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Effect of fish oil on metabolism in terrestrial animals

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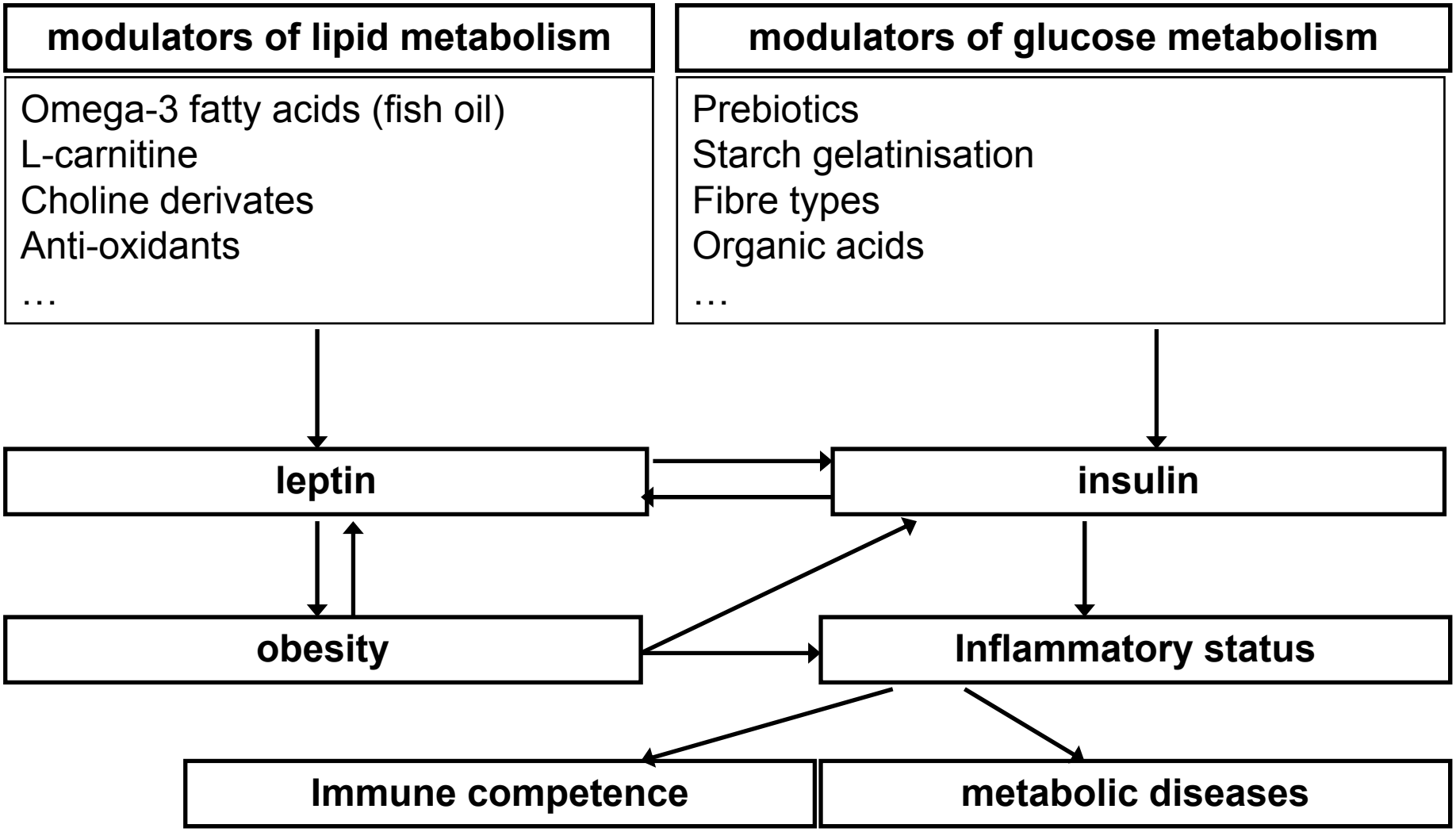
Meeting UGent R & D Aquaculture Consortium
12 Juni 2008

organigram

- Laboratory of Animal Nutrition
- Department of Nutrition, Genetics & Ethology
- Faculty of Veterinary Medicine
- Ghent University


modulators of lipid metabolism
Omega-3 fatty acids (fish oil)
L-carnitine
Choline derivates
Anti-oxidants
…
modulators of glucose metabolism
Prebiotics
Starch gelatinisation
Fibre types
Organic acids
…
leptin
insulin
obesity
Inflammatory status
Immune competence
metabolic diseases

