

MEMBRANE LIPIDS OF A DEEP-SEA ELASMOBRANCH

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EXTENDED ABSTRACT ONLY- DO NOT CITE

Introduction

Deep-sea elasmobranchs have membranes that are challenged by high pressure, low temperature as well as the peculiar solute system (urea plus methylamines) they possess. At cold temperatures, typically organisms incorporate greater proportions of unsaturated fatty acids in the membrane phospholipids to maintain fluidity and offset the rigidity imposed by low temperature (Cossins and Macdonald, 1986). High pressure has the same effect on membranes as low temperature and it has been shown that mitochondrial membrane phospholipid fatty acids of deep-sea teleosts are even more unsaturated, than those of cold water surface-dwelling fishes (Cossins and Macdonald, 1986). Urea and methylamines the main solutes in elasmobranch tissues, have also been shown to have complex effects on membrane properties (Barton et al. 1998). Mitochondrial membrane phospholipid fatty acids of surface dwelling elasmobranchs are more saturated in comparison to those of surface dwelling marine teleosts in apparent compensation for the effects of their solute system (Glemet and Ballantyne, 1995).

In deep-sea elasmobranchs the effects of cold temperature and high pressure would be expected to require membrane phospholipid fatty acids that are highly saturated while the effects of urea would be expected to require more saturated membrane fatty acids. There have been no studies of the membranes of deep-sea elasmobranchs to establish the nature of adaptation to cold temperature and high pressure in the presence of urea. We, therefore, examined the membrane phospholipid fatty acids of the deep-sea shark (*Centroscyllium fabricii*).

Materials and Methods

Black dogfish sharks, *Centroscyllium fabricii*, were captured by otter trawl at depths of 800-1000m, off the coast of Nova Scotia, Canada. Liver and muscle tissue was excised immediately and rapidly frozen in cryovials in liquid nitrogen. Lipids were extracted using chloroform and methanol and thin layer chromatography was used to separate phospholipids. Fatty acid quantification was determined utilizing gas chromatography as described by Glemet and Ballantyne (1996).

Results

There are differences in the proportions of fatty acids classes and the n3/n6 ratios between muscle and liver mitochondria (Table 1) for all phospholipids examined. Overall the phospholipid fatty acids of the deep sea elasmobranch have a lower proportion of polyunsaturated fatty acids compared to either deep-sea fish or surface elasmobranchs and a similar unsaturation index to that of a surface elasmobranch (Table 2).

Conclusions

The combined effects of high pressure and low temperature is expected to require phospholipid fatty acids that are highly unsaturated. This is not the case with the deep-sea elasmobranch we examined. The unsaturation index of a liver mitochondrial phospholipid (cardiolipin) is lower than that of deep-sea teleost fish. The unsaturation index is similar to that of a surface elasmobranch but the polyene content is lower by 50% in the deep-sea elasmobranch. This may imply that the effects of the solute system (urea and methylamines) on phospholipid fatty acid profiles is affected by pressure. Higher levels of methylamines have been found in deep-sea elasmobranchs compared to those of surface elasmobranchs (Treberg and Driedzic, 2002). It is possible that this difference may account in part for the unusual membrane phospholipids of the deep-sea shark.

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Table 1. Percentages of phospholipid fatty acids from muscle and liver tissue of the black dogfish shark (*Centroscyllium fabricii*). N=7 for muscle and N=6 for liver except cardiolipin (n=2) and PE (n=5).

	Saturates	Monoenes	Polyenes	n3/n6	Unsaturation index ^a
Cardiolipin					
Liver	36.3±12.8	46.0 ± 9.1	17.7 ± 3.6	4.3 ± 1.5	124.0 ± 27.5
Muscle	22.3±3.5	48.8 ± 6.0	28.9 ± 9.0	7.3 ± 2.4	188.9 ± 31.08
Phosphatidyl ethanolamine					
Liver	32.9±7.9	24.2 ± 3.9	42.9 ± 6.3	2.9 ± 0.3	242.7 ± 32.8
Muscle	17.3 ± 1.0	30.1 ± 7.6	52.6 ± 6.8	11.1 ± 1.3	330.7 ± 31.5
Phosphatidyl inositol					
Liver	36.5 ± 1.0	23.6 ± 2.2	39.9 ± 1.7	0.5 ± 0.1	192.8 ± 6.1
Muscle	23.0 ± 4.5	14.9 ± 5.3	62.1 ± 8.8	1.9 ± 0.2	325.4 ± 39.9
Phosphatidyl serine					
Liver	37.6 ± 4.4	26.2 ± 1.4	36.2 ± 5.8	9.6 ± 2.2	213.6 ± 23.9
Muscle	34.3 ± 2.2	28.6 ± 2.0	37.1 ± 2.1	9.3 ± 2.4	227.8 ± 16.7
Phosphatidyl choline					
Liver	36.1 ± 1.4	16.5 ± 1.0	47.5 ± 1.1	4.4 ± 0.6	257.2 ± 4.9
Muscle	32.0 ± 0.9	30.3 ± 0.7	37.7 ± 1.1	5.6 ± 0.7	226.9 ± 8.2

Percentages presented as mean \pm SEM

^aUnsaturation Index = $\sum m_i n_i$; where m_i is the mole percentage and n_i is the number of carbon-carbon double bonds of the fatty acid.

Table 2. Classes of phospholipid fatty acids from the cardiolipin portion of liver tissue from a deep-sea elasmobranch *C. fabricii*, the surface elasmobranch *R. erinacea* and 3 species of deep-sea teleost fish (*L. eques*, *P. blennoides* and *A. bairdii*).

	<i>Raja erinacea</i> (Glemet and Ballantyne, 1996)	<i>C. fabricii</i> (present study)	<i>Lepidion eques</i> (Cossins and Macdonald, 1986)	<i>Phycis blennoides</i> (Cossins and Macdonald, 1986)	<i>Alepocephalus bairdii</i> (Cossins and Macdonald, 1986)
Saturates	42.2 \pm 2.2	36.3 \pm 12.8	29.9	13.3	12.9
Monoenes	29.1 \pm 0.8	46.0 \pm 9.1	14.0	22.9	21.4
Polyenes	28.8 \pm 1.9	17.7 \pm 3.6	45.3	50	53.5
n3/n6	1.6 \pm 0.2	4.3 \pm 1.5	-	-	-
Unsaturation index	117.2 \pm 4.0	124.0 \pm 27.5	261.2	292.4	313.4

