Lipids in the Flesh of Cod (Gadus morhua L.) from Faroe Bank and Aberdeen Bank in Early Summer amd Autumn

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Lipids in the Flesh of Cod (*Gadus morhua* L.) from Faroe Bank and Aberdeen Bank in Early Summer and Autumn

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Abstract

Lipid was shown to be more concentrated in the musculature of cod from the Faroe Bank than in that from Aberdeen Bank. It was most concentrated in the dark muscle, less in white muscle and least in myocommata. The concentration increased between early summer and autumn, largely because of changes in the phospholipid fraction.

Lipid is present in relatively large concentrations in the liver of cod, and has been much studied in this organ. On the other hand, the concentration in the musculature is usually less than 1%, so it has tended to be ignored in publications.

In spite of the minute concentrations involved in muscle, well-marked seasonal cycles have been demonstrated in Canadian cod by Dambergs[1] and by Castell and Bishop[2], an annual minimum being clearly defined in April. In each case whole musculature was taken for analysis, but in fact neither the musculature nor the lipids are uniform in composition. It was therefore felt that a preliminary study should be undertaken to see how the lipid content varied seasonally in specific tissues and what were the relative contributions of the phospholipid and non-phospholipid fractions.

Cod from the Faroe Bank (60–53N; 08–20W) and Aberdeen Bank (57–05N; 01–15W) were used in the study, Faroe Bank cod apparently being unusually well nourished (Love et al.[3]) while those from Aberdeen Bank were more typical of fish from other grounds in the North Atlantic.

Methods

White muscle, dark muscle and, for the first time, myocommata were separated for analysis, the latter by the method described by Love et al.[4]. The fish were obtained at the beginning of June so as still to show some of the symptoms of depletion from spawning, and in September, when they would be nutritionally at their best.

In June, 20 fish about 60 cm long were obtained from each ground and in September 2 large cod were obtained from the Faroe Bank (84 and 105 cm in length) and 7 cod ranging from 46 to 63 cm in length from Aberdeen Bank. All samples were kept

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at −30° until required.

The extraction of the total lipids was carried out by the method of BLIGH & DYER[5], HANSON & OLLEY[6] and lipid fractionation as described by HARDY et al.[7].

Results and Discussion

The total lipids from the three tissues of cod from the two localities are shown in Table 1.

As already shown by others (reviewed by LOVE[8]), the dark muscle contains more lipid than the white and, as now shown, the myocommata contain less. With the exception of dark muscle in June-caught fish, the lipid values from Faroe Bank cod are always higher than the corresponding values from Aberdeen Bank cod, and furthermore the various tissues of the fish caught in September all contain more lipid than those of fish caught earlier.

Table 1. Total lipid (%) in cod muscle components in early summer and autumn.

	Faroe Bank	Aberdeen Bank
1. Summer caught		
White muscle	0.63	0.55
Dark muscle	1.74	1.85
Myocommata	0.42	0.41
2. Autumn caught		
White muscle	0.78	0.67
Dark muscle	2.14	1.87
Myocommata	0.64	0.61

(The reproducibility of the extraction technique is within ±5%: R. Hardy, unpublished).

The relative proportions of the different tissues in the whole musculature can be quantified in the case of myocommata but at present only roughly so in dark muscle. LOVE and LAVÉTY (unpublished) have shown from hydroxyproline analyses that the proportion of myocommata averaged over all the fillet is about 2%, so it is not an important organ for lipid storage. GREER-WALKER[9] showed from cross-sections of whole fish that dark muscle formed 17% of the musculature of cod just anterior to the last dorsal fin, and LOVE et al.[3] gave a value of over 30% in the caudal region, but as there is much less in the anterior part, it cannot be regared as forming more than 10% of the *total* musculature of this species-probably somewhat less.

Most of the lipid of the musculature therefore resides in the white muscle, although the biggest change appears to be in the myocommata (Table 1).

The lipid extracts were then fractionated into phospholipid and non-phospholipid classes, which may be considered to represent roughly the structural and the depot

Table 2. Major lipid fractions in cod muscle components (% of total lipids; actual amounts in g/100 g tissue in parenthesis).

	Faroe Bank		Aberdeen Bank	
	Non-phospholipid	Phospholipid	Non-phospholipid	Phospholipid
1. Summer caught				
White muscle	51.0 (0.32)	49.0 (0.31)	49.7 (0.27)	50.3 (0.28)
Dark muscle	20.8 (0.36)	79.2 (1.38)	48.5 (0.90)	51.5 (0.95)
Myocommata	88.3 (0.37)	11.7 (0.05)	87.3 (0.36)	12.7 (0.05)
2. Autumn caught				
White muscle	35.1 (0.27)	64.9 (0.51)	28.1 (0.19)	71.9 (0.48)
Dark muscle	52.9 (1.13)	47.1 (1.01)	34.0 (0.64)	66.0 (1.23)
Myocommata	46.7 (0.30)	53.3 (0.34)	41.3 (0.25)	58.7 (0.36)

lipid components respectively (Table 2).

The results were unexpected in that white muscle and myocommata showed an increase in phospholipids with improvement in nutritional state in the autumn. One would normally expect an increase in depot lipids (non-phospholipid) under these circumstances. Explanations of the change in phospholipid will have to await more detailed investigation, but in fact the results complement those of J. OLLEY (unpublished, quoted by WILKINS[10]) who found that it was the phospholipids rather than the neutral lipids which declined during the artificial starvation of cod.

More detailed analysis of the lipid classes was carried out in a qualitative manner, and it was found that the major phospholipids present were phosphatidyl choline, phosphatidyl ethanolamine and sphingomyelin, while the major non-phospholipids were sterols, free fatty acids, sterol esters and di- and tri-glycerides. It was noticeable that triglycerides did not form the major fraction of the non-phospholipids, although they normally predominate in depot lipids. In the present work, sterols and sterol esters were found present in greater amounts.

It would seem important to assess these changes quantitatively on a much larger group of fish to see how they relate to seasonal changes in their physiology as well as to the nutritional abundance of the locality.

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