Lung Polar Lipid Fatty Acid Composition in the Mice After Feeding Different Lipid Supplemented Diets

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Summary

This study aimed at investigating diet-induced changes on the fatty acid composition in the lung tissue. The dietary enriched oils, type PUFA and MUFA did not affect the total fatty acid composition in the total phospholipids of the lung tissue in the mice. Oleic and palmitic acids in the FOO group were significantly higher than in the control. Linoleic, eicosadienoic and lignoceric acid contents significantly increased, and eicosapentaenoic acid decreased in the FCO group. The lung saturated fatty acids significantly decreased and unsaturated increased in the FOO group. Monounsaturated fatty acid contents significantly decreased in the FCO group.

Introduction

The phospholipid (PL) fatty acid composition together with cholesterol content in biomembranes is basic determinants of physical properties of membranes. Long-chain saturated fatty acids (FAs) are the major FAs found in surfactant phospholipids (PLs)[1]. Changing the type and amount of lipid in the diet alters the FAs composition of surfactant[2], which may change the physical and physiological properties of surfactant[3] and the alveolar surface tension[4].

The aim of this work was to determine the potential of dietary fats, named as MUFA-diet (standard diet supplemented with olive oil) and PUFA-diet (standard diet supplemented with corn oil) to modulate the

fatty acid composition of mouse lung phospholipids. We believe that the fatty acid composition in the cell membranes in the lung is beneficial in various stress stages and can influence alveolar surface tension.

Materials and Methods

A total of 18 male 2-3 mo old Balb/C mice, divided into three groups of six, were studied. From their birth to the commencement of the study the mice were fed with a standard diet (Faculty of Biotechnology, Domzale, Slovenia). When the mice reached a weight of at least 25 g (around the age of 2-3 mo), they were assigned to three different groups. After three weeks of feeding lipid-supplemented diets containing standard diet supplemented olive oil (5% w/w, FOO group) and corn oil (5% w/w, FCO group), animals were sacrificed. Lung tissues were removed with plastic instruments, washed several times with saline solution to remove blood, weighed and stored at –80°C until further analysis.

Total lipids were extracted according to *Folch et al.*, and polar lipids were separated and purified by solid-phase extraction and fatty acids of polar lipids analysed in the form of fatty acid methyl esters by gas chromatographic analysis[5].

A statistical analysis was performed using the nonparametric *Kruskal-Wallis* one-way analysis of variance by rank and the *Mann-Whitney* U-test to assess significant differences among the different treatment groups in standard diet and the FOO- and FCO-groups. Statistical significance was assumed with a $P < 0.05$.

Results

In the first step of our study, as shown in Table 1, we analysed feeding edible oils; they were examined as monounsaturated fatty acid diet (MUFA-olive oil) and polyunsaturated fatty acid diet (PUFA-corn oil).

Relative percentages of fatty acids in the polar lipid fraction isolated from the examined lung tissue samples are shown in Table 2. Similar to total lipids, phospholipids were individual fatty acids affected by the type of dietary oils in the examined tissue. As showed in Table 2, palmitic acid predominated in the fatty acid composition of PL species in lung tissue samples.

The differences depended on dietary fats intake. Palmitic (16:0) and stearic (18:0) fatty acids were major saturated fatty acids (SFA) in polar lipids in the lung tissue. In the FOO- and FCO groups, the content of saturated fatty acids was lower than in the control group. Feeding lipid-supplemented diet reduced $C_{18:2}/C_{20:4}$ ratio in the FOO- and increased in FCO groups. The PUFA/MUFA and PUFA/SFA ratios in the FCO group were more increased than in the control group. The oleic acid and

*Table 1. Fatty acid profiles of supplemented oils of enteral diets**

Fatty acid	% of Total Fatty Acids	
	MUFA-diet	***PUFA-diet***
Myristic ($C_{14:0}$)	Trace	Trace
Palmitic ($C_{16:0}$)	12.7	13.1
Palmitooleic ($C_{16:1n-7}$)	1.5	Trace
Heptadecanoic ($C_{17:0}$)	Trace	0.5
Stearic ($C_{18:0}$)	3.7	5.9
Oleic ($C_{18:1n-9}$)	70.7	27.0
Linoleic ($C_{18:2n-6}$)	9.7	51.4
Arachidic ($C_{20:0}$)	Trace	0.5
Linolenic ($C_{18:3n-3}$)	0.4	0.9
Eicosenoic ($C_{20:1n-9}$)	0.6	0.7
Behenic ($C_{22:0}$)	0.3	Trace
Erucic ($C_{22:1n-9}$)	0.4	Trace
Lignoceric ($C_{24:0}$)	Trace	Trace

Percentage of individual fatty acids in each type of supplemented oils diet fed to three groups of mice (Control group, standard diet; FOO-group, olive oil diet (MUFA-diet); FCO-group, corn oil diet (FCO-diet). Trace is < 0.05%.

