SHORT COMMUNICATIONS

THE UPTAKE OF L-LACTATE AND D-GLUCOSE BY THE MAMMARY GLAND OF THE COW

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Although the uptake of large amounts of blood glucose by the lactating mammary gland of the ruminant is well documented, there are conflicting reports on the uptake of lactate. Graham (1937) reported a mean uptake of lactate of 16·7 mg/100 ml blood by the mammary gland of goats in which the arterial concentration of lactate was unusually high. A considerably smaller uptake was found in unanaesthetized cows (Shaw, Boyd, and Petersen 1938) but the results of subsequent studies on anaesthetized cows (Shaw 1946) indicated that the mammary gland did not utilize a significant amount of blood lactate.

It has been estimated that, in sheep, at least 40% of the lactate pool is derived from glucose and a minimum of 15% of the glucose pool is derived from lactate (Annison, Lindsay, and White 1963). If a similar interconversion occurs in the cow, the net uptake of L-lactate should be considered in assessing the net uptake of D-glucose. This communication describes studies carried out on lactating cows to determine the arteriovenous difference for L-lactate across the mammary gland. An attempt also has been made to relate the uptake of L-lactate to that of D-glucose.

Methods

(i) *Animals.*—The details of the four cows are presented in the following tabulation:

	Cow 1* Guernsey	Cow 2 Jersey	Cow 3 Crossbred†	Cow 4 Guernsey
Stage of lactation (months)	5	2	6	11
Milk production (litres/24 hr)	10·4	11·4	9·1	8·4

* Observations were also made on this cow during the dry period.

† Australian Illawarra Shorthorn × Ayrshire.

(ii) *Collection of Samples.*—The method used for sampling arterial and venous blood has been described previously (Hartmann and Lascelles 1964). The samples were collected from the cows about 3 hr before the afternoon milking. Additional samples were collected from cow 4, 5–10 min after exercise (a 15- or 30-min walk).

(iii) *Analytical Determinations.*—Plasma L-lactate was determined by the enzymic method of Scholz *et al.* (1959) and plasma D-glucose by the glucose oxidase method of Huggett and Nixon (1957). Plasma free fatty acid was titrated according

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to Dole (1956), as modified by Schnatz (1964), by the addition of isopropyl alcohol to produce a single-phase system for titration.

Results

(i) L-*Lactate*.—The mean concentration of L-lactate in arterial plasma from the lactating cows was $7 \cdot 9 \pm 2 \cdot 4$ (S.D.) mg/100 ml, which is similar to that observed in the unanaesthetized cow (Shaw, Boyd, and Petersen 1938) and sheep (Annison, Lindsay, and White 1963), but about twice that observed in the anaesthetized cow (Powell and Shaw 1942; Shaw 1946).

TABLE 1

MEAN CONCENTRATIONS OF L-LACTATE IN PLASMA SAMPLES COLLECTED FROM THE CAROTID ARTERY OF EACH OF THE FOUR COWS, TOGETHER WITH MEAN ARTERIOVENOUS DIFFERENCES

The range of the arteriovenous differences is shown in brackets. The negative sign indicates that the concentration in the venous plasma was higher than that in the arterial plasma

	Cow 1		Cow 2	Cow 3	Cow 4		
	Lactating	Non-lactating	Lactating	Lactating	Lactating		
No. of samples	5	3	5	3	1	2*	1†
L-Lactate (mg/100 ml) from carotid artery	6·9	9·2	6·4	10·4	8·6	11·2	15·3
Arteriovenous difference	1·5 (0·5 to 2·1)	0·7 (0·5 to 0·8)	−0·2 (−1·2 to 1·0)	2·1 (0·4 to 3·7)	1·8 —	1·6 (1·4 to 1·7)	1·7

* 15 min exercise. † 30 min exercise.

The observations made on cow 1 during the dry period, and on cow 4 after exercise were treated in the analysis of variance as "separate cows" (Table 1). There was a significant difference ($P < 0 \cdot 01$) between these "cows" in the concentration of L-lactate in the blood plasma. The sequence test of Tukey (Snedecor 1956), applied to the cow means, showed that for cow 4 the concentration of L-lactate in plasma obtained after exercise was significantly higher ($P < 0 \cdot 05$) than that obtained at rest. There was a significant arteriovenous difference ($P < 0 \cdot 05$) for L-lactate; the mean arterial concentration was 1·1 mg/100 ml higher than the mean venous concentration. In cows 1, 3, and 4 all arteriovenous differences were positive, whereas in cow 2 three of the arteriovenous differences were negative (see Table 1).

(ii) D-*Glucose*.—The concentration of D-glucose was 12–18 mg/100 ml higher in the arterial than in the venous plasma of the lactating cows. These results support those reported earlier by Hartmann and Lascelles (1964). There were no significant correlations between the concentrations of L-lactate and D-glucose in arterial plasma, or between the arteriovenous differences for L-lactate and D-glucose.

(iii) *Effect of Exercise.*—The concentration of L-lactate in the arterial plasma increased almost twofold after exercise, but the arteriovenous difference did not increase (Table 1). Therefore it would appear from this limited data that a significant increase in the concentration of L-lactate in the blood does not result in an increased uptake by the lactating mammary gland. No consistent changes were observed in either the concentration of D-glucose or its arteriovenous difference. Since only small inconsistent changes occurred in the concentration of free fatty acid in the arterial plasma, it would appear that the exercise had not excited the cow (see Kronfeld 1965).

Discussion

The limitations of the arteriovenous difference technique for studies on the net uptake of various substrates by the mammary gland of the cow, have been discussed previously (Hartmann and Lascelles 1964, 1965). Excitement of the cows during the collection of blood samples may lead to spurious estimates of the net uptake (Folley 1949). However, in the experiments described in this communication, excitement was minimized by the collection of samples from docile cows which had been trained to stand quietly, without restraint, during the sampling procedure.

The results have indicated that a net uptake of L-lactate by the lactating mammary gland may occur but its quantitative importance is small compared with that of D-glucose. There appeared to be no relationship between the net uptake of L-lactate and D-glucose.

The author wishes to thank Professor A. K. Lascelles for discussion and comments on this work and Miss R. L. Pell for technical assistance.

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