

Flesh quality of rainbow trout fed diets with graded replacement of fish meal and fish oil by plant ingredients

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Part of EU project :

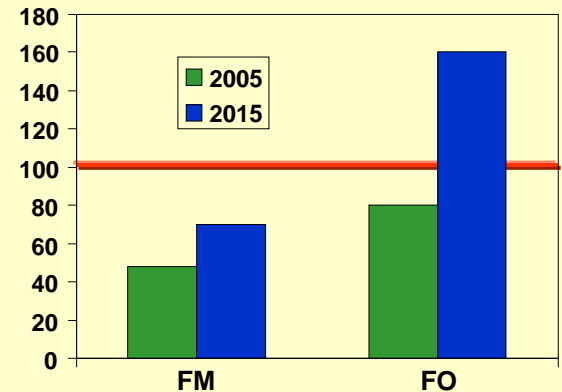


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AQUAMAX: Sustainable aquafeeds to maximise the health benefits of farmed fish for consumers

Context

- Expansion of aquaculture (> 8%/year)
- Demand for marine ingredients is increasing when availability is stable



- To reduce the use of fisheries derived products
- To find alternatives for aquaculture

Objectives

- Study the effects of **both FM and FO** replacement on growth and flesh quality:
 - * nutritional value (lipids & FA, pigments, lipid peroxidation)
 - * sensory properties (taste panel, electronic nose)

Experimental conditions

- ✓ 12 groups of 100 fish (IBW : 120 g)
- ✓ Rearing temperature : 17°C
- ✓ Fish fed by hand to visual satiation
- ✓ Duration : 12 weeks

Dietary treatments

4 diets tested:

- Diet A: 100% FM & 100% FO
- Diet B: 50% FM- PP & 50% FO-VO
- Diet C: 50% FM-PP & 100% VO
- Diet D: 100% PP & 100%VO

