Influence of Kid Rearing Systems on Milk Composition and Yield of Murciano-Granadina Dairy Goats

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ABSTRACT

One-hundred eight lactations of Murciano-Granadina goats from different years were used to compare two kid rearing systems. Goats were separated into two groups: suckling and milking. Dams in the suckling group were milked once daily until kids were weaned (wk 0 to 7) and then were milked twice daily. Dams in the milking group were separated from their kids at 48 h after birth; then, kids were raised artificially, and goats were milked twice daily. Total milk yield was estimated according to the oxytocin method during suckling. Stage of lactation, parity, prolificacy, and year effects on milk yield and composition were also studied. As expected, during the first 7 wk of lactation, marketable milk was higher for dams that were milked than for dams that were suckled. Neither milk yield nor milk composition throughout the entire lactation was affected by group or prolificacy with the exception of the percentage of milk CP. The lactation curve peaked at wk 4 or 5 and declined slowly afterward. First parity goats had the lowest milk yield but the highest fat and protein percentages. Third parity goats had the highest milk yield. The separation of kids from their dams after birth did not affect total lactation performance because of the minimal importance of the neuroendocrine milk ejection reflex in goats compared with that of other ruminants.
(**Key words**: Murciano-Granadina dairy goats, milk yield, suckling, milking)

Abbreviation key: **M** = milking, **S** = suckling.

INTRODUCTION

The primary role of Murciano-Granadina dairy goats is to yield marketable milk, although meat production from kids is also significant. Presently, almost all milk obtained is destined for cheese production (9). Therefore, achieving the maximum marketable milk yield with a high fat and protein content is desirable to producers to increase farm profitability. Also, the use of machine-milking and the consequent reduction in manual labor have allowed the enlargement of the herd and increased income on the farm (9). In addition, the possibility of milking twice daily instead of once daily, as commonly occurs for this breed, should be investigated. Several studies (24, 25, 26, 28) have shown a notable reduction in milk yield (35 to 45%) and milk fat and protein content (34 to 43%) when goats were milked one time daily instead of twice daily.

According to a previous study (10), when kids were allowed to suckle twice daily after goats were milked rather than being allowed to suckle before goats were milked, a higher yield of marketable milk was achieved without detriment to kid growth. However, in Spain, natural suckling may be advantageous in autumn and winter when meat price of the kid is higher. For the rest of the year, milking dams after the birth of a kid and artificial rearing of the kids appear to be optimal, as has also been demonstrated for dairy cows (12).

The aim of this study was to ascertain the effect of two different kid rearing systems, natural or artificial, on milk composition and yield of Murciano-Granadina dairy goats.

MATERIALS AND METHODS

Goats and Experimental Groups

Two treatments were studied over 5 consecutive yr (1988 to 1992) using 108 lactations (≥210 d) of Murciano-Granadina goats from the same herd (Veterinary Faculty experimental farm, Universitat Autònoma de Barcelona, Bellaterra, Spain). The treatments were suckling (**S**; n = 49) and milking (**M**; n = 59). For the S group, kids were kept with their dams until 7 wk of age, and suckling was allowed all day except when goats were on pasture

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(mean, 6 h/d); for the M group, milk was machine-milked in the morning. This group was standardized to one kid per dam immediately after the birth of the kids. In the M group, kids were separated from their dams at 48 h after birth and were raised artificially.

Groups were blocked by parity and by the milk yield of the previous year or, for primiparous goats, according to the milk yield of their dams during the previous year only. After weaning or permanent separation of kids, the goats were milked twice daily (0900 and 1700 h) in a double-12 stall (eight milking units) Casse system parallel milking parlor (Westfalia-Separator Ibérica, Granollers, Spain) with recorder jars (2 L ± 5%) and down milk pipeline. Milking was conducted at a vacuum pressure of 42 kPa, a pulsation rate of 90 pulses/min, and a pulsation ratio of 66%. The milking routine included machine-milking with machine-stripping operations.

