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Hake roe lipids: composition and changes following cooking

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Lipid content and composition of raw and cooked Southwest Atlantic hake (*Merluccius hubbsi*) roe were studied. Raw hake roe was high in lipids (6·6% on a dry weight basis). The major lipids were waxes (27·6%), triacylglycerols (42·0%), cholesterol (5·7%) and phospholipids (14·0%). Cooking roes in water does not change these values significantly. The fatty acid composition is characteristic of marine oils with a total amount of 45% of polyunsaturated fatty acids (PUFA). Hake roes constitute a valid alternative to enrich PUFA in the normal diet.

INTRODUCTION

The word 'roe' refers to the gonads of some fish in the pre-spawning season, which are used as food and in many countries are considered as a highly prized delicacy. In Uruguay the Southwest Atlantic hake (*Merluccius hubbsi*) roe, which is boiled in water and seasoned, is usually consumed during the autumn (March–June).

Previous workers have studied the edible roes from mullet (*Mugil cephalus*), orange roughy (*Hoplostethus atlanticus*) and white fish (*Coregonus albula*) and have recommended their use as sources of polyunsaturated fatty acids (PUFA) (Lu *et al.*, 1979; Body, 1985). The composition depends, among other factors, on the method of processing: salting, pickling, smoking, frying, etc. However, there is no such information available regarding roe from the Southwest Atlantic hake.

In this paper the effect of cooking in boiling water, on the lipid and PUFA content of hake roes, has been investigated so that its use as a source of dietary fatty acids can be evaluated.

MATERIALS AND METHODS

Sample preparation

Samples were obtained from a local shop and immediately frozen at −20°C until the analysis was carried out. Some roes were cooked in boiling water (without salt) for 5 min. Afterwards roes were removed from the water, taking care not to damage the outer membrane. Representative samples were prepared using a home-made homogenizer.

Methods

The lipid content from each sample was extracted by the method of Folch *et al.* (1957) and stored under an atmosphere of nitrogen at −20°C. The oil was fractionated in silica gel G layers (0·25 mm thickness), from Machery-Nagel (Germany). Lipids were developed using a petroleum ether/diethyl ether/acetic acid mixture (80:20:1, v/v/v) according to Christie (1989). Quantitation was carried out by means of direct densitometric measurements over the plate stained with 10% $CuSO_4$ (w/v)/8% H_3PO_4 (v/v) and heated in an oven at 140°C for 20 min. A TLC scanner, Shimadzu CS-9000, was employed and measurements were made at 360 nm.

Oils were saponified with 0·5 N NaOH in methanol (AOCS, 1988) and methylated with 14% BF_3 in methanol. Fatty acid methyl esters were analyzed in a Hewlett Packard 5840 A gas chromatograph equipped with FID and an electronic integrator. A stainless steel column packed with 10% SP 2330 in Supelcoport 100/200 mesh AW (Supelco Inc., USA) was used (3 m length and 3 mm i.d.). The programmed analysis was: 12 min at 185°C, heating until 230°C at a rate of 2°C/min, and then constant temperature (230°C).

Moisture content was determined by drying in an oven at 103°C until constant weight was obtained (approximately 10 h).

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Table 1. Oil content, moisture and lipid composition of hake fillet and roes (before and after cooking in water)

	Raw roe	Cooked roe	Raw fillet
% Oil (wet weight basis)	6·6 ± 1·4	10·6 ± 1·1	1·5
% Moisture	67	62	80
% Oil (dry weight basis)	20 ± 4	28 ± 3	7·5
Lipid fractions (g/100 g oil)			
Phospholipids	14·0	13·5	20·5
Diacylglycerols	2·1	2·9	4·3
Cholesterol	5·7	5·3	9·5
Fatty acids	8·5	3·5	16·7
Triacylglycerols	42·0	42·0	49·0
Waxes	27·6	32·6	—

Cholesterol was determined spectrophotometrically by means of the Liebermann–Burchard reaction, according to Huang *et al.* (1961).

RESULTS AND DISCUSSION

Oil content and lipid composition of raw and cooked hake roes are shown in Table 1. Raw roe contains 20% of oil (on a dry weight basis). This amount is comparable to values published by Tocher and Sargent (1984) for ripe roes of some northwest European marine fish.

