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Original article

The effects of milking method and post-milking suckling on ewe milk production and lamb growth

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Summary — The effects of milking method (machine milking, machine milking and hand stripping, hand milking) and of post-milking suckling on milk yield and milk fat percentage of Chios ewes were investigated in 2 separate trials over a 5-wk period following weaning at 6 wks of age. The effects of post-milking suckling and creep feeding *versus* creep feeding alone on the growth of lambs were also examined over the same period. Differences in the commercial milk (kg per ewe over the experimental period) between milking/rearing methods in trial 1 (machine milking, 51.5; machine milking and hand stripping, 58.3; machine milking and suckling, 52.3) and in trial 2 (machine milking, 67.5; machine milking and suckling, 66.8; hand milking, 71.4; hand milking and suckling, 69.7) were not significant ($P > 0.05$). In addition to the commercial milk, ewes suckling their lambs after milking produced between 18.8 and 22.4 kg/ewe, and differences in total milk (commercial plus suckled yield) between milking/rearing methods in each trial were significant ($P < 0.05$). In both trials, machine milked ewes sucking their lambs for 10–15 min after the morning and afternoon milkings, had a reduced fat content of commercial milk compared with ewes in the other treatment groups. In trial 2, following a post milking intravenous injection of oxytocin (2 IU), ewes on the post milking suckling treatments produced significantly more milk than those on the non-suckling treatments (0.44 *vs* 0.17 kg/ewe, respectively). In trial 1, the growth of the post-milking suckling group of lambs was 11.5% higher than that of the non-suckling group, while in trial 2, no treatment differences were observed in the growth of lambs.

milking method / suckling after milking / milk production / lamb growth

Résumé — Effets de diverses méthodes de traite complétées ou non par une tétée sur la production laitière des brebis et la croissance des agneaux. *Diverses méthodes de traite des brebis Chios (traite à la main, traite mécanique, traite mécanique suivie d'un égouttage manuel ou d'une tétée) sont comparées quant à leurs effets sur la production laitière et la composition en matières grasses du lait. Ce travail qui porte sur deux essais distincts a été conduit sur une période de cinq semaines après le sevrage qui a lieu à six semaines. Les effets de la conduite d'élevage (tétée après la traite et alimentation solide ou alimentation solide uniquement) ont également été mesurés sur la croissance des agneaux au cours de la même période. Les quantités de lait commercial exprimées en kg par brebis sur la période expérimentale au cours de l'essai 1 (traite mécanique, 51,5; traite mécanique et égouttage manuel, 58,3; traite mécanique et tétée, 52,3) et au cours de l'essai 2 (traite mécanique, 67,5; traite mécanique et tétées 66,8; traite manuelle, 71,4; traite manuelle et tétée, 69,7) ne sont pas significativement affectés par la méthode de traite (P > 0,05). Mais, en plus du lait commercial, les brebis qui sont tétées par leurs agneaux après la traite, produisent entre 18.8 et 22.4 kg/brebis de lait supplémentaire. Ainsi, la production laitière totale (lait commercial + lait tété) deviennent elles significativement différentes, qu'il s'agisse de l'essai 1 ou de l'essai 2 (P < 0,05). Toutefois, dans les deux essais, les brebis tétées par leurs agneaux après les traites du matin et de l'après-midi, produisent un lait commercial moins riche en matières grasses. Le lait résiduel obtenu au cours de l'essai 2 après une injection intraveineuse de 2 UI d'ocytocine s'avère être supérieur chez les brebis tétées après la traite (0,44 kg/brebis) contre 0,17 kg/brebis chez celles qui ne le sont pas). Enfin, au cours de l'essai 1, la croissance des agneaux ayant été après la traite a été améliorée de 11,5% par rapport à celle du groupe totalement sevré, mais cette amélioration n'a pas été constatée au cours de l'essai 2.*

méthode de traite / tétée après la traite / production laitière des brebis / croissance des agneaux