Goats gave birth once a year in October or November. The experimental groups were subjected to a semiintensive system based on the grazing natural pastures (6 h/d) and a supplementary concentrate (1.53 Mcal of NE_L and 16% CP, DM basis) fed at a flat rate according to stage of lactation (wk 0 to 12, 1.0 kg/d; wk 12 to 22, 0.75 kg/d; and wk 22 to 30, 0.5 kg/d); oat hay and barley straw were available for ad libitum consumption.

Measurement Schedule

Expressed milk yield was recorded once a week until 210 d using the recorder jars in the milking parlor. During the suckling period, the milk yield of each goat in the S group was estimated at 7-d intervals by an oxytocin and machine-milking method (8, 32). Samples were analyzed every 2 wk for fat by the Gerber method [International Standardization Office, standard 2446: 1976 (2, 37)] and for CP and TS according to the official reference methods for milk (2, 37). To avoid any possible diurnal variation in milk composition, two aliquants of both morning and afternoon milkings were mixed to obtain a representative sample. Throughout the final 3 yr (1990 to 1992), milk was analyzed by a near infrared spectrometer (Technicon InfraAlyzer-450; Bran+Luebbe S.L., Norderstedt, Germany). Calibration and weekly controls were performed using the official reference methods described previously.

Statistical Analyses

Results were analyzed by repeated measures using a split-plot analysis of variance procedure of the BMDP software statistical package (7). The model accounted for variation caused by group, parity, prolificacy, year, stage of lactation, interactions among all these factors (when possible), and error. The error term was used to test for differences caused by stage of lactation.

$$Y_{ijkln} = \mu + G_i + PA_j + PR_k + Y_l + (G \times PA)_{ij} + (G \times PR)_{ik} + (PA \times PR)_{jk} + (PA \times Y)_{jl} + (PR \times Y)_{kl} + \epsilon_{ijkln}$$

where

Y_{ijkln} = observations for dependent variables,
μ = overall mean,
G_i = fixed effect of treatment group (i = 1, 2),
PA_j = fixed effect of parity (j = 1 to 5),
PR_k = fixed effect of prolificacy (k = 1, 2),
Y_l = fixed effect of year (l = 1 to 5),
$(G \times PA)_{ij}$ = interaction effect of treatment and parity,
$(G \times PR)_{ik}$ = interaction effect of treatment and prolificacy,
$(PA \times PR)_{jk}$ = interaction effect of parity and prolificacy,
$(PA \times Y)_{jl}$ = interaction effect of parity and year,
$(PR \times Y)_{kl}$ = interaction effect of prolificacy and year, and
ϵ_{ijkln} = random effect of residual.

When the analysis of variance was significant ($P < 0.05$), Student's t test for unpaired observations were compared at $P < 0.05$.

RESULTS

Lactation Pattern and Milk Yield

Milk yield patterns during lactation, according to treatment group, are shown in Table 1 and Figure 1. Both S and M groups had a maximum yield of 2.00 ± 0.10 and 1.93 ± 0.06 L during wk 4 and 5 of lactation, respectively. Yield declined slowly following this peak; the rate of decline was similar for both groups (Figure 1). Mean daily expressed milk that could have been marketed was 0.75 ± 0.09 and 1.86 ± 0.06 L/d during the first 7 wk of lactation; the total expressed milk was 37 ± 4 and 91 ± 3 L for groups S and M, respectively. Although expressed milk during this period was influenced by group ($P < 0.001$), milk yield estimated by the oxytocin method for dams in the S group was similar to that obtained by milking