PP

Wheat

Soybean meal

Corn & wheat gluten

VO

Rapeseed 50%

Palm 30%

Linseed 20%

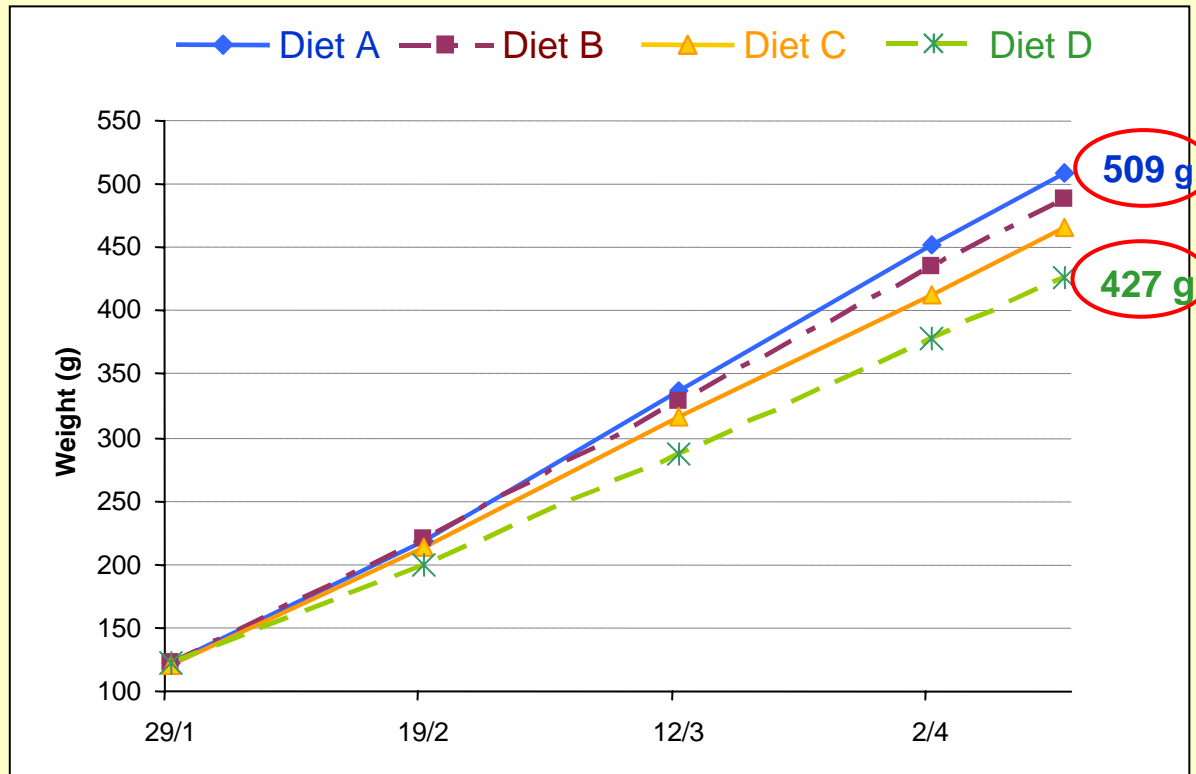
Composition of the experimental diets

	Diet A (100/100)	Diet B (50/50)	Diet C (50/0)	Diet D * (0/0)
Protein (%DM)	45.9	46.7	45.9	44.4
Lipid (%DM)	26.6	27.4	27.6	27.7
Sat	33.6	27.0	23.1	23.7
18:1	11.4	25.7	39.1	39.4
18:2 n-6	1.5	10.7	16.8	20.7
18:3 n-3	0.5	7.4	13.5	13.5
20:5 n-3	14.3	7.4	0.7	-
22:6 n-3	7.2	3.8	0.8	-

* Diet D supplemented in Lys & Arg

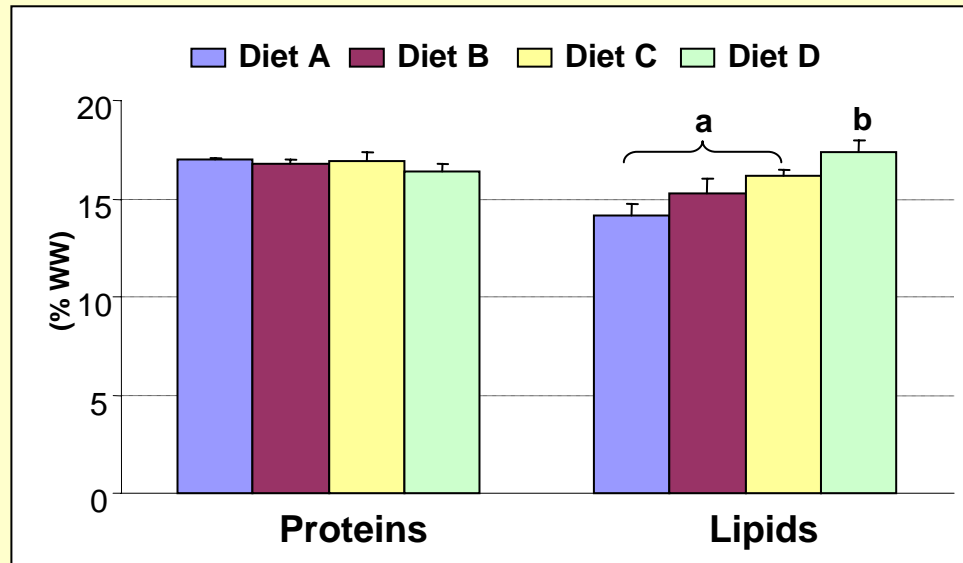
* All diets supplemented with astaxanthin (30ppm)

Growth performances of fish during the experiment



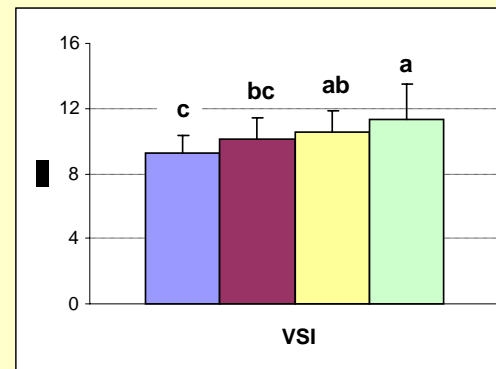
	Diet A	Diet B	Diet C	Diet D
SGR	1.93 ± 0.03 a	1.88 ± 0.01 b	1.82 ± 0.03 c	1.70 ± 0.03 d
Feed Eff.	1.17 ± 0.04 a	1.14 ± 0.02 a	1.14 ± 0.01 a	1.03 ± 0.01 b
P.E.R.	2.55 ± 0.07 a	2.46 ± 0.05 a	2.48 ± 0.02 a	2.33 ± 0.02 b