INTRODUCTION

In Mediterranean countries where sheep and goats are kept for dual purpose (meat and milk) animals, the amount of saleable milk and the growth of lambs and kids depend, among other factors, on the suckling regime and the age at weaning. Complete or partial early weaning increases the marketable milk yield (Louca *et al,* 1975; Geenty, 1980), but it is usually associated with reduced growth of lambs (Hadjipanayiotou and Louca, 1976) and kids (Louca *et al,* 1975). On the other hand, 15–30 min suckling after milking does not appear to affect the marketable milk or the growth of the offspring and increases total (milked + suckled yield) milk yield (Morag *et al,* 1970; Hadjipanayiotou and Louca, 1976; Gaya *et al,* 1977). Hand milking of sheep, a traditional milking method, is laborious and requires a constant availability of skilled labour during the lactation period. Therefore, the introduction of milking machines has been considered as an alternative. Previous work with the Chios breed of sheep indicated that these animals respond well to machine milking, and the % drop in milk production was between 20 (no udder massage) and 5 (with udder massage) compared to hand milking (Papachristoforou and Mavrogenis, 1981; Papachristoforou, unpublished observations). In the present work, post-milking suckling or hand stripping was applied in combination with machine and hand milking from 6–11 wks *postpartum* to investigate their effects on the total and commercial ewe milk production and milk fat content. Over the same period the growth performance of lambs weaned or suckling their dams after milking was also examined. The aim of the study was to obtain comparative data on the biological efficiency of the various milking/rearing systems applied.

MATERIALS AND METHODS

Trial 1

Sixty-three parous (2–5 yr old) Chios ewes and their lambs were used from 43–77 *postpartum.* From birth to 28 d *postpartum* ewes were allowed to suckle their lambs continuously, and from 29–42 d for 8 h daily (7 30–15 30). Allocation of ewes to the treatments was based on the daily milk production during the last pre-experimental wk (35–42 d *postpartum*), and on the number and sex of their lambs. The treatments were: (a) machine milking of ewes (M); (b) machine milking of ewes followed by hand stripping (MH); and (c) machine milking of ewes followed by suckling for 10–15 min (MS). Suckling started approximately 5 min after the end of milking. The milking machine used was of the high pipeline type with 4 milking units. Pump capacity was 900 l per min, the vacuum was set at 46 kPa with 90 pulsations per min at a 2:1 ratio. Before the start of machine or hand milking, a small quantity of milk from all ewes (each teat separately) was obtained and checked visually for signs of mastitis. For machine milked ewes, when the flow of milk ceased, milk let down was facilitated by udder massage while the teat cups were still on. Lambs on treatments M and MH were weaned at 43 d of age and kept as 1 group and separately from those on the MS treatment. All lambs had free access to creep feed (18% crude protein on dry matter basis) and 150 g hay per lamb daily. Ewes were housed separately according to treatment in open-yard sheds and were offered the same amount of feed. Ewes and lambs on treatment MS were housed in adjoining pens separated by a gate preventing direct contact but allowing audiovisual contact between the 2 groups. Lamb body-weight, feed intake and milk sucked (estimated by the weight-suckle technique) were recorded once weekly. Individual milk yield (in kg/ewe), milk fat content and group feed intake were recorded once a week. During recording in the MH group, hand stripped milk was added to that obtained by machine and thoroughly mixed before a sample was taken for fat determination. Fat was estimated using Gerber's method (Gerber, 1966). The ewes were weighed at the beginning and at the end of the trial.