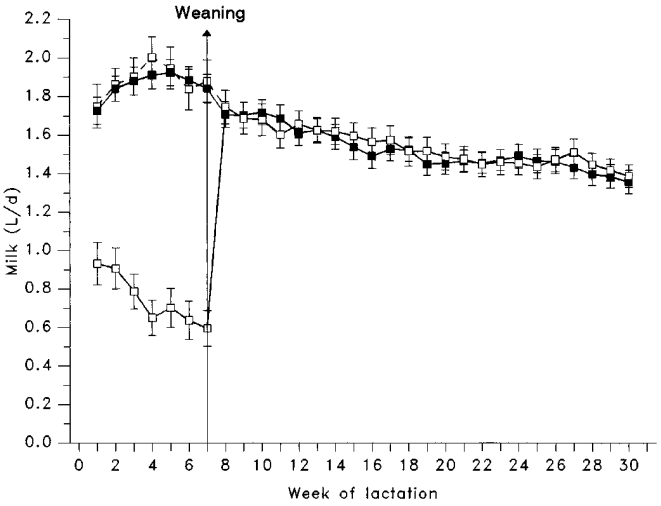

Figure 1. Changes in mean (±SEM) milk yield (—) throughout lactation in Murciano-Granadina dairy goats according to treatment. Dams in the suckling group (□; n = 49) were milked once daily until kids were weaned (wk 0 to 7) and then were milked twice daily; dams in the milking group (■; n = 59) were separated from their kids at 48 h after birth; then, kids were raised artificially, and goats were milked twice daily. Milk yield was also estimated by the oxytocin method during the first 7 wk of lactation for dams in the suckling group (– – –).

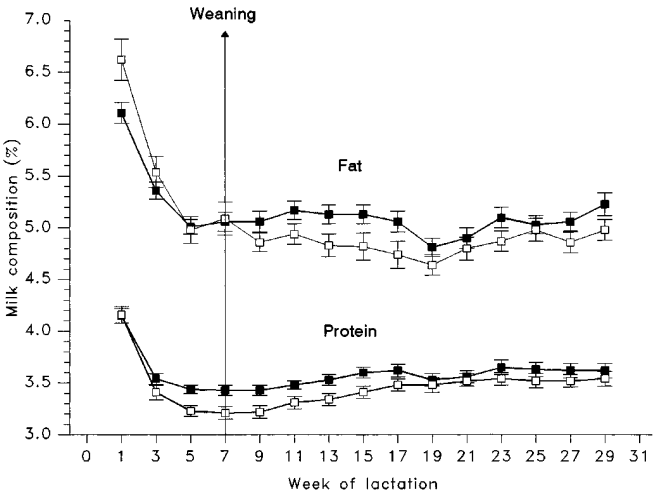

Figure 2. Changes in mean (±SEM) fat and protein contents of expressed milk throughout lactation in Murciano-Granadina dairy goats according to treatment. Dams in the suckling group (□; n = 49) were milked once daily until kids were weaned (wk 0 to 7) and then were milked twice daily; dams in the milking group (■; n = 59) were separated from their kids at 48 h after birth; then, kids were raised artificially, and goats were milked twice daily.

dams in the M group (92 ± 5 and 91 ± 3 L, respectively). From wk 7 to 30 (until 210 d), milk yield did not differ between groups. The mean daily yields were 1.54 ± 0.06 and 1.52 ± 0.06 L, and the total milk yields were 249 ± 10 and 245 ± 9 L for groups S and M, respectively. Throughout 30 wk of lactation, total marketable yields were 285 ± 13 and 336 ± 12 L for the S and M groups, respectively. There was no difference ($P > 0.10$) between treatments.

Milk yield was significantly affected by parity as shown in Table 2. Milk yield increased until goats reached their third lactation; a diminution in milk yield was noted for goats in subsequent lactations ($P < 0.05$). However, only first parity goats exhibited a lower ($P < 0.05$) milk yield when total expressed milk was considered, but the lactation curve of these goats also demonstrated higher persistency.

Prolificacy did not affect milk yield, although milk yield was always higher for goats that had given birth to twins than for goats that had given birth to a single kid (339 ± 13 L vs. 287 ± 11 L in 210 d of lactation, respectively). Nevertheless, the goats that had given birth to a single kid exhibited higher persistency during lactation. Neither total milk yield nor the lactation pattern was significantly affected by year of birth.

