Cardiac phospholipid composition during continuous administration of ethanol to mice: effect of vitamin E

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Continuous administration of ethanol to mice causes a reduction in the proportion of polyunsaturated fatty acids found in phospholipids of brain synaptosomes (Littleton & John, 1977). Here we report changes in cardiac phospholipid composition produced by ethanol. These changes may affect the physical characteristics of myocardial membranes and could explain some pathological effects of ethanol at the cellular level.

Male TO mice (20–25 g) were exposed to ethanol vapour as previously described (Griffiths, Littleton & Ortiz, 1974). Exposure for 10 days produced physical dependence on ethanol. Mice were killed by immersion in liquid nitrogen, hearts removed, sliced and surface blood removed, before phospholipid analysis (see Littleton & John, 1977). Results, shown in the table, indicate a profound reduction in the proportion of docosahexaenoic acid (22:6) and significant increases in oleic (18:1) and linoleic (18:2) acids in cardiac phospholipids of ethanol-dependent mice. These results show similarities with those obtained in the rat during prolonged feeding of ethanol-containing diets (Reitz, Helsabeck & Mason, 1973).

Three mechanisms are favoured for this ethanol-induced reduction in proportion of polyunsaturated fatty acid. It may represent cellular adaptation to the fluidizing effects of alcohols on membranes (see Hill & Bangham, 1975) inhibition of desaturation–elongation reactions for fatty acids, or increased lipid peroxidation produced by ethanol (see Di Luzio, 1973).

In subsequent experiments we have demonstrated a significant reduction in docosahexaenoic acid in heart phospholipids when mice are exposed to ethanol vapour (15 mg/l) for as little as 10 hours. Pretreatment with a large dose of vitamin E (D-α-tocopherol, Sigma Type I) prevented this change (see table). This protection suggests that lipid peroxidation is involved, but other effects of vitamin E on membrane lipids cannot be discounted. Even if lipid peroxidation is involved in the ethanol-induced change, the relationship need not be direct. The rate at which membrane lipid composition can be changed (whether for adaptation or as an incidental result of altered production of fatty acids) may depend on the rate of loss of fatty acids from the membrane by processes including peroxidation.

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Table 1 Percentage fatty acid composition of cardiac phospholipids during continuous administration of ethanol

Fatty acid	*Control*		*Ethanol administration*		
	No treatment	*Vitamin E*	*Dependent*	*10 h*	*10 h + vit. E*
16:0	17.9 ± 1.3	20.0 ± 1.1	18.5 ± 1.9	17.4 ± 0.4	17.4 ± 0.4
16:1	0.9 ± 0.1	2.1 ± 0.7	2.3 ± 0.7	0.8 ± 0.1	1.7 ± 0.5
18:0	20.4 ± 0.2	19.2 ± 0.9	19.0 ± 1.1	20.1 ± 0.4	19.5 ± 0.5
18:1	13.4 ± 0.4	11.4 ± 0.7	18.0 ± 0.6*	12.1 ± 0.6	10.6 ± 1.0
18:2	15.6 ± 0.5	11.0 ± 1.1	19.3 ± 0.8*	14.1 ± 1.5	12.3 ± 0.9
20:4	5.8 ± 0.5	5.4 ± 0.1	4.5 ± 0.9	6.0 ± 0.4	6.1 ± 0.5
22:6	24.3 ± 1.6	24.8 ± 1.8	13.9 ± 1.0*	19.6 ± 0.7*	26.6 ± 2.1

The table shows the main fatty acids (carbon chain:number of double bonds) found in cardiac phospholipids of mice, as determined by gas–liquid chromatography. Each fatty acid is expressed as a percentage (integrated peak area) of the total. Mice pretreated with vitamin E received 750 mg/kg D-α tocopherol acetate i.p. 24 h before death. All mice had free access to pelleted diet (Spiller modified 41B) and water. Values represent mean ± s.e.mean of at least 5 determinations.

* Denotes a value which, when compared with the appropriate control, achieves the level of significance $P < 0.05$ in a Student's unpaired t test.

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