Trial 2

Forty-two parous (2–5 year old) Chios ewes and their lambs were used from 43–77 d *postpartum*. The lambs sucked their dams continuously until 28 d of age and for 8 h (7 30–15 30) daily from 29–42 d. The same criteria as in trial 1 were used in allocating the ewes onto the following 4 treatments; (a) machine milking of ewes (M); (b) machine milking of ewes followed by suckling (MS); (c) hand milking of ewes (H); and (d) hand milking of ewes followed by suckling (HS). Lambs on treatments M and H were weaned at 43 d of age, while those on treatments MS and HS were allowed to suck their dams for 10–15 min after the morning (07 00 h) and afternoon (15 00 h) milking. Suckling started approximately 5 min after the end of milking. Lambs weaned and not suckling after milking were housed and fed together, while those on treatments MS and HS were housed and fed in separate pens. Ewes and lambs within MS and HS treatment were housed in adjoining pens separated by a gate preventing direct contact but allowing audiovisual contact between them. Milk yield and milk fat content were estimated from individual recordings once weekly. In addition, an attempt was made to collect by hand milking approximately 20 ml of milk from each teat into a volumetric cylinder on week 3 of the trial when ewes were transferred from the milking parlour in the shed immediately after the morning milking and before the lambs were allowed to suck. It was possible to take 40 ml of milk from all ewes in treatments MS and HS (in some cases milk could not be obtained from both teats so the 40 ml were from 1 teat) but not from ewes in treatments M and H. In order to obtain an estimate of the quantity of milk remaining in the udder after milking without affecting the results of the trial, the 4 treatment groups were kept for a further period of 4 d after d 77 *postpartum*, and in the morning of the 4th d all ewes were injected intravenously with 2 IU of oxytocin immediately after milking. The ewes were milked again approximately 2 min after oxytocin administration. Samples were taken from the quantity of milk produced during normal milking and from that produced after oxytocin.

Lamb body weights, feed intake and milk sucked were recorded once weekly. Ewe body weights were recorded at the beginning and at the end of the trial.

The data from each trial were analysed using analysis of variance procedures (Steel and Torrie, 1969). The model used for lamb data accounted for variation due to treatment, sex and type of birth, whereas in the model used for ewe data, treatment effects were tested. Differences between treatment means were tested by Duncan's new multiple range test.

RESULTS

Trial 1

Commercial milk yield was not affected by treatment (table I) but total milk yield was significantly higher ($P< 0.05$) in ewes suckling their lambs after milking compared to the non-suckling treatment groups. Significant ($P < 0.01$) treatment differences were found in the fat content of the commercial milk. Machine milking followed by hand stripping gave the highest fat percentage, while machine milking followed by suckling provided the lowest. The average feed consumption per ewe was 70 kg of concentrates and 28 kg of cereal hay, and treatment differences in body weight changes were not significant (table I).

The performance of lambs is shown in table II. Lambs sucking after milking gained 11.5% more weight ($P < 0.05$) than lambs weaned at 6 weeks of age. Males gained more weight than females, but no differences were found between single and twin lambs. Consumption of solid feed per lamb was 29.9 kg for non-suckling lambs and 25.6 kg for suckling lambs. In addition to the solid feed, the latter group consumed 13.4 kg of milk per lamb. There were no sex differences in the quantity of milk suckled but singles consumed more milk than twins ($P < 0.01$). Total (78.3 kg) and suckled (22.4 kg) milk yield was higher ($P < 0.05$) in ewes nursing twin lambs compared to ewes with single lambs (66.2 and 16.4 kg of milk, respectively).

Table I. Milk yield, milk fat percentage and body weight change of Chios ewes in trials 1 and 2. Figures in parentheses include suckled milk yield. Means within trials and colums followed by different superscripts are significantly different at $P < 0.05$.

Milking/rearing treatment	*No of observations*	*Initial daily milk yield (pre-experimental) (kg)*	*Total milk yield (kg)*	*Milk fat (%)*	*Body weight change (kg)*
Trial 1					
Machine	22	2.4	51.6^{a}	4.8^{b}	− 0.2
Machine & hand stripping	21	2.3	58.3^{a}	5.3^{a}	− 0.5
Machine & suckling	20	2.3	52.3^{a} ($71.1)^{b}$	3.6^{c}	1.1
SD			19.9	0.75	2.7
Trial 2					
Machine	11	3.3	67.5^{a}	5.7^{a}	1.2^{b}
Machine & suckling	10	3.5	66.8^{a} ($89.2)^{b}$	4.6^{b}	0^{a}
Hand	10	3.5	71.4^{a}	5.7^{a}	1.5^{a}
Hand & suckling	11	3.4	69.7^{a} ($90.3)^{b}$	5.2^{a}	-1.8^{b}
SD			15.2	0.62	2.2