PhD topics

- Leptin and insulin resistance in horses/ponies (S. Van Weyenberg)
- Insulin resistance and laminitis in horses/ponies (J. Vandermeiren)
- Periparturient dysgalactia syndrome in sows (G. Papadopoulos)
- Dietary carbohydrate effects in pigeons (E. Abd El-Khalek)
- Dietary modulation of omega-3 effects in sows (A. Cools)
- Dietary modulation of insulin resistance in cats (A. Verbrugghe)
- Zootechnical effects of choline derivates in pig and poultry feeding (I. Kalmar)
- Choline derivates pathway (M. Devroey)
- Immunomodulatory effects of prebiotics in dogs (H. Van de Velde ?)
- Nutritional origin of metabolic disorders in cheetahs (K. Johansen)
- Optimisation of feed resources for grazing cattle (Ethiopia) (B. Duguma)
- Bio-availability of trace elements (M. Van paemel)

+ cooperation with other institutes on additional topics

Aquaculture: interests in immunonutrition in broad sense …

Influence of fish oil on periparturient metabolism in sows

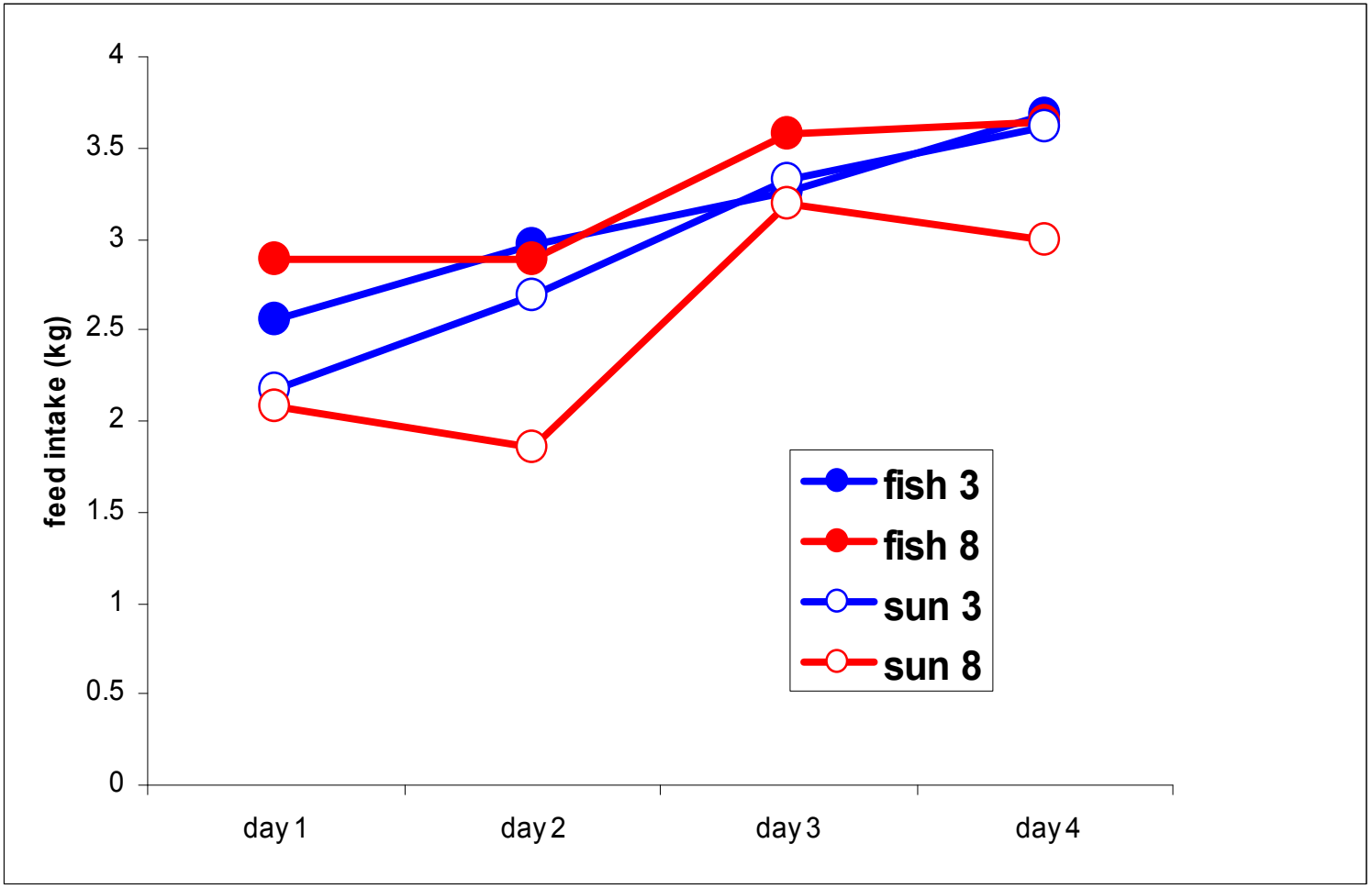
- Rationale
  - High incidence of metabolic disorders evolving from insulin resistance, e.g. agalactia
  - Effect of omega-3 PUFA on insulin sensitivity already shown in rats
  - Omega-3 PUFA and sow periparturient metabolism ?