Milk Composition

Patterns of milk composition (fat, CP, and TS) in milk throughout lactation were similar for dams in the S and M groups (Figure 2), and none of the differences between the groups were statistically significant during any of the lactation periods studied (Table 1). In both groups, effect of stage of lactation was significant for all milk components studied ($P < 0.01$). The percentages of fat and TS fell from peak values during wk 1 (6.35 ± 0.11 and 15.85 ± 0.13%, respectively) to minimum values by wk 5 of lactation (4.99 ± 0.07 and 13.84 ± 0.10%, respectively), remaining at these percentages until wk 19. In subsequent weeks, percentages slightly increased until the end of the lactation period studied (5.12 ± 0.07 and 13.84 ± 0.11% for fat and TS, respectively). The minimum percentage of CP was observed during wk 7 of lactation (3.33 ± 0.04%); values then increased slowly until wk 29 (3.59 ± 0.05%).

The effect of parity on milk components is given in Table 2. Percentages of fat and TS decreased, and milk yield increased, for goats in first or second lactation. A slight increase ($P < 0.05$) in fat and TS percentages also occurred for goats in fourth and subsequent lactations. The CP percentage was similar for first, second, or third lactation and increased in goats in fourth and subsequent lactations, but only during the first 7 wk of lactation ($P < 0.05$).

Milk CP percentage was always higher for goats that had given birth to twins than for those that had

given birth to a single kid (3.64 ± 0.05 and 3.42 ± 0.05%, respectively; $P < 0.05$). Finally, milk components were influenced by year of birth ($P < 0.05$), although the patterns throughout lactation were not affected by this factor (results not shown).

DISCUSSION

The mean milk yield of this herd of Murciano-Granadina goats at over 210 d of lactation was within the range reported for the same breed by other researchers (20, 31) who obtained milk yields ranging from 1.40 to 1.76 L/d. That the total marketable milk yield between the two groups was not statistically significant, in contrast to the observations of other researchers studying breeds indigenous to Damascus (21) and Greece (39). Those researchers showed that early weaning increased the milk that was available for market compared with different suckling regimens from 2 to 84 d. This result is in agreement with our results when the shorter duration of the sucking period, which lasted 7 wk, is taken into account.

The difference observed in our study between milk yield as estimated by the oxytocin method for dams in the S group during the first 7 wk of lactation and the expressed milk yield for dams in the M group throughout the same period was only 1%. Estimated and expressed values in our study differed from those in a previous work (22) in which French goats that were suckled yielded 19% more milk than did those that were milked after giving birth. Nevertheless, in that study (22), every goat kept two kids instead of one. This result suggests that Murciano-Granadina goats have a milk ejection mechanism similar to that of dairy cows; this reflex can be stimulated by milking nearly as effectively as by suckling as has been demonstrated by others (12, 21, 23). Therefore, the neuroendocrine milk ejection reflex is less important in the goat than in the dairy cow because the gland cistern is capable of storing up to 60 to 70% of the milk secreted between milkings (6, 32). However, in

TABLE 1. Mean values for milk yield and composition according to treatment and significance of effects of group (G), prolificacy (PR), and year (Y) in Murciano-Granadina dairy goats.