Whole body composition after 12 weeks feeding



- No difference in protein content
- Increase in body lipids when increasing level of substitution, highest content in fish fed diet D (100% PP/VO)

- Viscero somatic index higher in fish fed vegetable based diets (11 vs 9% for diet D & A)



Muscle lipid (%) and pigments content (µg/g)

	Diet A	Diet B	Diet C	Diet D
Lipid	9.2 ± 1.8	8.9 ± 1.1	9.7 ± 1.1	10.0 ± 0.8
Pigments	7.4 ± 1.3	6.9 ± 0.9	6.8 ± 0.5	6.2 ± 1.4
Astaxanthin	7.1 ± 0.4 a	5.4 ± 0.9 b	4.8 ± 0.5 b	4.8 ± 1.0 b

- No difference in total lipids and pigment contents
- Astaxanthin content lower in fish fed vegetable ingredients
 - **Presence of other carotenoids in the flesh with these diets**
- Changes in colour parameters with ↗ hue angle & ↘ chroma with PP and VO based diets.

Fatty acid composition of muscle total lipids (% total FA)

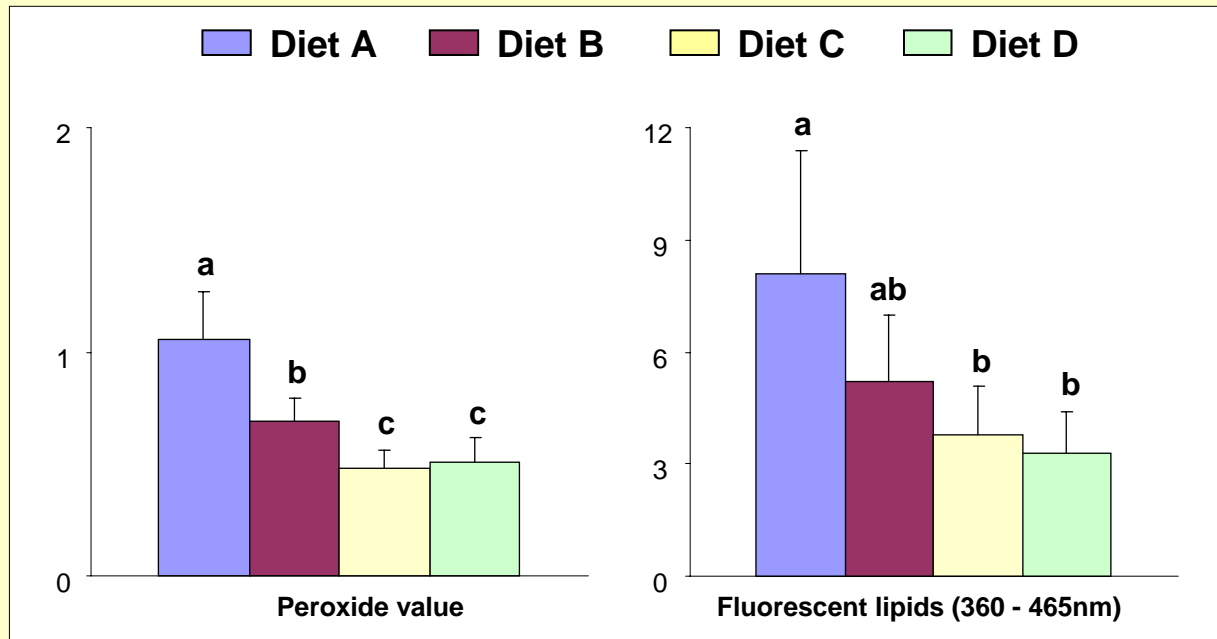
	Diet A (100/100)	Diet B (50/50)	Diet C (50/0)	Diet D (0/0)
Sat	26.9	22.7	19.9	19.6
16:1	7.6	4.4	1.8	1.5
18:1	16.9	29.1	40.1	40.5
20:1	3.0	2.0	2.1	1.0
22:1	2.5	1.2	0.9	0.2
18:2 n-6	2.6	11.1	15.4	18.3
18:3 n-3	0.7	5.7	8.5	7.7
20:5 n-3	10.4	4.9	1.2	1.0
22:6 n-3	13.2	8.6	4.4	3.0

