EFFECT OF DIETARY CHOLESTEROL AND OXIDATION PRODUCTS ON METABOLICAL CHANGE OF THE LIVER TISSUES IN RABBITS

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Background

Liver plays an important role in maintaining whole-body cholesterol homeostasis by controlling uptake of extracellular cholesterol, cholesterol synthesis and storage of cholesterol (Dietschy et al., 1993). Gordon et al. (1988) reported that cholesterol-fed New Zealand White rabbits had distortion of hepatic cellular architecture from severe fat deposition in the livers, fat deposition in hearts were similar to that in the livers. Alterations in hepatic cholesterol homeostasis by dietary or drug interventions significantly influence whole body cholesterol balance and plasma low density lipoproteins (LDL) cholesterol levels (Sun et al., 1999). Thus, dietary cholesterol and cholesterol oxidation products (COPs) should important for health because the LDL cholesterol levels are positively correlated with risk of cardiovascular disease. Dietary cholesterol enters the body by way of the chylomicron pathway and is removed from the plasma by the liver as a component of chylomicron remnants (Paik and Blair; 1995). Therefore the metabolical change of liver tissues should barometer for potential risk to atherosclerosis and coronary heart disease (CHD) but still largely unknown the relationship between atherosclerosis and metabolical changes of liver tissues and the type of cholesterol and liver metabolical changes of liver tissues.

Objectives

The objectives of this study were the establish a relationship between dietary cholesterol and COPs on cholesterol , COPs, fatty acid levels of liver tissues in rabbits.

Methods

In the first study, a total of 40 male New Zealand White rabbits were divided into 5 groups and fed commercial rabbit chow added with none, 1g CHO, 0.9g CHO+0.1 COPs, 0.8 g CHO+0.2g COPs, 0.5g CHO+0.5g COPs per kg diet. In the second study, a total of 24 male New Zealand White rabbits were divided into 3 groups and fed a diet containing 2g CHO, 1.6g CHO+0.4g COPs, or 1.2g CHO+0.8g COPs per kg diet. The COPs method (Ahn et al, 1999) was used to determine the extend of cholesterol oxidation in liver tissue. Cholesterol and fatty acid was determined by the modified AOAC. Data were analyzed using the generalized liear model procedure of SAS software (SAS itute 1996) Student-Newman-Keuls multiple range test. Significance was defined at $P<0.05$.

Results and discussions

The cholesterol content were significantly ($P<0.05$) increased with dietary cholesterol and COPs in all diet groups but 1.2 chol. + 0.8 COPs diet group did not changed significantly between feeding periods. Both 6 week and 12 week, high levels of cholesterol in diet significantly ($P<0.05$) increased in cholesterol content of liver than the low levels of cholesterol in diet. In the present study we suggest that animals with a high response to dietary cholesterol and COPs have a higher efficiency of cholesterol absorption in liver. The levels of COPs significantly ($P<0.05$) increase with increased of feeding periods all of the treatments. Both At the 6 weeks and 12 weeks, the levels of COPs was significantly($P<0.05$) highest in 1.2chol + 0.8COPs followed by 0.5chol + 0.5COPs group or 1.6chol + 0.4COPs group and 0 g group significantly ($P<0.05$) lowest among the treatments. We can suggest that the levels of COPs in liver depend on amounts of COPs in diets but amount of cholesterol in diets should less. The composition of fatty acids in liver was markedly influenced by dietary cholesterol and COPs. The major change of fatty acids composition in liver were an increase unsaturated fatty acid and decrease in saturated fatty acid. Dietary COPs had stronger effect on the fatty acid composition of liver than cholesterol. The percentage of palmitoleic acid linolenic acid increased ($P<0.05$), whereas that of stearic acid decreased ($P<0.05$) with dietary cholesterol and COPs.

Conclusions

The metabolisms of liver were quite altered with dietary cholesterol and COPs. Amounts of cholesterol in liver were significantly increased with the levels of cholesterol in diet but COPs in diet should less effect. The COPs of liver increased with dietary cholesterol and COPs, especially, the amount of COPs in diet have more effects than cholesterol on increased of COPs values. The percentage of palmitoleic acid linolenic acid increased, whereas that of stearic acid decreased with dietary cholesterol and COPs. More research is needed to determine the effect of dietary cholesterol on lipid metabolism in liver and their relation to the induce the liver lesion in animal models.