- Set-up
  - 4 groups x 16 sows:
    - F3 = fish oil supplemented diet from 3 days before parturition
    - F8 = fish oil supplemented diet from 8 days before parturition
    - S3 = sunflower oil supplemented diet from 3 days before parturition
    - S8 = sunflower oil supplemented diet from 8 days before parturition

Papadopoulos et al., in press, Br. J. Nutr.

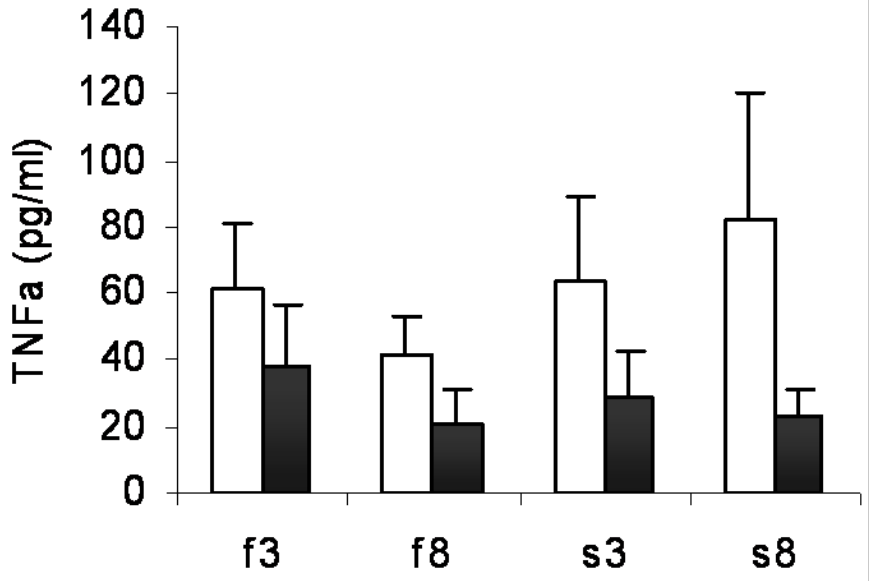
	Diet supplement	
	Fish oil	Sunflower oil
Diet (g/kg)		
DM	899	886
Ash	65	65
Crude protein	171	167
Crude fat	61	61
Neutral-detergent fibre	181	181
Metabolizable energy (kJ/kg)	12 300	12 300
Fatty acids (% of total fatty acids)		
SFA	33·5	26·5
MUFA	33·4	29·7
PUFA	33·1	43·3
Total *n*-6 (% of PUFA)		
18:2*n*-6	20·9	38·3
20:4*n*-6	0·2	0·2
Total *n*-3 (% of PUFA)		
18:3*n*-3	2·1	2·4
18:4*n*-3	1·4	0·3
20:4*n*-3	0·2	ND
20:5*n*-3	2·8	0·4
22:5*n*-3	0·2	0·1
22:6*n*-3	3·4	0·6
n-6:*n*-3	2·09	10·13