Fatty acid composition of muscle total lipids (% total FA)

	Diet A (100/100)	Diet B (50/50)	Diet C (50/0)	Diet D (0/0)
Sat	26.9	22.7	19.9	19.6
16:1	7.6	4.4	1.8	1.5
18:1	16.9	29.1	40.1	40.5
20:1	3.0	2.0	2.1	1.0
22:1	2.5	1.2	0.9	0.2
18:2 n-6	2.6	11.1	15.4	18.3 ←
18:3 n-3	0.7	5.7	8.5	7.7
20:5 n-3	10.4	4.9	1.2	1.0
22:6 n-3	13.2	8.6	4.4	3.0 ←

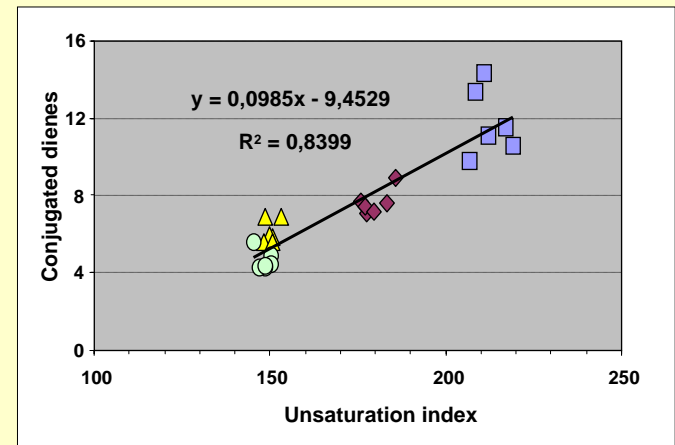
- ↗ in FA characteristics of VO and ↘ of EPA & DHA with PP/VO diets
- additional effect of total FM substitution on 18:2 n-6 & DHA
- selective retention of DHA and/or synthesis