	Group[1]				*P*		
Item	S		M		G	PR	Y
Goats, no.	49		59				
Milk yield, L	$\bar{X}$	SEM	$\bar{X}$	SEM			
Estimated[2]	92	5	. . .	. . .	. . .	NS[3]	†
Expressed							
wk 1 to 7	37	4	91	3	***	NS	*
wk 8 to 30	249	10	245	9	NS	NS	NS
Total lactation (210 d)	285	13	336	12	NS	NS	NS
Milk composition, %							
Fat							
wk 1 to 7	5.56	0.11	5.38	0.06	†	NS	**
wk 8 to 30	4.85	0.08	5.06	0.07	NS	NS	†
Mean	5.04	0.08	5.15	0.06	NS	NS	*
CP							
wk 1 to 7	3.50	0.05	3.64	0.05	†	**	†
wk 8 to 30	3.44	0.06	3.57	0.05	NS	†	NS
Mean	3.46	0.05	3.59	0.05	NS	*	NS
TS							
wk 1 to 7	14.38	0.14	14.63	0.12	NS	†	***
wk 8 to 30	13.53	0.13	13.89	0.10	NS	NS	NS
Mean	13.76	0.12	14.09	0.10	NS	NS	*

[1]S = Suckling; M = milking. Dams in the suckling group were milked once daily until kids were weaned (wk 0 to 7) and then were milked twice daily. Dams in the milking group were separated from their kids at 48 h after birth; then, kids were raised artificially, and goats were milked twice daily.

[2]Estimated by the oxytocin method only in the S group (wk 1 to 7).

[3]$P > 0.10$.

†$P \leq 0.10$.

*$P < 0.05$.

**$P < 0.01$.

***$P < 0.001$.

a recent work with cows (4), suckling caused a greater short-term increase in milk yield than did machine-milking, although the residual effect was then delayed by the psychological disturbance of calf removal, which was not observed for our goats. Other researchers (1, 4) have suggested that suckling plus frequent milking during early lactation enhance mammary development, increasing both mammary proliferation and differentiation of mammary cells of goats (38) and cows (15). Mammary proliferation continues for the first few weeks postpartum in goats (18). Previous research (18) also has indicated the effect of the feedback inhibitor of lactation, which decreases milk secretion rate as milk accumulates in the udder. In our study, as has already been stated, the difference in milk yield was minimal and nonsignificant. Evidence exists that efficient milking is of supreme importance for cows at peak lactation because of a higher secretion rate at this stage of lactation (16). Cisternal milk volume does not increase significantly in goats and cows between 2 and 6 h postmilking (16); further secretion during this time accumulated solely within alveolar tissue where the feedback inhibitor of lactation exerts its action (29). In the goat, milk moves more easily into the cistern (30), which is relatively more spacious and adaptable than the cistern of the cow, which can also explain our results.

The effect of parity on milk yield might have been due to the proportion of mammary alveoli from the previous lactation that did not involute. Those alveoli would then be added to alveoli that developed in subsequent lactations. This continuity is interrupted as the age of the goat increases (17). In addition, as the goat ages, its digestive system develops (35), DMI is higher, and as a consequence, milk yield is increased (34). Conversely, the decrease in milk yield of goats in their fourth or greater lactation might have been caused by a decline in the production of lactogenic hormones, reduced efficacy of the milk ejection reflex (6, 35), or loss of secretory cells that occurs when either age or lactation advances (19).

A higher persistency of lactation in first parity goats has been reported (13). Other researchers (14, 36) also noted a decrease in persistency when milk yield increased. This conclusion agrees with the high

TABLE 2. Mean values for estimated and expressed milk yield and composition in Murciano-Granadina dairy goats.

