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SHORT COMMUNICATION

Dose-Dependent Hypocholesterolaemic Effect of Oyster Mushroom (Pleurotus ostreatus) in Rats

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Summary

A highly significant negative correlation ($r = -0.981$, $p < 0.001$) between the amount of oyster mushroom (*Pleurotus ostreatus*) in the diet and cholesterol levels in the serum has been found in male Wistar rats fed shortly after weaning by a a diet with 0.3 % cholesterol. The addition of 1.0, 2.5 and 5.0 % of oyster mushroom to the diet reduced the levels of serum cholesterol by 11, 31 and 46 %, respectively. The diet containing 5 % of oyster mushroom suppressed cholesterol accumulation in the liver and increased the fraction of cholesterol carried by high-density lipoproteins.

Key words

Oyster mushroom – Cholesterol – Serum – Lipoproteins – Liver – Heart – Aorta

It is generally accepted that lowering of serum cholesterol levels plays a key role in the prevention of atherosclerosis (Gould *et al.* 1995). Modification of the nutritional regime and application of natural substances with hypocholesterolaemic activity are two important approaches to the prevention and treatment of hypercholesterolaemias of various etiology. We have shown in a series of studies that the addition of oyster mushroom (*Pleurotus ostreatus*; a wood-rotting fungus produced on an industrial basis) to the diet of rats inhibits very effectively the development of nutritionally-induced hypercholesterolaemia and the accumulation of cholesterol in the liver (Bobek *et al.* 1991, 1993). With respect to the perspective application of experimental results to the clinical studies we decided to investigate the dependence of this hypocholesterolaemic effect on the concentration of oyster mushroom in the diet.

Male Wistar rats (Top-Velaz, Czech Republic, $n = 40$) with initial body weight about 60 g were used in the experiments. The animals were fed *ad libitum* with a semisynthetic diet (Yamashita *et al.* 1980) of the following composition (g/100 g): starch 60, casein 18, pork fat 10, cellulose 6, mineral and vitamin mixtures, 4 and 1, respectively, Fel tauri 0.55, cholesterol 0.3 and choline chloride 0.15 (control diet). In the experimental diets, 1.0, 2.5 and 5.0 % of dried powdered oyster mushroom fruiting bodies were substituted for cellulose. After 8 weeks, animals fasted for 18 hours and were then killed by decapitation. The cholesterol content in the serum and lipoproteins was determined by the kit Oxochrom 250 E (Czech Republic) and cholesterol content in chloroform-methanol (2:1) extracts of selected tissues by Bio-La-Test (Lachema, Brno, Czech Republic). The content of triacylglycerols in serum and selected tissues was estimated by test kits of the same provenance.

The diet containing the oyster mushroom did not affect the final body weight of experimental animals during the 8-week period. The oyster mushroom present in the diet in amounts of 1.0, 2.5 and 5.0 % reduced cholesterol levels in the serum by 11 % (not significant), 31 % and 46 %, respectively. A closed negative correlation ($r = -0.981$, $p < 0.001$) was found between serum cholesterol levels and the oyster mushroom content in the diet. Very-low-density

lipoproteins (VLDL) were the dominant serum cholesterol carrier in animals fed the diet containing 1 and 2.5 % oyster mushroom. An increase of the oyster mushroom content in the diet to 5 % significantly reduced the concentration of these lipoproteins as well as their contribution to total cholesterol transport (by almost 40 %). On the other hand, feeding the diet containing 2.5 and 5 % oyster mushroom caused a pronounced increase of high-density lipoproteins (HDL) and their contribution to total cholesterol transport. The concentration of this lipoprotein fraction increased by about 50 % for the highest oyster mushroom dose. This dose also significantly reduced cholesterol levels in the liver, heart and aorta while the levels of triacylglycerols in the serum, liver and heart were not affected by the oyster mushroom diet (Table 1).

Table 1. The effect of increasing doses of oyster mushroom in the diet on lipid content in the serum, lipoproteins and in selected tissues of rats.

