Influence of dry diets on reproductive performance & egg lipid composition during the first spawning season of captive pollack

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In a domestication purpose, development of dry pellets have been demonstrated to be effective for the reproduction of several fish species. Nutritional quality food is required and attention was focused in diet fatty acid content to optimise levels in n-3, n-6 PUFA, polyunsatured fatty acids in fish eggs, i.e. docosahexaenoic acid (DHA 22:6n-3), eicosapentaenoic acid (EPA 20:5n-3) and arachidonic acid (ARA 20:4n-6).

Ratios of these fatty acids were also related to reproductive performance. Pollack *Pollachius pollachius* known to be one of appreciated white fish, has been always reared by feeding on fish food (FF). Fish were used to determine their ability to spawn normally after being fed experimental diet (ED) and their egg quality in terms of fatty acid content compared with that of egg -FF.

Effect of dietary treatment on spawning performance

Fish three groups of pollack (5 females /5 males, 2.5kg & 560 mm) fed dry pellets

Food commercial broodstock pellet (9 mm pellet, Neo LF Repro 9®, Le Gouessant, France) enriched with 6% added oils :

- -capelin oil (Feedoil®), as the control diet : diet - CAP
- -5.8% capelin oil plus 0.2% arachidonic acid (Polaris®, France) : diet - ARA
- -DHA rich tuna orbital oil (Polaris®, France) : diet - DHA (Table 1)

Feeding period two months before spawning and during the spawning period (February to May).

TABLE 1 : Proximate composition of ED (A) and main fatty acids of lipids per dietary treatment (B)

(A)	CAP	ARA	DHA	(B) fatty acids	CAP	ARA	DHA
Lipid	13.2	13.8	13.1	16:0 (palmitic a.)	16.0	16.1	19.3
Protein	50.4	50.1	50.2	18:1n-9 (oleic a.)	11.0	11.0	12.2
NFE*	15.0	14.2	15.3	18:2n-6 (linoleic a.)	9.0	9.0	8.2
Moisture	10.4	11.1	10.5	20:4n-6 (ARA)	0.6	1.4*	1.1
Ash	11.4	10.9	10.8	20:5n-3 (EPA)	9.6	9.6	7.9
				22:6n-3 (DHA)	12.5	12.5	19.0*
				ARA/EPA	0.06*	0.14*	0.14*
				DHA/EPA	1.30*	1.31*	2.39*

*nitrogen free extract

Eggs : no oil globule ; 14% lipid content in egg -ED (*versus* 25% in egg -FF) ; no effect on mean egg size : 1212 ± 2µm nor in mean egg dry weight : 85.3 ± 0.9µg ; effect on mean egg wet weight $_{ARA}$: 1.11mg > ww$_{DHA}$: 1.06mg > ww$_{CAP}$: 1.03mg.
Reproductive parameters : fig. 1 & fig. 2.

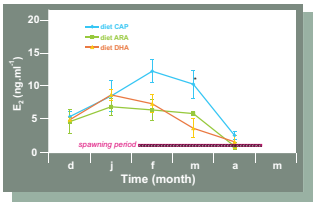


Fig.1. Plasma estradiol-17β (E_2) concentration (n = 3) in pollack females fed ED

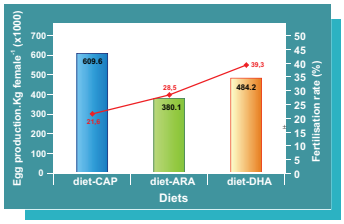


Fig. 2. Egg production & fertilisation rate of pollack fed ED

Fatty acid profiles of egg lipids from fish fed ED compared to those of fish fed FF

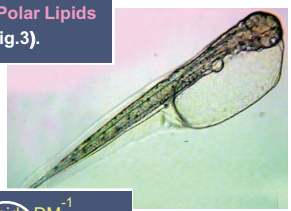
6-years-old pollack were fed with fresh or thawed fish (mainly sardine) FF. The natural food in captivity is the most similar that that which fish would find in the wild environment. Eggs were collected and fatty acid lipids analysed. A relative comparison could be only made with the content of eggs from fish fed ED.

Fatty acid saturates : palmitic a.: similar contents
Monoenes : oleic a.: increase ↗ 8% in NL, ↗ 3.6% in PL, ED
n-6 PUFA : linoleic a.: ↗ 6% in NL, ↗ 3% in PL, ED; arachidonic a.: difference (P<0.05) in egg -ED ; highest levels close to egg -FF content.
n-3 PUFA : EPA and DHA : in FF (↗ 4.9 and 6.0 in NL ; ↗ 1.7 and 3.5% in PL) ; higher n-3 HUFA in FF, balanced by low oleic acid (18:1n-9) content (fig.4). Ratio of fatty acids, table 2.