	Lactation							
Item	1	2	3	4	≥5			*P*
Goats, no.	31	23	21	18	15	$\bar{X}$	SEM	
Milk yield, L								
Estimated[1]	63[b]	102[a]	111[a]	106[a]	108[a]	92	5	**
Expressed								
wk 1 to 7	42	76	77	78	73	66	4	†
wk 8 to 30	210[c]	260[ab]	292[a]	241[b]	248[ab]	247	7	*
Total lactation (210 d)	252[b]	336[a]	369[a]	319[a]	321[a]	313	9	*
Milk composition, %								
Fat								
wk 1 to 7	5.90[a]	5.28[bc]	5.10[c]	5.51[b]	5.30[bc]	5.46	0.06	**
wk 8 to 30	5.05	4.95	4.70	5.11	5.00	4.97	0.05	NS[2]
Mean	5.28[a]	5.04[ab]	4.81[b]	5.22[a]	5.08[ab]	5.10	0.05	*
CP								
wk 1 to 7	3.55[a]	3.50[a]	3.51[a]	3.61[ab]	3.81[b]	3.58	0.04	*
wk 8 to 30	3.41	3.47	3.44	3.70	3.67	3.51	0.04	NS
Mean	3.45	3.47	3.46	3.68	3.71	3.53	0.04	NS
TS								
wk 1 to 7	15.00[a]	14.28[bd]	13.97[b]	14.52[ab]	14.63[ad]	14.51	0.09	**
wk 8 to 30	13.80	13.64	13.34	14.09	13.83	13.73	0.08	†
Mean	14.12[a]	13.81[bc]	13.51[b]	14.21[ac]	14.04[ac]	13.94	0.08	*

[a,b,c,d]Values within a row without common subscript letters differ ($P < 0.05$).

[1]Estimated by the oxytocin method only in goats that were milked once daily until kids were weaned and then milked twice daily (n = 16, 11, 10, 6, and 6, respectively).

[2]$P > 0.10$.

†$P \leq 0.10$.

*$P < 0.05$.

**$P < 0.01$.

persistency exhibited in our study by first lactation goats and goats that gave birth to a single kid.

In contrast to our results, other studies (40, 41) have shown that goats with twins tend to yield significantly higher amounts of milk than do goats with a single kid. However, in our study, goats kept one kid as a maximum. Thus, differences in the suckling stimulus did not exist.

The mean values of the measured milk constituents were similar to the composition observed by other researchers for the same breed (20, 31) and slightly high relative to the composition for different breeds (11, 12). This result could be related to both the genetic traits of the Murciano-Granadina dairy goat and the reported milk yield associated with a high nutritional environment. In general, as milk yield increases, the proportion of milk components decreases (27). In this study, similar results were obtained throughout lactation and in reference to a specific parity.

The effect of prolificacy on the CP percentage of milk might have been a consequence of a greater effect of placental lactogen during pregnancy, which increased mammary tissue development and DMI (5), combined with the lower suckling stimulus that resulted from the removal of one or more kids at birth.

Finally, year significantly affected milk yield and composition because goats grazed natural pastures and because environmental conditions varied among years, affecting grass characteristics as has been previously indicated (33).

CONCLUSIONS

Results showed that the rearing systems used affected neither milk yield nor milk composition during the entire lactation. Nevertheless, marketable milk can be increased by approximately 50 L when kids are removed at 48 h after birth. Moreover, the milk ejection mechanism in goats can be stimulated by milking as effectively as by suckling plus milking. Thus, Murciano-Granadina dairy goats can be efficiently machine-milked as has also been stated in a previous work (32).