The contents of major fatty acids, greater than 1%, of the oil extracted from raw and cooked roes (average of three determinations) are shown in Table 2. The relatively high wax content indicates that the nutritional requirements of the larvae differ from those of fish (Iyengar & Schlenk, 1967; Body, 1985).

The purpose of cooking the roes was to determine the effect on the content and composition of lipids. The literature (Mai *et al.*, 1978) showed that the cooking of fish fillets in boiling water leads to a transport of lipids towards the cooking medium, which decreases their content (on a dry weight basis). When a microwave oven is used, the absence of a liquid cooking medium leads to a decrease in moisture only; therefore the oil content, expressed on a dry weight basis, remains constant (Hearn *et al.*, 1987).

According to this, the cooking of roes in boiling water should decrease the oil content. The results show that the content remains practically unchanged due to the fact that the outer membrane of the roes behaves as a physical barrier to the mass transport. This was confirmed experimentally. For example, experience showed that the oil content decreased from 18 ± 0·9 to 11·6 ± 0·6 (on a dry weight basis) when the roes were cooked without the outer membrane.

The cooking process did not modify the composition of the lipid fractions within the experimental error (approximately 10%). This could be explained because

Table 2. Fatty acid composition of hake fillet and roe lipids (before and after cooking in water)

Fatty acid[a]	Raw roe	Cooked roe	Raw fillet
14:0	3·7	3·2	1·0
16:0	15·5	14·8	13·4
18:0	2·0	1·3	3·9
16:1	4·9	4·5	2·2
18:1	16·1	14·8	10·8
22:1	3·9	4·8	6·3
24:1	1·8	2·4	7·0
18:2	2·4	2·4	2·3
20:4	2·2	2·4	2·8
20:5	8·2	7·5	9·4
22:4	1·5	2·1	2·8
22:5	1·8	1·9	1·5
22:6	23·2	24·2	24·7
PUFA	45·1	46·7	47·9
Saturated	22·9	21·0	21·9
Monounsaturated	31·2	31·3	30·2

[a] Number of carbon atoms:number of double bonds.

the short time of cooking and the relatively low temperature were not enough to produce hydrolysis. The content of PUFA was also not affected. Hearn *et al.* (1987) suggest some kind of interaction between the lipids and the other chemical components of the tissue which makes them resistant to autoxidation and thermal oxidation (which are typical of oils extracted from the tissue). On the other hand, boiling water reduces the concentration of oxygen dissolved and the permeability of the tissue to oxygen, which contributes to the stability of fatty acids (Aubourg & Gallardo, 1989).

From a nutritional point of view, the contents of polyunsaturated fatty acids (especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) and saturated fatty acids should be taken into account in order to compare hake roes with hake fillets. Results referred to 100 g of raw material (on a wet weight basis) are shown in Table 3. Percentages of EPA, DHA and total polyunsaturated fatty acids were calculated from Tables 1 and 2, according to Exler *et al.* (1975). These results demonstrate that hake roes are a richer source of PUFA than hake fillets. This means that, for an intake of 3 g of EPA and DHA, 167 g of raw roes is required, whereas 811 g is needed when taking raw fillets.

Like other seafoods, such as roes of *Mugil cephalus*

Table 3. PUFA and cholesterol contents of hake roe and hake fillet

	Raw roe (100 g)	Raw fillet (100 g)
PUFA (g)	2·6	0·5
EPA (g)	0·5	0·07
DHA (g)	1·3	0·3
Cholesterol (mg)	376	143
PUFA/saturated	2·0	2·2

(Lu *et al.*, 1979), the hake roe was high in cholesterol. Recent studies on cholesterol intake and its influence on cardiovascular diseases show that it is more important to keep a diet rich in polyunsaturated fatty acids and low in saturated fatty acids rather than a diet limited only in cholesterol (Sugano & Lee, 1989; Fremont, 1990; Damerval & Labouze, 1991). Hence it is unlikely that the cholesterol content will adversely influence the nutritional quality of hake roes.

We can conclude that hake roes are a rich source of PUFA, and therefore a valid alternative for normal diets. Cooking in boiling water does not change the oil content and composition provided that the outer membrane of the roes remains intact.

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