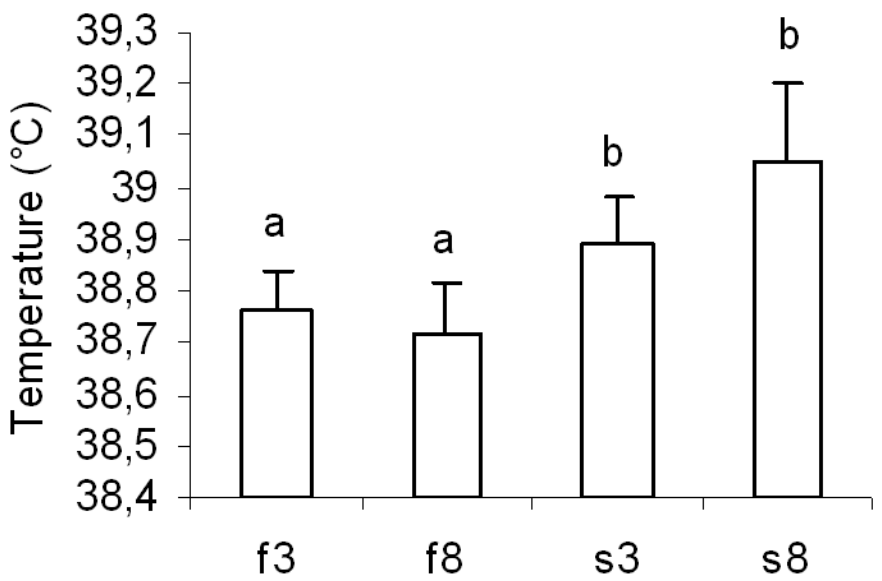
Feed intake profile

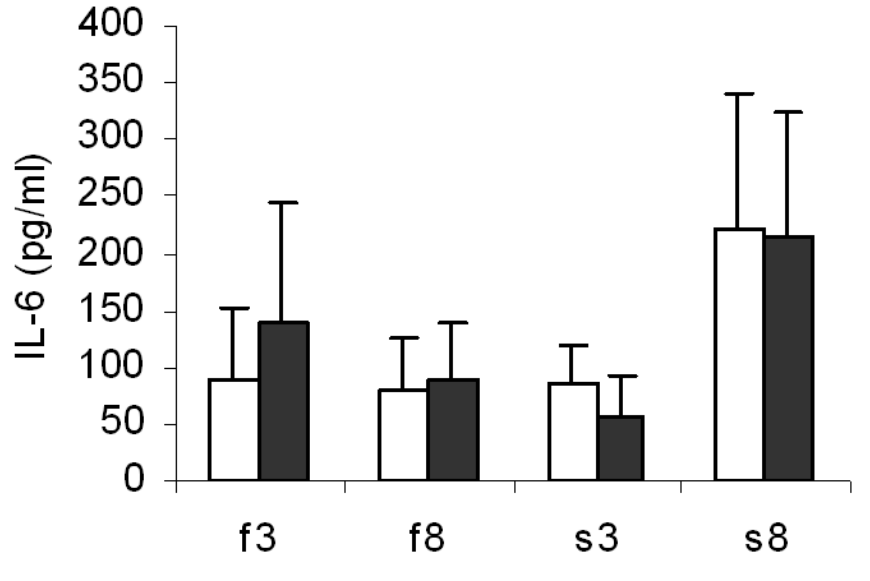


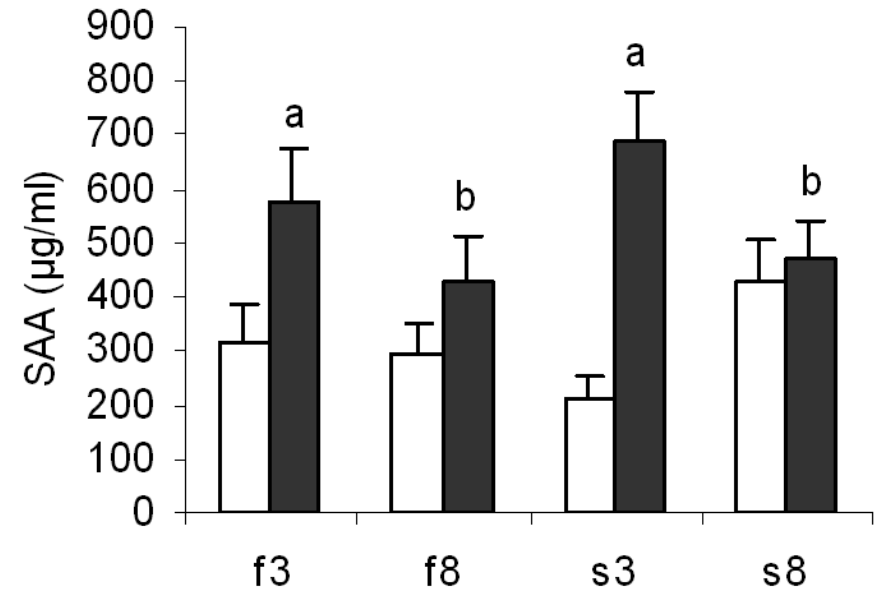
Postpartum hypofagia → reduced growth of neonates
→ increased risk piglet mortality

