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Y. Chilliard, Daniel Sauvant, P. Morand-Fehr. GOAT MAMMARY, ADIPOSE AND MILK LIPOPROTEIN LIPASES. Annales de Recherches Vétérinaires, 1979, 10 (2-3), pp.401-403. hal-00901193

HAL Id: hal-00901193

<https://hal.science/hal-00901193>

Submitted on 11 May 2020

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GOAT MAMMARY, ADIPOSE AND MILK LIPOPROTEIN LIPASES

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Information on the origin and secretion mechanisms of milk lipoprotein lipase (LPL) is interesting for two reasons: firstly, this enzyme activity which is easily obtainable could give valuable information on the metabolism of lactating animals, and secondly it is one of the factors responsible for spontaneous lipolysis in cold stored milk.

It is generally assumed that milk LPL is synthesized within mammary epithelial cells (Hamosh and Scow, 1971). However Jensen and Pitas (1976) made the assumption that it could originate from peripheral tissues, as adipose tissues, and is probably due to leakage of serum LPL across mammary membranes.

In this work, adipose, mammary and milk LPL activities were simultaneously measured in lactating goats to specify possible relationships between these three enzymic activities.

Material and methods

Omental adipose tissue and mammary tissue were sampled by biopsy 3 and 9 weeks after normal or premature parturition in 5 French Alpine goats with various milk production levels (Chilliard *et al.*, 1978). A biopsy was made on a sixth goat with a high production level 3 weeks after parturition. Milk samples representative of the whole morning milking were taken just before biopsies, and also 1, 6 and 12 weeks after parturition.

In a seventh goat in mid lactation (15 weeks after parturition) tissues and milk were sampled by biopsy after a 48 hour fast and at slaughter after 7 days of refeeding.

Methods used for measuring LPL activities were indicated elsewhere (Chilliard and Morand-Fehr, 1978; Chilliard *et al.*, 1978).

Results and Discussion

Mammary and milk LPL activities were negatively correlated (table). Mammary LPL activity decreased between 3 and 9 weeks after parturition in the high yielding goats (Chilliard *et al.*, 1978 - fig. 1). On the other hand, milk LPL activity increased (fig. 1) according to earlier results on other high yielding goats (Chilliard and Morand-Fehr, 1978). In the low yielding animals, LPL activity was stable in milk and increased in mammary tissues during the studied period (fig. 1).

Milk and adipose tissue LPL activities were positively correlated (table), in particular when adipose activity was expressed on a fresh weight basis and when milk activity was adjusted for its evolution during the first three months of lactation. This was due to simultaneous increases between 3 and 9 weeks after parturition (fig. 1), and also to variations in these two activities between goats.

Adipose tissues and milk LPL activities were extremely low after a 48 hour fast, and high

after the refeeding period, whereas mammary LPL activity was more stable (fig. 2).

The observed effect of fasting and refeeding confirms earlier results obtained with other goats for milk (Chilliard and Morand-Fehr, 1978) and adipose tissue (Chilliard, unpublished results) LPL activities. The result on adipose tissue LPL has also been reported in other mammal species. There are only very few data on the effect of fasting and refeeding on milk and mammary LPL activities in other species. However Mc Bride and Korn (1963) reported no variation of milk LPL activity in the fasted guinea pig.

Positive relationships between milk and adipose tissue LPL activities could reflect a transport of adipose LPL, firstly from its site of action on the capillary endothelium to the blood flow, and then by leakage across mammary membranes, as assumed by Jensen and Pitas (1976). Correlation data are however not sufficient *per se* to prove this hypothesis.

Another hypothesis is that milk LPL originates from mammary LPL, but there is no direct

Table 1. - Correlations between mammary, adipose and milk LPL activities in goats in early lactation

	Mammary LPL (units/g) (1) (n = 11 ; 6 goats) (2)	Adipose LPL	
		units/g (n = 11 ; 6 goats) (2)	units/mol of DNA bases (n = 10 ; 5 goats) (2)
Milk LPL (units- /ml) ⁽³⁾	- 0.69*** (5)	+ 0.60**	+ 0.30
Adjusted ⁽⁴⁾ milk LPL (units/ml)	- 0.60**	+ 0.84****	+ 0.46
Mammary LPL (units/g)	(1.00)	- 0.54*	- 0.49

(1) LPL unit : 1 μ mol of fatty acids released per hour at 35°C.

