The impact of dietary supplementation with arachidonic acid on egg quality in Atlantic cod broodstock (*Gadus morhua*, L.)

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Abstract: This study investigated supplementation of Atlantic cod broodstock diets with arachidonic acid (ARA). This resulted in a rapid increase in the ARA content of the eggs. Maximum concentrations were measured in eggs from fish fed the supplement for 2 months prior to peak spawning indicating that short term supplementation was effective in boosting ARA concentrations. There was no correlation between the duration of ARA supplementation and the number or quality of eggs produced. However, groups fed the ARA supplement produced higher numbers per batch of floating eggs per kg female and of fertilised eggs per kg female than the control group. The supplementation of diets with ARA provided only limited benefit in terms of improved reproductive performance.

INTRODUCTION

Differences have been identified in concentrations of arachidonic acid (20:4n-6; ARA), an essential fatty acid of the n-6 series, between eggs from wild and farmed cod (Salze et al. 2005). Pickova et al. (1997) showed that ARA concentration was correlated with hatching success and other egg quality parameters in different stocks of wild cod. Supplementation of broodstock diets with ARA has been shown to improve egg quality in halibut, sea bass and Japanese flounder.

This project investigated the impact of dietary supplementation with ARA on egg quality in cod. The experiment investigated the effect of feeding a diet supplemented with ARA, for 1, 2 or 3 months prior to peak spawning, on egg quality in wild cod in order to determine the optimum period of supplementation for best reproductive performance.

METHODS

The broodstock were kept at the Machrihanish Marine Environmental Research laboratory in four fiberglass 12m^3 tanks. The experiment used four treatment groups with 16 males and 8 or 9 females each. Group A was fed an unsupplemented control diet and Groups B, C and D were fed a diet supplemented with 3 % ARA (Vevodar® oil) DSM Nutrition Products (Basel, Switzerland) for 1, 2 or 3 months prior to peak-spawning. Fish were fed to satiation twice daily with Vitalis ® Marine Broodstock Mix), from Skretting UK.

Eggs were collected each day during the 92 day spawning period. Egg quality and fecundity was assessed using standard techniques. Samples of floating eggs were collected on 14 different dates for hatch rate and fertilization rate determination. ARA content was measured in floating eggs collected from each tank on 11-13 different dates during the spawning period.

RESULTS

1. Supplementation for more than 2 months did not provide any significant increase in egg ARA (Table 1).
2. There was no correlation between fecundity or egg quality parameters and the length of time supplementation was provided. However, there were higher numbers per batch of floating eggs per kg per female and fertilized eggs per kg female in the three tank groups fed the ARA supplement than in the single unsupplemented control tank group (Table 1 and Figure 1).
3. The performance of the control group was affected by the lack of ARA supplementation in the diet as they had the lowest egg and larval performance when compared to the pooled ARA groups (e.g. cumulative egg production, Figure 2).
4. Short term supplementation of broodstock diets with ARA for 1, 2 or 3 months before peak spawning resulted in increased concentrations of ARA in eggs (Figure 3) .

Table 1. Egg production and egg quality indicators

Group	A	B	C	D	B - D
Treatment	No ARA Control	+ARA 1 month	+ARA 2 months	+ARA 3 months	+ ARA pooled
Total no. of eggs produced/kg female	590185	738132	356707	572813	555884
No. of batches produced	61	62	50	55	56
Mean no. per batch of eggs produce/kg female	9675	11905**	7134**	10415	9818
Total weight of eggs collected (g)	24660	34220	20729	26537	27162
Total no. of collected eggs/kg female	376339	556097	320337	442727	439720
Mean no. per batch of eggs collected /kg female	6169*	8969*	6407	8045	7809
Total weight of floating eggs (g)	13118	17352	12161	13877	14463
Mean no. per batch of floating eggs/kg female	3282*	4623	3835	4283	4247*
Mean fertilisation rate % floating eggs	55%*	56%	70%*	60%	62%
Mean no. per batch of fertilised eggs/kg female	2122*	3013	2934	3045	2997*
Mean hatch rate (% floating eggs)	24	18	20	16	18
ARA (%)	1.8 ± 0.4*	2.1 ± 0.7	3.0 ± 1.2*	2.2 ± 0.5*	2.4 ± 0.5
EPA (%)	14.5 ± 2.9	12.1 ± 1.7	12.1 ± 2.5	13.2 ± 1.7	12.5 ± 0.7
DHA (%)	31.5 ± 5.9*	26.8 ± 3.8	25.3 ± 5.0*	29.1 ± 4.3	27.1 ± 1.9
DHA/EPA ratio	2.2 ± 0.2	2.2 ± 0.1	2.1 ± 0.1	2.2 ± 0.1	2.2 ± 0.13
EPA/ARA ratio	8.4 ±1.2***	6.3 ± 1.7***	4.4 ±1.1***	6.1 ± 0.8	5.6±1.5***

Egg numbers are expressed as numbers per kg female. Differences in mean weights or numbers per batch are shown as * (p<0.05), ** (p<0.01) or *** (p<0.001).

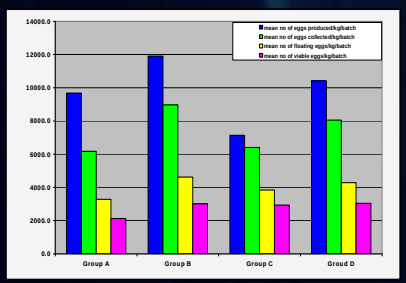

Figure 1. Egg production and egg quality parameters

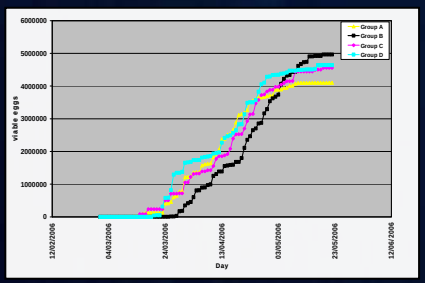

Figure 2. Cumulative egg production

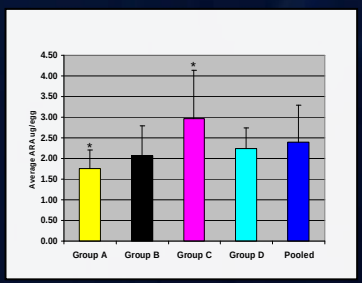

Figure 3. Arachidonic acid content in cod egg

CONCLUSIONS

- Supplementing cod broodstock diets with ARA resulted in uptake and deposition of ARA into eggs.
- Short term supplementation of the diets of cod broodstock with ARA for a period of two months prior to peak spawning resulted in the highest concentration in eggs.
- Higher numbers per batch of floating eggs/kg female and fertilised eggs/kg female were measured in groups of fish fed the ARA supplement.
- No correlation between egg production or egg quality and the duration of ARA supplementation was identified.
- The supplementation of diets with ARA to 3 % of total fatty acids provided some limited benefit but it was not a major factor for improved reproductive performance.

References

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