Papadopoulos et al., 2007

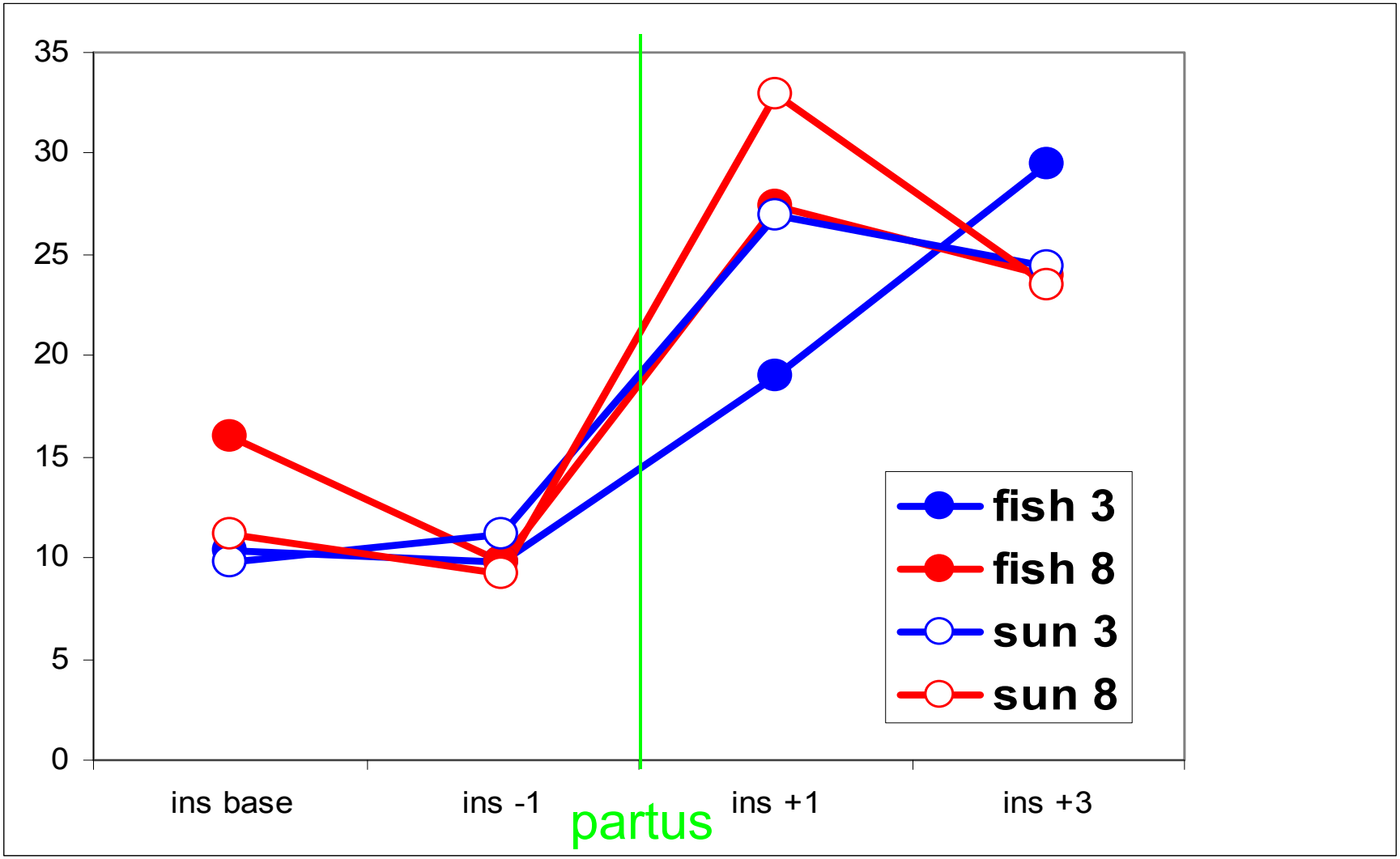

TNFa (pg/ml)
140
120
100
80
60
40
20
0
f3
f8
s3
s8


Temperature (°C)
39,3
39,2
39,1
39
38,9
38,8
38,7
38,6
38,5
38,4
a
a
b
b
f3
f8
s3
s8

