)	(2.7)	(3.2)	(5.9)
Number of records	351	363	348	265	127

Means with the same subscript do not differ significantly at the $P<0.05$ level.

DISCUSSION

While the effect of ewe-age found in this study was similar to that found in Merino ewes (Corbett, 1968), Awassi ewes have been reported producing peak milk yields at 5 years of age before declining within successive years until 9 years of age (Finci, 1957). However, while this study found significant differences in total milk yield for ewes of different ages, other authors have been unable to detect significant differences (Karam *et al.*, 1971; Wohlt *et al.*, 1981).

Increasing body weight resulting in larger digestive systems for greater nutrient uptake and larger mammary glands for greater milk secretion are two possible reasons for increases in milk yield with age for dairy cows (Schmidt, 1971). It is also likely younger animals use a larger proportion of nutrients for growth rather than milk production (Holmes and Wilson, 1984).

In contrast to the results from this study, Wohlt *et al.* (1981) found no significant difference in the concentration of milk fat, milk protein and total milk solids between ewes aged 1.5 to 8 years of age.

However in this study a 19 % decrease in the yield of total milk solids and a 28% decrease in total milk volume of ewes 5 years and older compared with 4 year-olds questions the economic worth of ewes 5 years and older. the older animals.

Whereas this study found parturition in Spring and Winter produced the highest total milk yields, others have reported parturition in Summer (Aboul-Naga *et al.*, 1981), Autumn (Schmidt, 1971), or Spring (Singh and Pandey, 1970) resulted in higher total milk yields than in other seasons.

Variations in total and daily milk yield between lambing groups at each stage- of- lactation were possibly due to quality and quantity of feed. Aboul-Naga *et al.*, (1981) observed that seasonal variation could be attributed mainly to differences in type of feed available in addition to possible effects of climate. Blau (1949) found that, where feeding was at the same level throughout the year, time of parturition had no effect on milk production.

Higher milk fat concentrations of Autumn calving cows compared with Spring calving cows (Kniga, 1967) are consistent with the results of this study.

Declines in daily milk yield with stage-of-lactation are consistent with reports from other authors (Boylan *et al.*, 1988), and although timing and size of peak milk yield is variable and depends on factors such as breed (Aboul-Naga *et al.*, 1981) and feeding level (Peart, 1970). In general peak milk yield occurs at any time between the first (Guirgis *et al.*, 1980) and fifth week of lactation (Karam *et al.*, 1971). In this study peak milk yield occurred within a month of lambing. Echler and McFadden (1996) suggested that loss of mammary capacity was an important cause of declining milk production due to stage-of-lactation.

The pattern of variation in milk fat, milk protein and lactose concentrations through lactation agreed with those reported by Corbett (1968) and are consistent with trends observed in cows milk (Holmes and Wilson, 1984). This contrasts with Williams *et al.*, (1976) who found no effects due to stage-of-lactation for milk fat, lactose or total solids. However, in that trial concentration was only determined at days 1, 21 and 49 of lactation, which may have been too early to detect significant changes.

SUMMARY

Overall mean yield of milk fat, milk protein and total milk solids are lower in older ewes and culling from the milking flock of all ewes except the highest producers in this age group would be worthwhile. Ewes lambing in Winter and Spring in the Manawatu have the highest milk production, and sheep milking systems need to target this period. These results could be modified by increasing the quality and quantity of feeding during the Autumn and Summer months but at a cost.

The 28% decrease in milk yield and 19% decrease in total milk solids for ewes older than 4 years of age suggests that culling all but the highest producing ewes from this age group is warranted.

Dorset ewes have relatively short durations of lactation and for a continuous supply of milk at least 3 lambing periods would be required in a 12 month period. Ewes lambing in Winter and Spring had the highest milk production but a further lambing would be required in either Summer or Autumn. While there is no significant difference in total milk volume between these two groups,

Summer lambing ewes tended to produce more (9 L/ewe) than Autumn lambing ewes. In addition Summer lambing ewes produce more on a daily basis. The milk production of Summer or Autumn lambing ewes could be modified by increasing the quality and quantity of feeding during Autumn and Summer, but there would be an associated cost.

Stage-of-lactation had a greater influence on daily milk and milk solids yield and milk protein and lactose concentration than season-of-lambing.

ACKNOWLEDGMENTS

Thanks to staff in the Flock House sheep milking centre who looked after the sheep and assisted in the collection of the data. Financial support was provided by the Foundation for Research, Science and Technology.

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