(2) Biopsies were made on 5 goats 3 and 9 weeks after parturition, and on 1 goat only after 3 weeks.

(3) Similar correlations were obtained when total milk LPL activity (produced per day) was considered.

(4) Weekly fluctuations of milk LPL activity were large. Therefore values obtained 3 and 9 weeks after parturition were adjusted with aid of values registered after 1, 6 and 12 weeks.

(5) $P \leq 0.10$ (*) ; 0.05 (**) ; 0.02 (***) ; 0.005 (****)

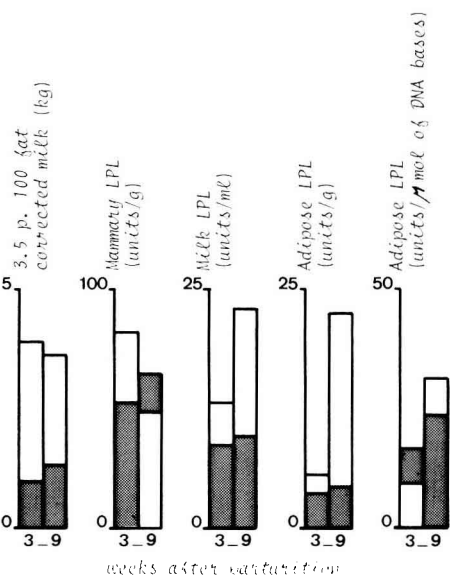


Fig. 1. - Evolutions of mammary, adipose and milk LPL activities between 3 and 9 weeks after parturition.

□ mean value registered on 3 high producers
▨ mean value registered on 2 low producers

(1 LPL unit = 1 μ mol released fatty acids/h)

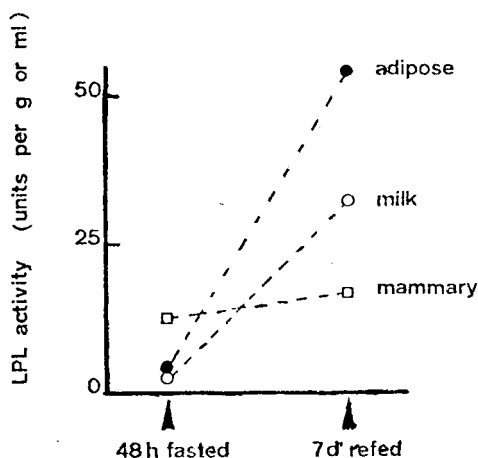


Fig. 2. - Effect of 48 hours fasting and 7 days refeeding on mammary, adipose and milk LPL activities in one goat in mid lactation.

relationship between tissue total LPL activity and the LPL leaking into milk. Thus, the results of Emery, Liesman and Shirley (personal communication, 1977) suggest the existence of at least three pools of LPL in the mammary gland: a capillary pool, normally released into the blood; a heparin releasable pool; and an intracellular precursor pool. A possible explanation of our results would be that when total mammary LPL activity is high, intracellular synthesized LPL is preferentially directed to the first two pools. At the same time, the intracellular fraction (that is assumed to pass into milk during the secretion process) would be decreased. This would explain negative correlations observed in the goat between milk fat and milk LPL secretion (Chilliard and Morand-Fehr, 1978 and unpublished results), since LPL of the capillary pool seems to control the uptake of circulating triglyceride fatty acids (Emery *et al.*, op. cit.).

Such a hypothesis on the mammary origin of milk LPL would furthermore be in accor-

dance with the increase in its activity observed at the end of milking (Chilliard and Morand-Fehr, 1978). It is the same with the between-species differences in milk LPL activity which were observed in the female rat, guinea pig and cow and which could be due to species variations in the amount or nature of mammary epithelial cytoplasmic fragments that are released with the secretory substances (Hamosh and Scow, 1971).

Conclusion

Milk LPL activity is positively correlated with the adipose tissue one, and negatively correlated with the whole LPL activity of the mammary tissue. Consequently, milk enzyme could not be used as a direct indicator of the udder LPL activity. Other studies must be done to specify the origin and mechanisms of secretion of milk LPL, from peripheral tissues, as adipose tissue, or from an intracellular mammary pool.

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