

COLD EXPOSURE AND FREE FATTY ACID METABOLISM IN THE BOVINE HIND LIMB

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We have previously observed that the cold-induced fat mobilization in young cattle is associated with increased utilization of plasma free fatty acids (FFA) by shivering muscle (Bell and Thompson 1974). However, these observations were based on measurements of net exchange of FFA across the hind limb, and their quantitative significance could not be assessed because values for true uptake were almost certainly masked by increased release of FFA from leg adipose tissue. In particular, the small responses of recently fed animals were difficult to interpret. Therefore we have repeated the experiments on fed animals, using ^{14}C -labelled FFA as a tracer for estimation of true (as opposed to net) leg uptake of FFA; the simultaneous release of $^{14}\text{CO}_2$ was used to calculate FFA oxidation rate in leg tissues.

Four Ayrshire steers weighing 160–185 kg and surgically prepared with a carotid loop and permanent indwelling catheters in the abdominal aorta, and in the external iliac artery and vein of one hind limb, were exposed to thermoneutral (13–17°C, still air) or cold (–1 to +1°C, wind speed 2–3 m.s⁻¹) conditions for several hours after being fed 2 kg of a mixture of chopped straw, rolled barley, cattle pellets and molasses. From about 2½ to 6 h after feeding, when plasma FFA levels in unstressed animals were minimal, a mixture of [1- ^{14}C]-labelled FFA, complexed in bovine plasma, was infused into the abdominal aorta. During the final hour of infusion (5–6 h after feeding) leg blood flow and the arteriovenous difference in specific activities of plasma ^{14}C -FFA and blood $^{14}\text{CO}_2$ were measured, for calculation of uptake, release and oxidation of FFA in the hind limb.

The steers shivered continuously during cold exposure, which caused a 54% increase in total metabolic rate and a 6½-fold increase in oxygen uptake by the hind limb. Some accompanying responses in the metabolism of plasma FFA are shown in Table 1.

TABLE 1. Effect of cold exposure on arterial concentration, and uptake, release and oxidation in the hind limb of plasma FFA. Mean (\pm S.E.M.) for 4 steers.

	Thermoneutral	Cold
Arterial concentration ($\mu\text{mol.l}^{-1}$)	138 \pm 24	499 \pm 42
Leg uptake ($\mu\text{mol.min}^{-1}$)	19.5 \pm 4.5	141.8 \pm 18.3
Leg release ($\mu\text{mol.min}^{-1}$)	34.3 \pm 8.2	88.6 \pm 11.2
Fractional oxidation of leg uptake (%)	2.8 \pm 0.6	31.9 \pm 5.8

The results clearly illustrate the inadequacy of using values for net exchange of FFA across the limb to estimate FFA utilization in muscle. It is also notable that even during cold exposure, when FFA uptake and oxidation were greatly increased, most FFA taken up by shivering muscle were apparently not immediately oxidized to CO_2 .

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