Lipid peroxidation products in muscle



➤ graded decrease in lipid peroxidation products when increasing PP/VO level

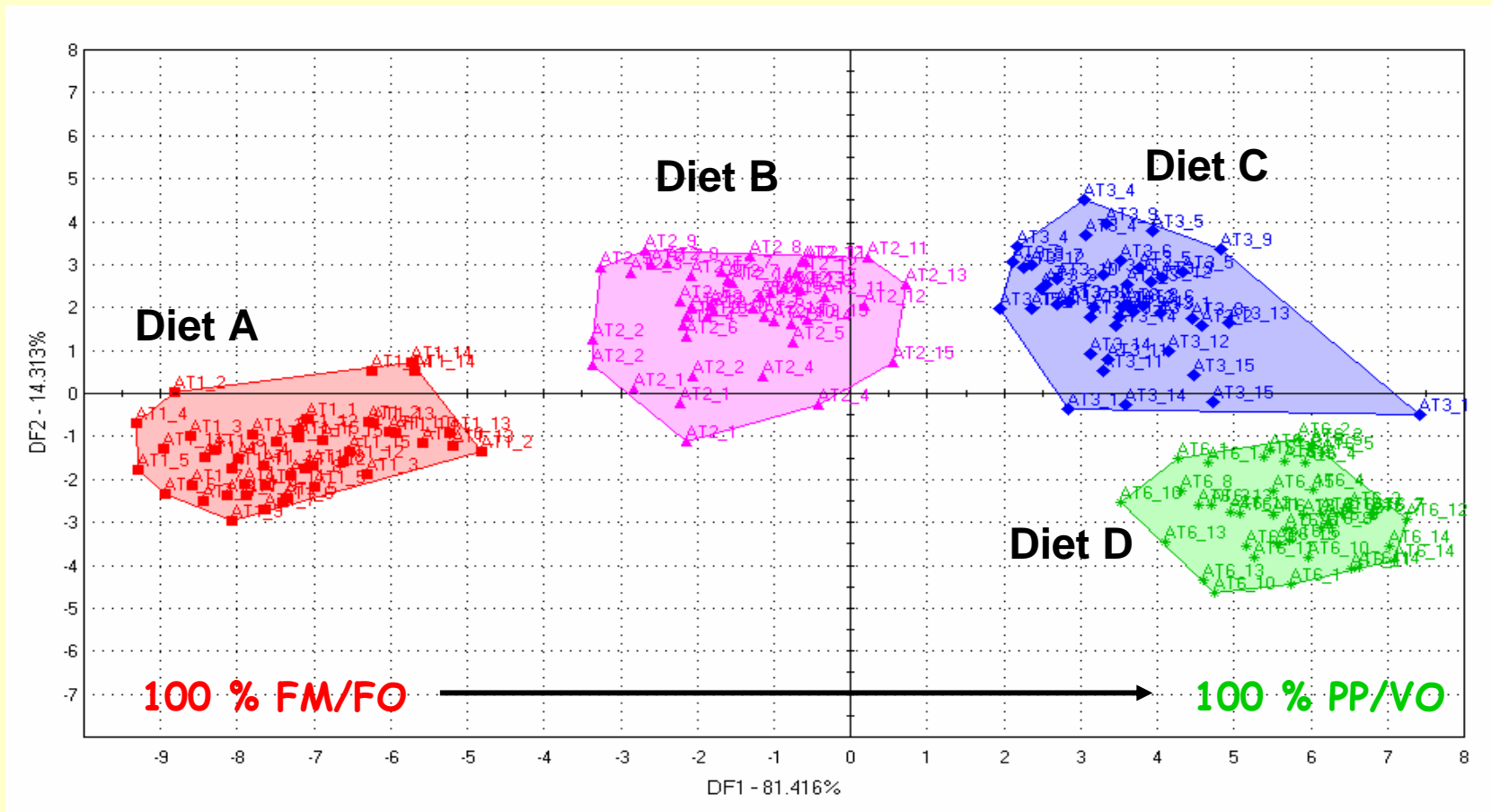
➤ lipid peroxydation strongly correlated to unsaturation index and n-3 PUFA level



Organoleptic analysis of cooked fillets

	Diet A	Diet B	Diet C	Diet D	p value
Odour					
Global intensity	6.5	6.4	6.3	6.4	0.92
Fatty fish	4.5 a	3.8 ab	3.4 b	3.4 b	0.02 (A>C,D)
Aspect					
Pink color	4.1	4.6	4.6	4.7	0.74
Fatty aspect	3.2	2.8	3.0	3.2	0.55
White spots	4.8 a	4.5 a	4.0 ab	3.6 b	0.02 (A>D)
Texture					
Firmness	4.5	4.5	4.6	4.8	0.75
Springiness	2.0	2.3	2.3	2.2	0.68
Pasty texture	2.9	2.9	3.0	2.8	0.94
Flavour					
Global intensity	5.8	5.5	5.8	5.4	0.66
Fatty fish	4.5	4.0	4.3	3.4	0.09

Olfactive fingerprint of flesh determined by electronic nose (Factorial discriminant analysis)



- discrimination between the diets according to the level of FM/FO substitution
- no clear discrimination between diets C & D

Conclusion

Concomitant replacement of FM & FO by plant ingredients :

100 % FM/FO  100 % PP/VO

➤ Lowered growth performance (20%)

➤ Increased body lipid content :



- * due to increase in perivisceral adipose tissue (VSI) since there is no variation in muscle lipid content
- * seems to be linked to plant protein incorporation

➤ Muscle FA composition closely related to that of dietary oils, with an additional effect of plant protein



- * retention and/or synthesis of DHA
- * nutritional value of the flesh

Conclusion

100 % FM/FO



100 % PP/VO

- Lowered lipid peroxidation which is correlated to n-3 PUFA and thus to FO substitution
- Enhanced the presence of other carotenoids than astaxanthin in the flesh
 - * changes in colour parameters
- Induced minor variations in sensory properties of cooked fillets evaluated by a trained panel
- Modified the olfactive fingerprint evaluated by electronic nose
 - * could be linked to the less pronounced fatty fish odour detected by the taste panel
 - * seems to be more related to FO substitution

**Thank you for
your attention**

