THE ALKYL AND ALK-1-ENYL GLYCEROLS IN THE LIVER OF RATS FED LONG-CHAIN ALCOHOLS OR ALKYL GLYCEROLS

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Dietary long-chain alcohols and alkyl glycerols, including polyunsaturated compounds, are incorporated into the alkyl and alk-1-enyl moieties of the ionic alkoxylipids of rat liver, whereas polyunsaturated fatty acids are not.

1. Introduction

The routes of biosynthesis and catabolism of the alkoxylipids, i.e., compounds containing long-chain alkyl or alk-1-enyl groups are largely unknown [1]. The suggestion that the two types of alkoxylipids may be related metabolically [2] seems to be supported to some extent by structural similarities between the alkyl and alk-1-enyl chains in the lipids of various human and animal tissues: both the alkyl and the alk-1-enyl moieties bound in neutral and ionic glycerol-derived lipids of animal tissues have saturated and monounsaturated chains of 16 and 18 carbon atoms [3–6].

In previous investigations of the metabolism of alkoxylipids, only saturated and monounsaturated compounds have been used [7–12]. Consequently, it is not known whether animal tissues are unable to produce polyunsaturated precursors for the synthesis of alkyl and alk-1-enyl moieties, or whether they cannot incorporate these precursors into glycerol-derived lipids. Neither is it known whether animal tissues can metabolize polyunsaturated alkyl and alk-1-enyl glycerols.

The following experiment was carried out to determine whether dietary monounsaturated and diunsaturated long-chain alcohols and alkyl glycerols can be incorporated into the ionic alkoxylipids of rat liver.

Groups of rats were fed a basic diet and water plus supplements of *cis*-9-octadecenyl alcohol, *cis*, *cis*-9,12-octadecadienyl alcohol, *cis*-9-octadecenyl glycerol-(1), or *cis*,*cis*-9,12-octadecadienyl glycerol-(1). The constituent alkyl, alk-1-enyl, and acyl moieties in the phosphoglycerides isolated from the liver of the rats were analyzed to determine whether the dietary lipids had been incorporated into the tissue lipids of these animals.

The results presented in this communication show that dietary monounsaturated and diunsaturated alcohols as well as the corresponding alkyl glycerols can be used by the rat as precursors of both the alkyl and alk-1-enyl moieties of phosphoglycerides. Moreover, the results of our experiments show that polyunsaturated alkyl glycerols cannot only be synthesized by the rat, if precursors are supplied through

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Table 1

Composition of the alkyl glycerols derived from the total alkyl acyl phosphoglycerides in the liver of rats fed long-chain alcohols or alkyl glycerols.

Chain length: number of double bonds in alkyl chain *	Control animals (%)	Animals fed long-chain alcohols		Animals fed alkyl glycerols	
		18:1 alcohol (%)	18:2 alcohol (%)	18:1 glycerol (%)	18:2 glycerol (%)
16:0	51.5	46.0	48.0	32.8	43.2
16:1	2.5	3.0	–	Trace	Trace
18:0	7.5	8.0	4.5	5.4	9.8
18:1	37.5	43.0	42.0	58.3	42.2
18:2 **	–	–	3.0	3.6	4.8

* The following alkyl glycerols were found in trace amounts: 13:0, 17:0, 18:0 br(?), 20:0, 20:1.
** Including an unidentified alkyl glycerol, possibly 19:0.

Table 2

Composition of the alk-1-enyl glycerols derived from the total alk-1-enyl acyl phosphoglycerides in the liver of rats fed long-chain alcohols or alkyl glycerols.

Chain length: number of double bonds in alk-1-enyl chain *	Control animals (%)	Animals fed long-chain alcohols		Animals fed alkyl glycerols	
		18:1 alcohol (%)	18:2 alcohol (%)	18:1 glycerol (%)	18:2 glycerol (%)
16:0	36:0	37.0	21.5	40.1	23.1
16:1	Trace	1.6	1.7	Trace	Trace
18:0	31.0	21.7	38.4	18.9	33.6
18:1	32.8	39.7	35.9	35.2	30.9
18:2	Trace	Trace	2.5	5.8	11.9

* The following alk-1-enyl glycerols were found in trace amounts: 13:0, 17:0, 18:0 br(?), 20:0, 20:1.
** Including an unidentified alk-1-enyl glycerol, possibly 19:0.

the diet, but they can be metabolized as well.