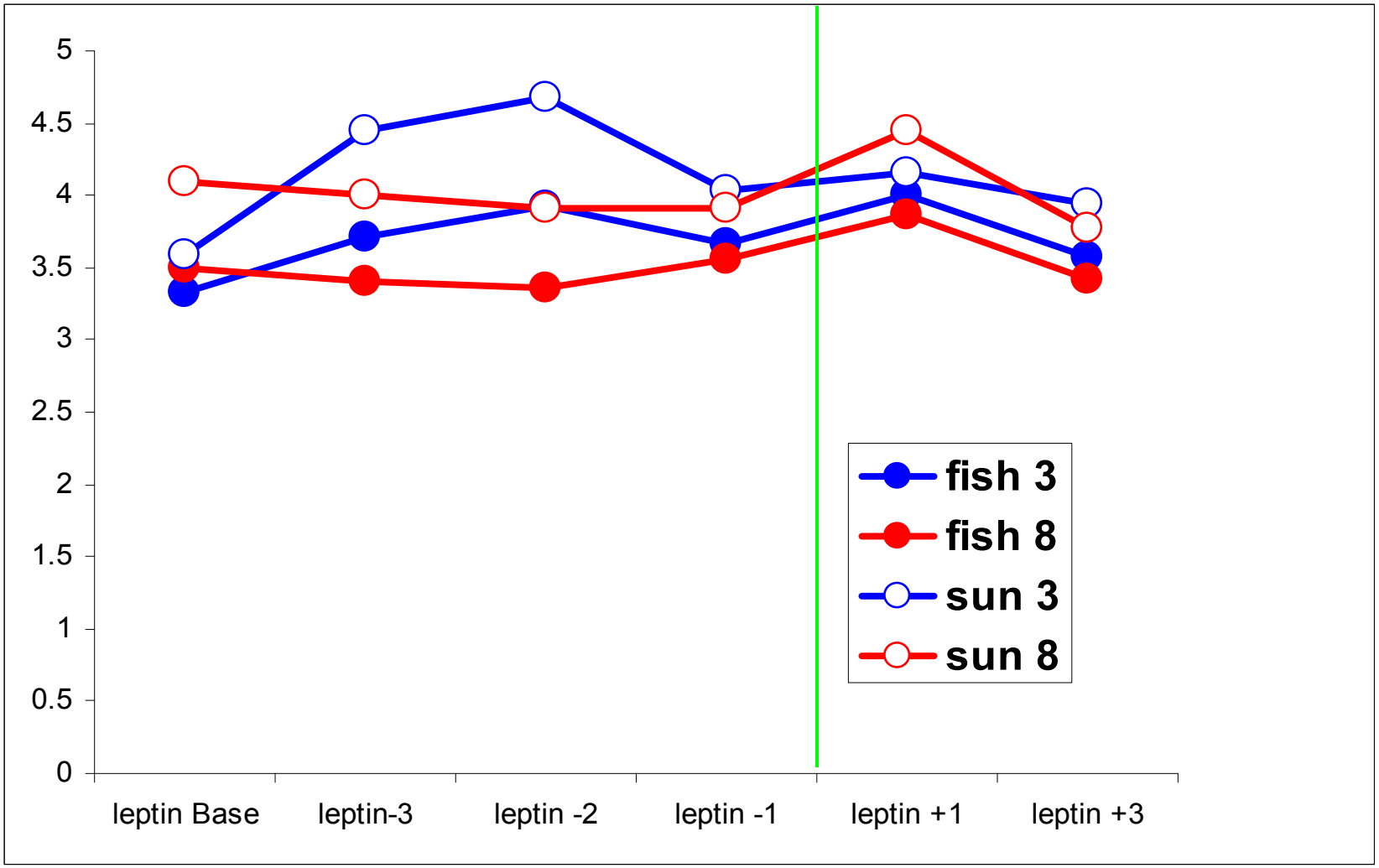

IL-6 (pg/ml)
400
350
300
250
200
150
100
50
0
f3
f8
s3
s8

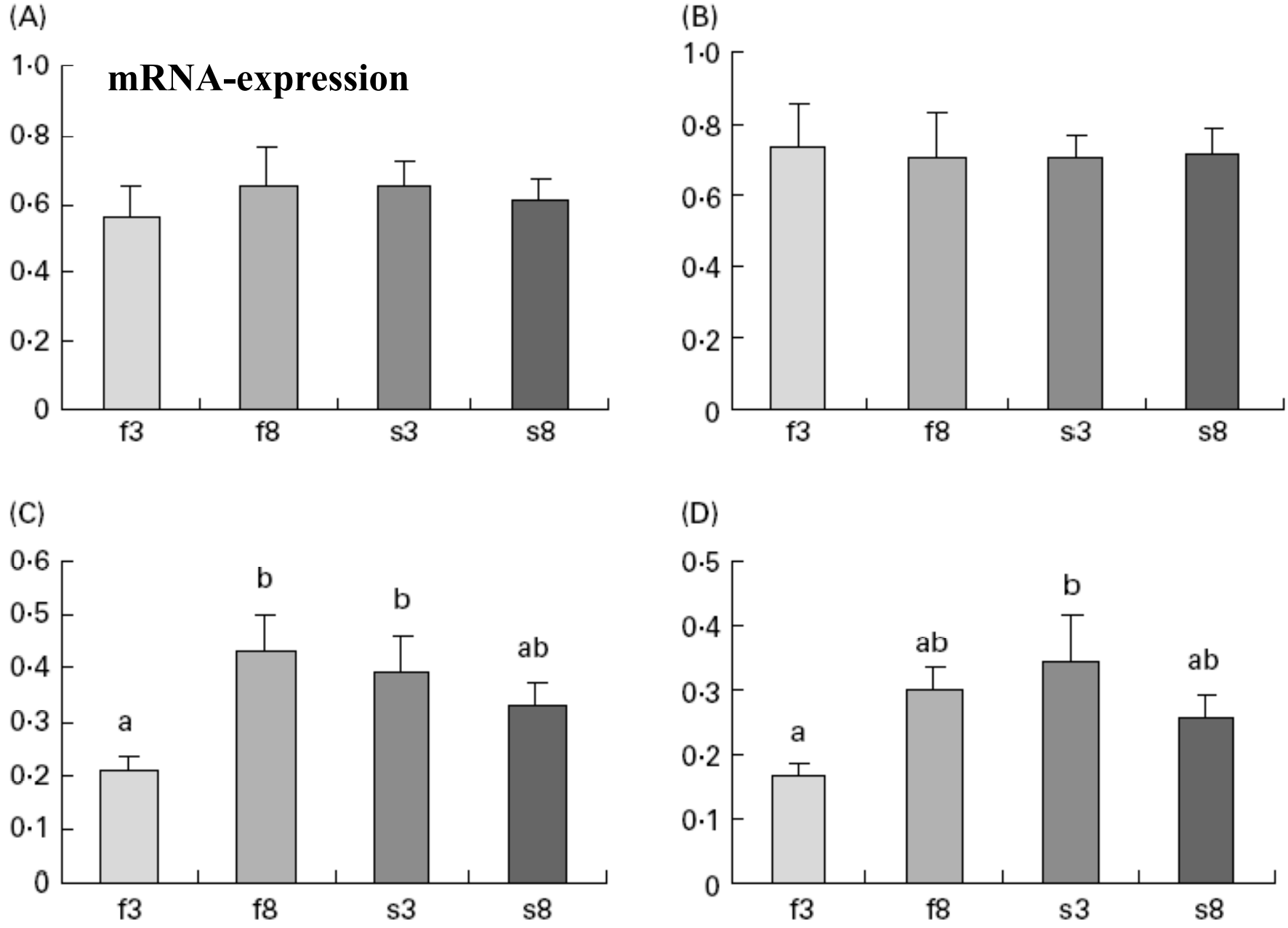

SAA (µg/ml)
900
800
700
600
500
400
300
200
100
0
a
b
a
b
f3
f8
s3
s8

Insulin profile



Leptin profile





PPARγ1c/d (A), PPARγ1a/b (B), PPARγ2 (C) and PPARγ coactivator 1A (D)