	Diet	Oyster mushroom		
	Control	1 %	2.5 %	5 %
Body weight (g)	337±13	300±12	314±12	305±17
Cholesterol (mmol/l)				
Serum	5.60±0.70	4.96±0.31	3.84±0.27[a]	3.04±0.25[c]
VLDL	3.14±0.43	2.75±0.17	1.88±0.22[b]	1.06±0.12[e]
%*	55.0±3.3	59.0±2.0	51.4±2.2	34.5±1.2[e]
LDL	1.69±0.33	1.11±0.17	0.85±0.12[a]	0.75±0.18[a]
%*	29.4±3.2	23.0±2.4	23.3±1.5	24.3±2.1
HDL	0.86±0.11	0.83±0.04	0.88±0.10	1.27±0.12[a]
%[rs]*	15.6±2.2	18.0±0.6	25.3±3.6[a]	41.2±3.2[e]
Cholesterol (mmol/kg)				
Liver	326±19	327±19	276±32	232±12[e]
Heart	7.60±0.62	6.02±0.30	6.65±0.70	5.11±0.11[e]
Aorta	4.04±0.15	3.96±0.16	3.58±0.10	3.62±0.09[a]
Triacylglycerols (mmol/l)				
Serum	0.43±0.04	0.54±0.04	0.37±0.02	0.44±0.03
Triacylglycerols (mmol/kg)				
Liver	37.3±6.0	42.9±10.9	32.6±5.7	37.0±10.0
Heart	3.94±0.39	3.89±0.68	3.47±0.45	4.22±0.66

*Values are means ± S.E.M., for 10 animals in all groups. Lipoproteins were isolated by flotation technique on ultracentrifuge at $d<1.006$ (VLDL), $d<1.063$ (VDL) and $d<1.21$ g.ml^{-1} (HDL). *Contribution to total serum cholesterol. Statistical significance of differences compared with the control diet: $^{a}p<0.05$, $^{b}p<0.02$, $^{c}p<0.01$, $^{d}p<0.002$, $^{e}p<0.001$.*

These results have unequivocally proved that the hypocholesterolaemic effect of oyster mushroom is dose-dependent with the lowest effective concentration being between 1–2.5 % of oyster mushroom in the diet. The increasing of oyster mushroom content in the diet above 5 % gradually reduced food intake by the experimental animals. The dose of 5 % oyster mushroom was therefore chosen for a series of experiments which proved that oyster mushroom affects several key steps in the regulation of cholesterol metabolism. Reduced production and accelerated catabolism of cholesterol-enriched VLDL plays a fundamental role in the regulation of blood cholesterol levels (Bobek and Ozdín 1994, 1996). The production of primary lipoproteins is influenced by reduced cholesterol absorption as well as its biosynthesis in the liver (Bobek *et al.* 1994a, 1995). Cholesterol absorption was affected by the effect of predominantly water-soluble components of fibrous matter (beta-glucans,

pectin). By their ability to sequester bile acids, these components are able to suppress the formation of micelles necessary for lipid absorption. Increased excretion and reduced enterohepatal circulation of bile acids accelerates cholesterol catabolism by a feedback mechanism (Vahouny *et al.* 1980, Bobek *et al.* 1994b). Decreased cholesterol biosynthesis is significantly affected by reduction of the activity of the key enzyme HMG-CoA reductase by mevinolin present in the oyster mushroom (Gunde-Cimerman *et al.* 1993). The mechanism by which the oyster mushrooms increased HDL concentration and the contribution of these lipoproteins to cholesterol transport by the oyster mushroom is not clear yet. The hypocholesterolaemic effect of oyster mushroom is comparable to the effect of a related wood-rotting fungus shii-take (*Lentinus edodes*) (Kaneda and Tokuda 1966). The experiments performed 30 years ago have shown that 5 % of the fungus in the cholesterol diet reduced hypercholesterolaemia by 64 % after 10 weeks and by 35–46 % after 30 weeks of feeding. The reduction of serum cholesterol levels was distributed proportionally to all lipoprotein classes. Decrease in cholesterolaemia was accompanied by a simultaneous increase in cholesterol and triacylglycerol levels in the liver. In this respect, oyster mushroom appears to be more beneficial as a hypolipidaemic agent since it causes a shift from the atherogenic lipoprotein profile to a profile with HDL as the dominant cholesterol carrier which resembles the physiological situation induced by a standard diet. In addition, oyster mushroom induced a favourable reduction of the cholesterol content in the liver, heart and aorta and did not increase triacylglycerol levels in the liver. Whereas the mechanism of the hypocholesterolaemic effect of shii-take has not yet been clarified and there is no reference about its clinical use, our ongoing clinical study indicates that 15–20 g of dried oyster mushroom supplemented daily for a period of 1 month increases the fraction of probands with reduced hypercholesterolaemia in some patients (Bobek *et al.* nnpublished data).

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