PN 1216

Cholesterol esters and the synthesis of milk fat*

It is a current objective of biological and medical research to reveal the role(s) of cholesterol in lipid metabolism. While studying synthesis of milk fat, we have secured evidence that the cholesterol esters of milk have a remarkably active metabolic history. In addition, capacity of the mammary gland to synthesize all three types of ester lipids (cholesterol esters, glycerides and phosphatides) of milk from available fatty acids was demonstrated.

The procedure of infusing metabolites into the mammary gland via the teat canal has proven particularly useful in this research. With this approach, ^{14}C-labeled simple metabolites, such as acetate, and serine[1,2] and even non-labeled lipids[3] have been readily introduced into metabolic pathways of the gland. In the latter work[3] infusion of potassium pentadecanoate produced a 5- to 10-fold increase in the pentadecanoate content of the milk triglycerides and phospholipids. In pursuing this point further using potassium linoleate, we noted a less dramatic increase but it appeared significant that among ester lipids, the cholesterol esters showed the greatest increase in linoleate, thus suggesting active metabolism of this lipid class (Table I).

TABLE I

THE DISTRIBUTION OF LINOLEIC ACID IN MILK-LIPID FRACTIONS BEFORE AND AFTER INTRAMAMMARY INFUSION OF ITS POTASSIUM SALT

Lipid fraction	*Linoleate concentration**		*Increase in linoleate (%)*
	Before (wt. %)	*After (wt. %)*	
Cholesterol esters	8.5	19.6	130
Triglycerides	1.7	2.2	29
Phospholipids	9.8	14.7	50

* Calculated from peak areas of gas chromatograms of the methyl esters by the method of PATTON *et al.*[6].

Additional evidence regarding the metabolic activity of the cholesterol esters of milk was obtained as follows: After completely milking a goat, a tracer dose of 6 mg potassium [1-^{14}C]palmitate ($50 \cdot 10^6$ counts/min) in 12 ml of water was infused into one-half of her udder through the teat canal. Milk was collected separately from each half of the udder at the intervals 2, 6, 14, 22, and 30 h after infusion. Previous experiments[2,3] have shown that infused metabolites do not enter the metabolism of the uninfused half of the udder to any significant extent; thus milkings from the uninfused side were discarded. The five milkings from the infused side were subjected to Roese–Gottlieb extraction to recover the lipids. The individual lipid samples were separated on silicic acid columns into cholesterol ester, glyceride, free fatty acid and phospholipid fractions. Measurement of radioactivity in the three ester lipid classes for the five samples yielded the data plotted in Fig. 1. Specific activities of free fatty acids are not shown since it was impossible to distinguish labeled fatty acid which had entered tissue metabolism from residual infused fatty acid. In securing the data

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the following points were established. More than 90 % of the activity of all lipid classes was confined to palmitate as shown by trapping from a gas chromatograph. The lipid classes were properly recovered and identified by their behavior on silicic acid chromatography columns[4,5], by fatty acid composition[6] and by infrared spectra.

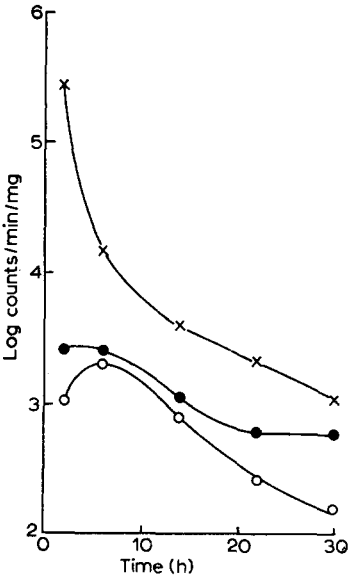

Fig. 1. Changes in specific activity of goat-milk lipid classes after intramammary infusion of 50 μC of potassium [1-^{14}C]palmitate. ×—×, cholesterol esters; ●—●, phospholipids; O—O, triglycerides.

The data of Fig. 1 demonstrates synthesis *de novo* of the three ester lipid classes of milk within the mammary gland from the infused palmitate. The sharp rise and decline in the specific activity of the cholesterol esters suggests a rapid turnover of their fatty acid moieties. The possibility of a precursor–product relationship between these moieties and the fatty acids of milk glycerides and phosphatides is under investigation.

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