2. Materials and methods

2.1. *Lipids*

Methyl esters, which were used as reference compounds, were purchased from the Hormel Institute Lipids Preparation Laboratory; aldehydes [13], alkyl acetates [3], and isopropylidene derivatives of alkyl glycerols [14, 15] were prepared as described previously. *cis*-9-Octadecenyl alcohol (oleyl alcohol) and *cis,cis*-9,12-octadecadienyl alcohol (linoleyl alcohol), which were used as dietary supplements, were prepared by hydrogenolysis of the corresponding methyl esters, with lithium aluminum hydride [16]; *cis*-9-octadecenyl glycerol-(1) (α-oleyl glyceryl ether) and *cis,cis*-9,12-octadecadienyl glycerol-(1) (α-linoleyl glyceryl ether) were synthesized by reacting the corresponding mesylates with isopropylidene glycerol, and subsequent hydrolysis of the isopropylidene alkyl glycerols [14].

2.2. *Animals and diets*

Groups of 4–5 week old rats, four to each group, were fed for 28 days, *ad libitum*, a basic diet consisting of 20% extracted casein, 68% sucrose, 5% salt mixture, 0.5% vitamin mixture, 0.5% choline chloride and, as the sole source of lipids, 6% peanut oil, and water.

Group A: the control group, received the basic diet;
Group B: the basic diet plus 100 mg/day/animal of *cis*-9-octadecenyl alcohol;
Group C: the basic diet plus 100 mg/day/animal of *cis,cis*-9, 12-octadecadienyl alcohol;
Group D: the basic diet plus 100 mg/day/animal of *cis*-9-octadecenyl glycerol-(1);
Group E: the basic diet plus 100 mg/day/animal of *cis,cis*-9, 12-octadecadienyl glycerol-(1).

All of the supplements were fed by stomach tube. The animals were killed 10 hr after the last feeding, their brain, heart, kidneys, liver, and testes were excised, weighed and inspected; the lipids were extracted with chloroform–methanol (2:1, v/v) and purified following established procedures [17].

2.3. *Lipid analysis*

Thin-layer chromatography of the total lipid extracts was carried out on Silica Gel H using hexane–diethyl ether (60:40, v/v) as solvent, and the phosphoglycerides were eluted from the adsorbent with chloroform–methanol–water (30:50:20, v/v/v) [18]. The phosphoglycerides were subjected to hydrogenolysis [19], and the alkyl glycerols and alk-1-enyl glycerols formed were separated from the alcohols by thin-layer chromatography on Silica Gel G with the solvent hexane–diethyl ether (80:20, v/v). The mixture of alkyl and alk-1-enyl glycerols was treated with hydrochloric acid in diethyl ether [20] and the resulting mixture of aldehydes and alkyl glycerols treated with lithium aluminum hydride in diethyl ether [16]. The alcohols derived from alk-1-enyl glycerols, and the alkyl glycerols were resolved by thin-layer chromatography on Silica Gel H with hexane–diethyl ether (20:80, v/v) as solvent. Acetates of the alcohols [3] and isopropylidene derivatives of the alkyl glycerols [15] were prepared as described previously. The alkyl acetates were analysed by gas chromatography at 170°, on a column, 6 ft by 1/8 inch, filled with 20% diethyleneglycol succinate on Anakrom A, 80–100 mesh, whereas the isopropylidene derivatives of alkyl glycerols were analyzed, at 200°, on the same column.

3. Results and discussion

The dietary long-chain alcohols and alkyl glycerols did not produce any obvious ill effects in the rats.

The addition of long-chain alcohols or alkyl glycerols to the basic diet dit not markedly alter the distribution of lipid classes nor the fatty acid composition of the phosphoglycerides in the liver of the animals. In contrast, dietary long-chain alcohols, as well as alkyl glycerols effected pronounced changes in the composition of both the alkyl moieties (table 1) and the alk-1-enyl moieties (table 2) in the phosphoglycerides of rat liver.

Long-chain alcohols and alkyl glycerols are not normally present in the diet of rats. Our results show that, if added to the diet, such compounds, including polyunsaturated ones, are incorporated into both the alkyl moieties of the alkyl acyl phosphoglycerides and the alk-1-enyl moieties of the alk-1-enyl acyl phosphoglycerides of rat liver. Although the lipids of the basic diet were rich in linoleic acid, neither the phosphoglycerides of the control animals nor those of rats fed monounsaturated alcohol contained diunsaturated alkyl or alk-1-enyl moieties.

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