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REFERENCES

1 Akers, R. M. 1985. Lactogenic hormones: binding sites, mammary growth, secretory cell differentiation, and milk biosynthesis in ruminants. J. Dairy Sci. 68:501.
2 Analla, M., I. Jiménez-Gamero, A. Muñoz-Serrano, J. M. Serradilla, and A. Falagán. 1996. Estimation of genetics parameters for milk yield and fat and protein contents of milk from Murciano-Granadina goats. J. Dairy Sci. 79:1895.
3 Association of Official Analytical Chemists. 1990. Official Methods of Analysis. 15th ed. AOAC, Arlington, VA.
4 Bar-Peled, U., E. Maltz, I. Bruckental, Y. Folman, Y. Kali, H. Gacitua, R. Lehrer, C. H. Knight, B. Robinson, H. Voet, and H. Tagari. 1995. Relationship between frequent milking or suckling in early lactation and milk production of high producing dairy cows. J. Dairy Sci. 78:2726.
5 Byatt, J. C., P. J. Eppard, L. Munyakazi, R. H. Sorbet, J. J. Veenhuizen, D. F. Currant, and R. J. Collier. 1992. Stimulation of milk yield and feed intake by placental lactogen in the dairy cow. J. Dairy Sci. 75:1216.
6 Delouis, C. 1980. La lactation chez la chèvre. Des mécanismes à conaître pour mieux les maîtrisser. L'Élevage Bovin, Ovin Caprin 97:47.
7 Dixon, W. J., M. B. Brown, L. Engelman, M. A. Hill, and R. I. Jennrich. 1988. BMDP Statistical Software Manual. California Press, Berkeley, CA.
8 Doney, J. M., J. N. Peart, W. F. Smith, and F. Louda. 1979. A consideration of the techniques for estimation of milk yield by suckled sheep and a comparison of estimates obtained by two methods in relation to the effect of breed, level of production and stage of lactation. J. Agric. Sci. (Camb.) 92:123.
9 Falagán, A. 1988. Caracterización productiva de la raza caprina Murciano-Granadina en la región de Murcia. Monog. Inst. Nacional Invest. Agrarias No. 63. Inst. Nac. Invest. Agrarias, Min. Agric., Pesca Alimentación, Madrid, Spain.
10 Falagán, A., and P. Dayenoff. 1990. Natural suckling characteristics of Murciano-Granadina kids in the Murcia region (S.E. Spain). Page 182 *in* Proc. 41st Annu. Mtg. Eur. Assoc. Anim. Prod., Cons. Reg. Midi Pyrénées, Toulouse, France.
11 Flamant, J. C., and P. Morand-Fehr. 1982. Milk production in sheep and goats. Page 275 *in* Sheep and Goat Production. I. E. Coop, ed. Elsevier, Amsterdam, The Netherlands.
12 Gall, C. 1981. Milk production. Page 10 *in* Goat Production. C. Gall, ed. Acad. Press, New York, NY.
13 Gipson, T. A., and M. Grossman. 1990. Lactation curves in dairy goats: a review. Small Ruminant Res. 3:383.
14 Gipson, T. A., M. Grossman, and G. R. Wiggans. 1987. Lactation curves for dairy goats by yield level. J. Dairy Sci. 70(Suppl. 1): 153.(Abstr.)
15 Hillerton, J. E., C. H. Knight, A. Turvey, S. D. Wheatley, and C. J. Wilde. 1990. Milk yield and mammary function in dairy cows milked four times daily. J. Dairy Res. 57:285.
16 Knight, C. H. 1995. The environment of the mammary secretory cell. Page 1 *in* Intercellular Signalling in the Mammary Gland. C. J. Wilde, M. Peaker, and C. H. Knight, ed. Plenum Press, London, United Kingdom.
17 Knight, C. H., and M. Peaker. 1982. Development of the mammary gland. J. Reprod. Fertil. 65:621.
18 Knight, C. H., and M. Peaker. 1984. Mammary development and regression during lactation in goats in relation to milk secretion. Q. J. Exp. Physiol. 69:331.
19 Knight, C. H., and C. J. Wilde. 1987. Mammary growth during lactation: implications for increasing milk yield. J. Dairy Sci. 70:1991.
20 Lafuente, A., A. Falagán, B. Urrutia, and J. A. Carrizosa. 1993. Notas preliminares lactaciones normalizadas de cabras Murciano-Granadinas en Murcia: II. Efecto número de parto. Inf. Téc. Econ. Agraria. Prod. Anim. 12(Suppl.):6.
21 Louca, A., A. Mavrogenis, and M. J. Lawlor. 1975. The effect of early weaning on the lactation performance of Damascus goats and the growth rate of the kids. Anim. Prod. 20:213.