Influence of fish oil on dermatitis in dogs

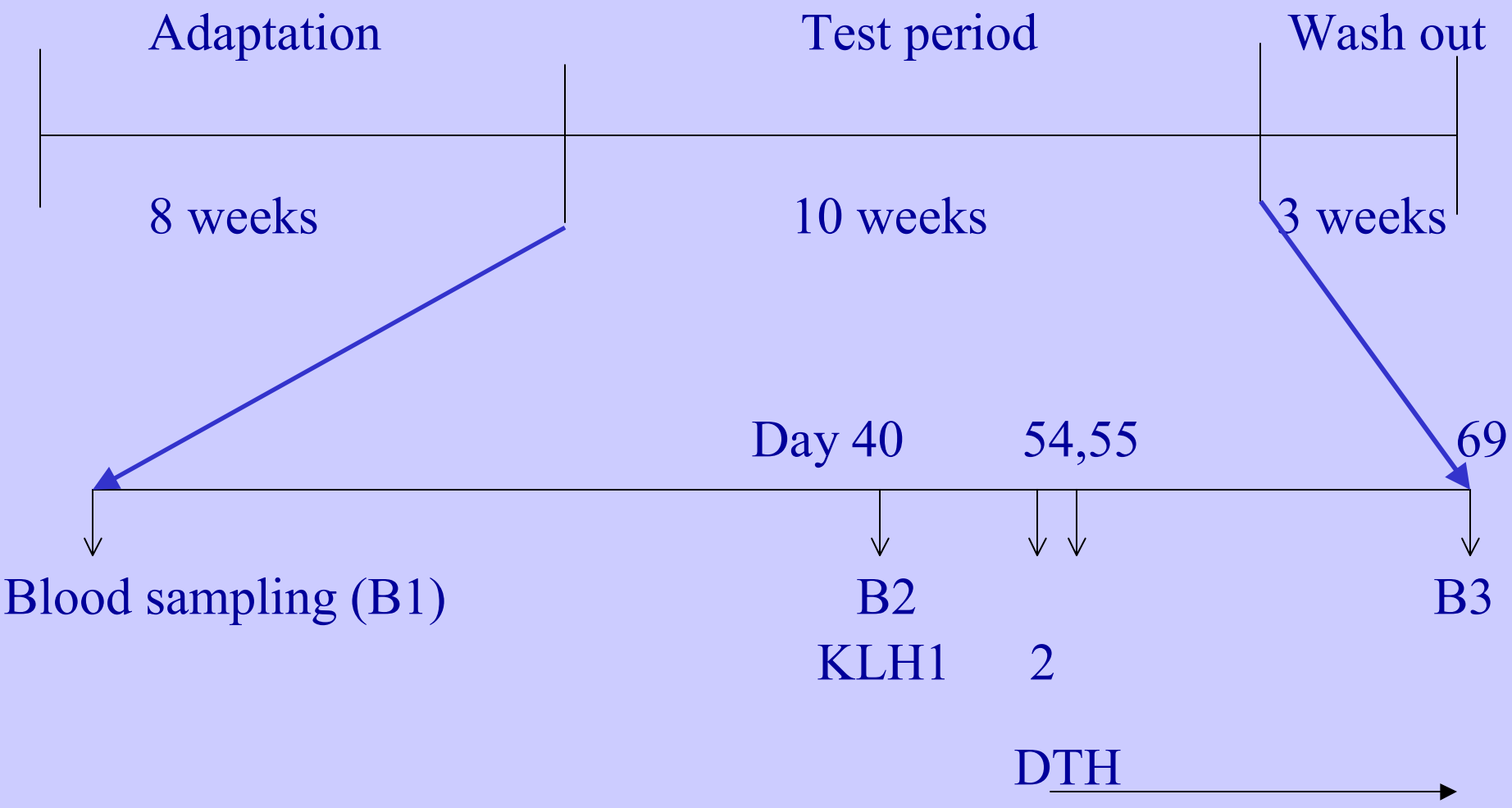
- Rationale
  - Dermatological problems in dogs are common
  - Omega-3 fatty acids have anti-inflammatory properties
  - Fish oil is prone to lipid peroxidation
  - Effect of fish oil on dermatitis in dogs in combination with lipid peroxidation status ?
- Set-up