Table 2. Fatty acid composition (%) of the total phospholipids in the mice lung tissue samples in the control and after feeding diets supplemented with 5% olive oil (FOO) and 5% corn (FCO)

Fatty acid	Control	FOO group	FCO group
Myristic ($C_{14:0}$)	1.00±0.09	0.88±0.24	1.21±0.35
Myristoleic ($C_{14:1n-5}$)	0.00	0.00	0.00
Palmitic ($C_{16:0}$)	48.86±1.21	41.91±3.49	46.77±1.13
Palmitoleic ($C_{16:1n-7}$)	4.09±0.05	3.32±0.61	3.06±0.18
Stearic ($C_{18:0}$)	8.93±0.34	10.66±0.87	9.72±0.37
Oleic ($C_{18:1n-9}$)	10.85±0.67	13.50±0.18	9.75±0.96
Linoleic ($C_{18:2n-6}$)	6.80±0.36	7.40±0.81	9.25±0.35
Arachidic ($C_{20:0}$)	0.23±0.09	0.22±0.14	0.19±0.10
γ-linolenic ($C_{18:3n-6}$)	0.37±0.21	0.52±0.16	0.34±0.11
Eicosenoic ($C_{20:1n-9}$)	0.00	0.00	0.00
Behenic ($C_{22:0}$)	0.00	0.00	0.00
Eicosadienoic ($C_{20:2n-6}$)	0.44±0.05	0.40±0.11	0.61±0.10
Homo-γ-linolenic ($C_{20:3n-6}$)	0.58±0.10	0.78±0.20	0.76±0.08
Arachidonic ($C_{20:4n-6}$)	7.10±0.35	8.34±1.67	7.33±0.41
Eicosapentaenoic ($C_{20:5n-3}$) (EPA)	1.27±0.29	0.58±0.02	0.49±0.06
Lignoceric ($C_{24:0}$)	0.33±0.15	0.45±0.08	1.24±1.15
Docosahexaenoic ($C_{22:6n-3}$) (DHA)	9.15±0.41	11.04±1.11	9.28±1.02
Total saturated (SFA)[a]	59.35	55.13	61.6
Total monounsaturated (MUFA)[a]	14.94	18.06	12.87
Total polyunsaturated (PUFA)[a]	25.71	26.81	25.97
PUFA/SFA[a]	0.43	0.49	0.42
PUFA/MUFA[a]	1.72	1.48	2.02
$C_{18:2}/C_{20:4}$[a]	0.96	0.92	1.35
Eicosanoid precursor ratio	0.26±.017	0.17±0.02	0.19±0.04

Data are means ±S.D. (n=6 per group); [a] average value.
Eicosanoid precursor ratio was calculated according Palombo et al.[2]

palmitic acid contents were significantly increased in the MUFA diet than in the control. Oleic acid was the major monounsaturated acid in the lung polar lipid tissue. Docosahexaenoic acid was the major polyunsaturated acid in the lung tissue sample. A higher content of docosahexaenoic acid was present in the FOO group than in the control and FCO group. Linoleic, eicosadienoic and lignoceric acid contents significantly increased and eicosapentaenoic acid decreased in the FCO group. The lung unsaturated and saturated fatty acids significantly depended on the diet in the FOO group and monounsaturated in the FCO group. In the present study, the eicosanoid precursor ratios in the lung tissues from the mice receiving either the FOO- or FCO group did not depend significantly on the diet, as was the situation with the eicosanoid precursor ratio in the lung tissue from the mice receiving the standard diet. It is to conclude that the dietary enriched oils, type PUFA and MUFA did not affect the total fatty acid composition in the total phospholipids of the lung tissue.

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