

INFLUENCE OF DAILY REPEATED COLD EXPOSURES ON THE TCA CYCLE IN THE SHEEP LIVER

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Introduction

Our previous studies indicated that the metabolism of acetate, propionate, butyrate and pyruvate, and the insulin secretion in sheep and rabbits were markedly altered by daily repeated cold exposures (Fujita et al., 1980; Seto et al., 1983; Seto et al., 1984; Seto et al., 1985). It was established that short-chain fatty acids and pyruvate were metabolized via the TCA cycle, but there has been no reports on the metabolic responses of the TCA cycle in the sheep liver to daily repeated cold exposures.

Materials and Methods

Female Merino sheep weighing 45 kg were used for the experiments. Animals were given 1, 4 or 7 daily cold exposures which were applied for 12 h, from 12:00 to 24:00, at $2^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and their influences upon the metabolism in the liver were studied. In non-cold exposed groups, animals were maintained in a constant ambient temperature ($20^{\circ}\text{C} \pm 2^{\circ}\text{C}$). All animals were killed by decapitation at 24:00, their liver slices were incubated with one of ^{14}C -labelled substrates in KRB buffer for 3 h at 38°C , and ^{14}C transfer rates from ^{14}C -substrate into various fractions were determined using the procedures described previously (Seto et al., 1983).

Results and Discussion

The 1st cold exposure (cold exposure on the 1st day) significantly increased ^{14}C transfer rates from ^{14}C -citrate into CO_2 , glucose (G), triglyceride (TG), free fatty acids (FFA) and phospholipids (PL), and significantly decreased those rates

into ketone bodies (KB), cholesterol ester (CE) and free cholesterol (FC). The 4th cold exposure (cold exposure on the 4th day) significantly increased ^{14}C transfer rates from ^{14}C -citrate into CO_2 , G, KB, TG and PL, and significantly decreased those rates into FC and FFA, but the increased or decreased rates for the 4th cold exposure were significantly low as compared with those for the 1st cold exposure. There were no effects of the 4th cold exposure on ^{14}C transfer rates from ^{14}C -citrate into CE. The 7th cold exposure (cold exposure on the 7th day) had no effects on ^{14}C transfer rates from ^{14}C -citrate into all fractions.

The 1st cold exposure significantly increased ^{14}C transfer rates from ^{14}C -succinate into CO_2 , KB, CE, TG, FC and FFA, but significantly decreased those rates into G and PL. The 4th cold exposure significantly increased ^{14}C transfer rates from ^{14}C -succinate into CO_2 , KB and TG, and significantly decreased those rates into CE, FC and FFA, but the increased or decreased rates for the 4th cold exposure were significantly low as compared with those for the 1st cold exposure. The 4th cold exposure had no appreciable effects on ^{14}C transfer rates from ^{14}C -succinate into G and PL. There were no effects of the 7th cold exposure on ^{14}C transfer rates from ^{14}C -succinate into all fractions.

The 1st cold exposure significantly increased ^{14}C transfer rates from ^{14}C -malate into CO_2 , CE, TG, FC and FFA, and significantly decreased those rates into G, KB and PL. The 4th cold exposure significantly increased ^{14}C transfer rates from ^{14}C -malate into CO_2 , KB and TG, and significantly decreased those rates into G, CE, FC, FFA and PL, but the increased or decreased rates for the 4th cold exposure were significantly low as

compared with those for the 1st cold exposure. The 7th cold exposure had no effects on ^{14}C transfer rates from ^{14}C -malate into all fractions.

The 1st cold exposure significantly increased ^{14}C transfer rates from ^{14}C - α -ketoglutarate (KG) into CO_2 , CE, FG, FC and PL, and significantly decreased those rates into G, KB and PL. The 4th cold exposure had no effects on ^{14}C transfer rates from ^{14}C -KG into PL. There were no effects of the 7th cold exposure on ^{14}C transfer rates from ^{14}C -KG into all fractions.

Thus, daily repeated cold exposures had various effects on the metabolism of member substances of the TCA cycle, and these effects varied with kinds of substances. However, the metabolic responses of these substances to cold exposures diminished with increased frequency of the daily exposures to cold stress until disappearing completely. Exposure to other types of stress, such as heat or immobilization stress, produced a marked change in the metabolism of these substances while the metabolic responses to cold exposures were completely extinguished by the seven times repetition of cold exposures. These results suggested that the daily repetition of cold exposures established the metabolic adaptation of these substances to daily cold exposures and this meta-

bolic adaptation to daily repeated cold exposures seem to be specific to cold exposures.

(Key Words: Sheep Liver, Cold Exposure, TCA Cycle)

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