Trial 2

Treatment differences in commercial milk were small and insignificant (table I). Total milk yield was significantly higher ($P < 0.05$) in the suckling (MS and HS) than in the non-suckling (M and H) treatments. Treatment differences in the fat content of the commercial milk were also significant ($P < 0.05$); ewes on the MS treatment had a lower fat % compared to the other 3 treatments. Milk samples taken in the shed on 1 occasion during wk 3 of the trial immediately after the morning milking, gave an average fat content of 9.5 and 8.6% for ewes on treatments MS and HS, respectively. Following oxytocin administration after milking, ewes on the post-milking suckling (MS and HS) treatments produced 2.5 times more milk, (0.44 *vs* 0.17 kg/ewe) but with lower fat % than ewes on the M and H treatments (table III).

The average feed consumption per ewe was 83 kg of concentrates, 19 kg of lu-

Table II. The effect of rearing method, sex and type of birth on the growth of Chios lambs (trial 1 and 2). Figures in parentheses indicate number of observations. Comparisons are within main effects and means with different superscripts are significantly different at $P < 0.05$.

Effect	*Subclass*	*No of observations*	*Initial weight (kg)*	*Weight gain (kg)*	*Feed intake (kg/lamb) conc*	*hay*	*Milk sucked (kg/lamb)*	
Trial 1								
Treatment	No suckling	56	14.1	7.8[a]	24.9	5.0		
	Suckling	28	14.0	8.7[b]	20.7	4.9	13.4	
Sex	Males	38	14.5	8.9[a]			13.0[a]	(13)
	Females	46	13.8	7.5[b]			13.7[a]	(15)
Type of birth	Singles	39	14.5	8.2			16.4[a]	(12)
	Twins	45	13.8	8.1			11.1[b]	(16)
Overall		84	14.1	8.1				
SD				1.3				
Trial 2								
Treatment	No suckling	38	13.2	11.5	33.5	3.8		
	Machine & suckling	16	13.5	11.0	27.0	3.8	15.7[a]	
	Hand & suckling	17	13.3	10.9	26.9	3.8	12.1[b]	
Sex	Males	30	14.1	12.9[a]			13.3[a]	(14)
	Females	41	12.7	10.0[b]			14.1[a]	(19)
Type of birth	Singles	18	15.6	11.1			17.1[a]	(9)
	Twins	53	12.5	11.3			12.6[b]	(24)
Overall		71	13.3	11.2				
SD				1.4				

cerne hay and 15.5 kg of barley hay. Ewes on the HS treatment lost weight, while those on the other treatments maintained and/or increased their weight (table I). Treatment differences in body weight changes were significant ($P < 0.01$).

Differences in lamb growth between treatments and between singles and twins were not significant, but males gained more weight than females (table II). Consumption of solid feed per lamb was 37.3 kg for non-suckling lambs, 30.8 kg for those suckling after machine milking and 30.7 kg for those suckling after hand milking. Lambs on the MS and HS treatments consumed, in addition to the solid feed, 15.7 and 12.1 kg of milk, respectively. The quantity of milk sucked was similar for both sexes, but it was higher in singles than in twins. Total milk and milk suckled per ewe

Table III. Milk yield and milk fat percentage of Chios ewes before and after oxytocin administration. Figures refer to morning milking. Means within columns with different superscripts are significantly different at $P < 0.05$.