22 Masson, C., and C. Decaen 1978. Allaitement et traite au cours des premières semaines de lactation de la chèvre latière. Page 38 *in* 3rd World Congr. Anim. Feeding, Madrid, Spain.
23 McNeilly, A. S. 1972. The blood levels of oxytocin during suckling and hand-milking in the goat with some observations on the pattern of hormone release. J. Endocrinol. 52:177.
24 Mocquot, J. C. 1978. Effets de l'omission regulière et irregulière d'une traite sur la production laitière chez la chèvre. 2ème Symp. Int. Traite Mécanique des Petits Ruminants, Ist. Zootec. Caseario Sardegna, Alghero, Italy.
25 Mocquot, J. C., and T. Auran. 1974. Effets de différentes fréquences de traite sur la production laitière des caprins. Ann. Genet. Sel. Anim. 6:463.
26 Mocquot, J. C., and P. Guillimin. 1975. Effets de différentes fréquences de traite sur la production laitière des chèvres. Rech. Ovine Caprine 1:108.
27 Morand-Fehr, P., G. Blanchart, P. Le Mens, F. Remeuf, D. Sauvant, J. Lenoir, G. Lamberet, J. C. Le Jaouen, and P. Bas. 1986. Données recentes sur la composition du lait de chèvre. llèmes J. Rech. Ovine Caprine. 11:253.
28 Papachristoforou, C., A. Roushias, and A. P. Mavrogenis. 1982. The effect of milking frequency on the milk production of Chios ewes and Damascus goats. Ann. Zootech. (Paris) 31:37.
29 Peaker, M. 1995. Autocrine control of milk secretion: development of the concept. Page 193 *in* Intercellular Signalling in the Mammary Gland. C. J. Wilde, M. Peaker, and C. H. Knight, ed. Plenum Press, London, United Kingdom.
30 Peaker, M., and D. R. Blatchford. 1988. Distribution of milk in the goat mammary gland and its relation to the rate and control of milk secretion. J. Dairy Res. 55:41.
31 Pedauye, J. 1989. Curvas de lactación y composición en cabras de raza Murciano-Granadina. An. Vet. Murcia 5:3.
32 Peris, S., X. Such, and G. Caja. 1996. Milking ability of Murciano-Granadina dairy goats. Milk partitioning and flow rate during machine milking according to parity, prolificacy and mode of suckling. J. Dairy Res. 63:1.
33 Piergiovanni, L., and A. Casassa. 1982. Latte di capra. Industria Latte 18:73.
34 Randy, H. A., C. J. Sniffen, and J. F. Heintz. 1988. Effect of age and stage of lactation on dry matter intake and milk production in Alpine does. Small Ruminant Res. 1:145.
35 Rathore, A. K. 1970. Goats—milk production and the effect of age on milk quality. Aust. Goat World 22:1.
36 Sauvant, D., and P. Morand-Fehr. 1975. Clasification des types de courbes de lactation et d'evolution de la composition du lait de la chèvre. Rech. Ovine Caprine 1:90.
37 Tuinstra-Lawaars, M., E. Hopkin, and S. Boelsma. 1985. Inventory of IDF/ISO/AOAC adopted Method of Analysis for Milk and Milk Products: 1985 Update. IDF Bull. 193. Int. Dairy Fed, Brussels, Belgium.
38 Wilde, C. J., A. J. Henderson, C. H. Knight, D. R. Blatchford, A. Faulkner, and R. J. Vernon. 1987. Effects of long-term thrice-daily milking on mammary enzyme activity, cell population and milk yield. J. Anim. Sci. 64:533.
39 Zygoyiannis, D. 1987. The milk yield and milk composition of the Greek indigenous goat (*Capra prisca*) as influenced by duration of suckling period. Anim. Prod. 44:107.
40 Zygoyiannis, D. 1994. A note on the effect of number and genotype of kids on milk yield and composition of indigenous Greek goats (*Capra prisca*). Anim. Prod. 58:423.
41 Zygoyiannis, D., and N. Katsaounis. 1986. Milk yield and milk composition of indigenous goats (*Capra prisca*) in Greece. Anim. Prod. 42:365.