Pertinent literature

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Table 1. Effect of dietary cholesterol and cholesterol oxidation products on cholesterol content in liver.

Dietary Chol[1)]+COPs g/kg diet	Cholesterol in liver		
	6 week	12 week	SEM
		mg/g	
Experiment 1			
0 g	1.123^{by}	3.120^{az}	0.156
1g chol	3.231^{bx}	16.727^{aw}	0.405
0.9chol+0.1COPs	2.787^{bx}	10.737^{ax}	0.813
0.8chol+0.2COPs	2.271^{bxy}	9.004^{axy}	0.714
0.5chol+0.5COPs	2.580^{bx}	6.890^{ay}	0.948
Experiment 2			
2g chol	17.795^{bv}	27.735^{av}	0.940
1.6chol+0.4COPs	11.072^{bw}	16.218^{aw}	0.894
1.2chol+0.8COPs	10.558^{w}	11.665^{x}	0.555
SEM	0.446	0.929	-

Table 2. Effect of dietary cholesterol and cholesterol oxidation products on cholesterol oxidation products in liver.

Dietary Chol[1)]+COPs g/kg diet	COPs in liver		
	6 week	12 week	SEM
		µg/g	
Experiment 1			
0 g	Trace	0.048^{z}	0.003
1g chol	0.030^{by}	0.068^{ay}	0.005
0.9chol+0.1COPs	0.042^{bx}	0.074^{ay}	0.004
0.8chol+0.2COPs	0.055^{bw}	0.094^{ax}	0.005
0.5chol+0.5COPs	0.055^{bw}	0.096^{awx}	0.004
Experiment 2			
2g chol	0.053bwx	0.109^{awx}	0.006
1.6chol+0.4COPs	0.054bwx	0.112^{aw}	0.006
1.2chol+0.8COPs	0.082bv	0.146^{av}	0.006
SEM	0.004	0.006	-

[a,b,c,d,e] Different letters within a row are significantly different ($P<0.05$).

[v,w,x,y,z] Different letters within a column are significantly different ($P<0.05$).

[1)] chol: natural cholesterol

Table 3. Effect of dietary cholesterol and cholesterol oxidation products on fatty acid composition in liver

	Study 1					Study 2			
Fatty acid	0g cho	1g cho	0.9 cho+ 0.1 COPs	0.8 cho+ 0.2 COPs	0.5 cho+ 0.5 COPs	2g cho	1.6 cho+ 0.4 COPs	1.2 cho+ 0.8 COPs	SEM
	Fatty acid (%)								
Myristic acid	0^{d}	0^{d}	0^{d}	0^{d}	0^{d}	0.40^{c}	0.63^{a}	0.47^{b}	0.01
Palmitoleic acid	1.10^{e}	1.95^{d}	2.35^{bc}	2.40^{bc}	2.05^{cd}	2.30^{bc}	2.93^{a}	2.66^{ab}	0.10
Palmitic acid	20.46^{c}	22.39^{a}	21.37^{b}	21.81^{b}	21.42^{b}	20.82^{c}	19.27^{d}	19.32^{d}	0.18
Linoleic acid	29.42^{c}	27.95^{d}	26.85^{e}	27.96^{d}	29.42^{c}	31.41^{b}	31.11^{b}	32.32^{a}	0.31
Oleic acid	16.66^{c}	20.03^{b}	21.50^{a}	19.99^{b}	18.95^{b}	18.62^{b}	19.56^{b}	18.99^{b}	0.36
Linolenic acid	2.29^{b}	3.34^{ab}	3.44^{ab}	3.57^{a}	3.78^{a}	3.57^{a}	3.45^{ab}	3.58^{a}	0.13
Stearic acid	22.92^{a}	18.18^{b}	18.67^{b}	17.80^{b}	17.84^{b}	15.89^{c}	15.69^{c}	15.56^{c}	0.29
Arachidonic acid	6.27^{a}	5.03c	4.99^{c}	5.17^{c}	5.11^{c}	5.63^{b}	5.54^{b}	5.58^{b}	0.12
Unidentified	0.90^{b}	0.94^{ab}	0.84^{bc}	0.92^{ab}	1.03^{a}	0.96^{ab}	0.79^{c}	0.89^{bc}	0.12
SFA/USFA	43.38/ 55.74	40.57/ 58.30	40.04/ 59.13	39.61/ 59.09	39.26/ 59.31	37.11/ 61.53	35.59/ 62.59	35.26/ 63.13	-