Treatment	*Number of observations*	*Milk/ewe*		*Milk/ewe after oxytocin*	
		kg	*fat%*	*kg*	*fat%*
Machine	11	0.96	5.7[a]	0.17[a]	11.5[a]
Machine & suckling	10	1.02	4.3[b]	0.43[b]	8.8[b]
Hand	10	1.23	5.4[a]	0.17[a]	10.2[a]
Hand & suckling	11	1.14	4.8[b]	0.44[b]	8.8[b]
SD		0.36	1.0	0.18	1.8

in the post-milking suckling groups was higher in ewes nursing twin lambs. The respective values (kg milk/ewe) for ewes with twin and single lambs were: MS treatment, total milk yield 91 and 85 ($P > 0.05$), milk suckled 28.5 and 21.9 ($P < 0.05$); HS treatment, total milk 98.0 and 84.3 ($P < 0.05$), milk suckled 21.1 and 14.4 ($P < 0.01$).

DISCUSSION

Within suckling and non suckling groups, commercial and total milk yield was not significantly different between machine and hand milked ewes. Previous results (Papachristoforou and Mavrogenis, 1981) showed small and insignificant differences in the quantity of milk and milk fat content of *Chios* ewes milked by hand or machine. Massage of the udder was applied in machine milked ewes in the present work and this technique has been shown to increase the total quantity of milk obtained by machine (Delmas and Poussou, 1978).

The amount of milk suckled after milking varied between 20% (hand milking) and 26.4% (machine milking) of the total milk yield and this is in general agreement with the findings of Folman, Volcani and Eval (1966) and Hadjipanayiotou and Louca (1976). Post-milking suckling did not affect the commercial milk yield in any of the present trials. Similar results were obtained by Morag *et al* (1970) and Hadjipanayiotou and Louca (1976) in sheep, and by Davidson *et al* (1975), Gaya *et al* (1977) and Philips (1982) in cattle. Post-milking suckling in the present study, caused a reduction in the fat content of the commercial milk of machine milked ewes in both trials. This is contrary to the findings of Morag, Raz and Eyal (1970) who reported similar fat content of the commercial milk during the first 15 wks *post partum* in machine milked ewes weaned immediately after parturition and in those suckling their lambs after milking. The same workers, however, found significantly higher quantities of milk and fat after milking in the suckling compared to the weaned group of ewes, an observation

which is consistent with the present results, and with those of Ugarte (1978) in dairy cattle. These findings indicate that the suckling female has the ability to withhold a certain amount of milk in the udder during milking and this milk is released only when the female is stimulated by the presence of her offspring. The latter is supported by the positive response of suckling ewes when an effort was made to collect a milk sample immediately after milking (trial 2). Apparently, a proportion of the milk remaining in the udder of suckling ewes after milking, was produced additionally to the amount of commercial milk since the latter was not affected by suckling (Folman *et al,* 1966; Morag *et al,* 1970; and the present study). Furthermore, ewes nursing twin lambs had higher total and suckled yield than ewes with single lambs (Hadjipanayiotou and Economides, 1986; and the present study) and this suggests that udder stimulation and evacuation is associated with a higher milk production when ewes nurse additional lambs (Labussière and Combaud, 1978; Doney *et al,* 1983; Loerch *et al,* 1985). It appears that suckling ewes produced the additional milk (suckled yield) at the expense of body weight and/or energy content of the commercial milk since feed allowance and intake was the same in all treatments.

The growth of lambs that were allowed to suck their dams after milking and of those weaned at six weeks of age was similar in the second trial but in the first trial there was an improvement of 11.5% with post-milking suckling. Type of birth (singles or twins) did not affect lamb growth, but the growth of males was better than that of females. These observations are in agreement with those of Hadjipanayiotou and Louca (1976) and Hadjipanayiotou and Economides (1986).

The results of the present study showed no substantial benefits in terms of marketable milk from the extension of the suckling period by the post-milking suckling methods employed. There may be some benefit in terms of lamb growth, but the extra labour involved and the continued stress on the mother and offspring of joining and separating, together with the adverse effect on the fat content of the marketable milk in machine-milked ewes should be taken into account before deciding on the application of post-milking suckling in sheep.

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