Effect of dietary treatment on egg quality over the spawning season

Egg lipids were analysed on subgroups of eggs collected at early (February), mid and late spawning season (early of May) (n = 3 x 3). Extraction of the total lipids from samples was followed by preparation of fatty acid methyl esters. Fatty acids were separated by gas chromatography, identified and quantified relatively to the internal standard.

No difference in fatty acid content related to sampling period
Slight increase ↗ of arachidonic a. over time, in Neutral lipids (NL) and Polar Lipids (PL) from eggs of diet - ARA group in NL from eggs of diet - DHA group (fig.3).



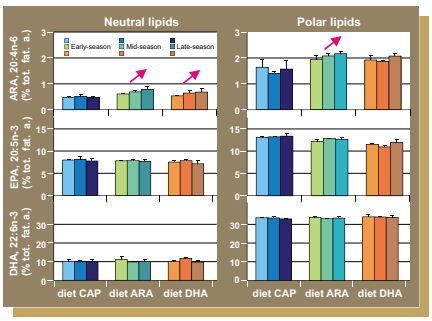


Fig. 3. Distribution of main fatty acids in neutral (NL) and polar (PL) lipids of eggs from pollack fed ED, throughout the spawning season : early, mid and late season

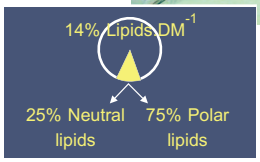


TABLE 2. Fatty acid ratios in NL and PL in eggs following ED and FF

NL	CAP	ARA	DHA	FF	PL	CAP	ARA	DHA	FF
ARA/EPA	0.06	0.09	0.08	0.06	ARA/EPA	0.12	0.16	0.17	0.12
DHA/EPA	1.27a	1.33a	1.41b	1.40	DHA/EPA	2.51a	2.66b	2.95c	2.62

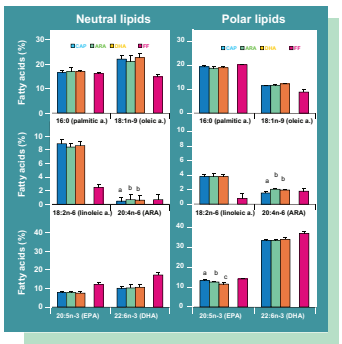


Fig.4. Comparison of fatty acid composition of eggs from pollack fed ED diet -CAP, -ARA, -DHA, and from pollack fed FF

Conclusion

Pollack fed dry pellet diet had shown reproductive success ; diet- DHA had led to the highest egg quality.

Polar lipids were lipids the most important as in eggs of the cold or temperate species.

Arachidonic and Tuna orbital oils increased ARA content, as constant effect, both in diet-ARA and diet-DHA eggs. Oil had not influenced DHA content which did not reach DHA level of eggs of the fishes fed on FF .

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Abstract:

Four year old pollack *Pollachius pollachius* L., previously fed on dry pellets since their juvenile stage, were divided into three experimental groups two months prior their first spawning season. They were fed a commercial broodstock pellet enriched with 6% added oils, either: (1) capelin oil (control), (2) capelin oil plus arachidonic acid, or (3) DHA rich tuna oil. Spawning performance was determined in each group and egg lipids were analysed. During the vitellogenic period, the estradiol levels in plasma increased with oocyte enlargement, indicating that captivity and pelleted feed did not affect reproductive capacity. Females from each group spawned spontaneously between February and May. Egg production per kg of female was highest in the control group. Fertilization rate was highest (39%) in the group fed on diet enhanced in DHA. Lipid content in eggs reached 16% of dry mass, containing mainly phospholipids (75%). Egg fatty acid profiles showed few differences between dietary treatments. There was no significant difference in the concentration of docosahexaenoic acid (22:6n − 3) between groups. Arachidonic acid (20:4n − 6) was lower in neutral and polar lipids of eggs from the control group than in the other groups. Tuna oil diet induced the highest DHA/EPA ratio in eggs and seemed to provide sufficient arachidonic acid for pollack broodstock. Egg fatty acid profiles are compared with 6 year old pollack broodstock fed on fish, and with other cultured and wild fish species.