  18 beagle dogs
  - **A**: Extruded; with 3% chicken lard
  - **B**: Extruded; with 3% salmon oil without added anti-oxidants
  - **C**: Extruded; with 3% salmon oil with added anti-oxidants

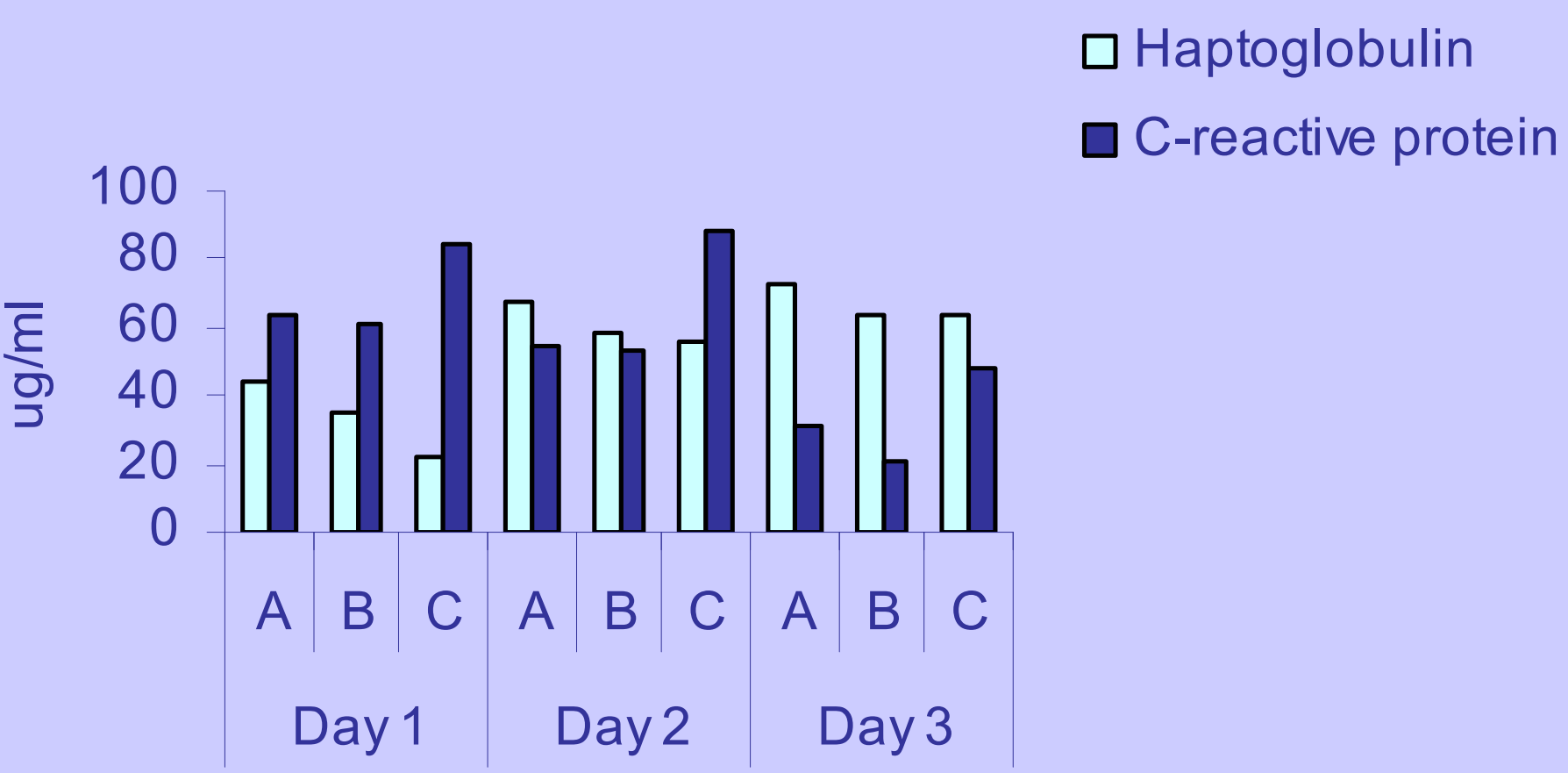
Hesta et al., in preparation

Diet composition

% as fed	Feed A	Feed B	Feed C	fatty acids (mg/100g)	Feed A	Feed B	Feed C
Moisture	8.2	7.7	8.2	linoleic acid	1965	1673	1574
Crude protein	24.2	24.1	23.8	arachidonic acid	44,3	135	273
Crude fat	10.4	11.9	12.0	alpha-linolenic acid	170	233	195
Crude fiber	3.3	2.8	2.9	eicosapentaenoic acid	5,86	123	173
Crude ash	7.2	7.3	7.3	docosapentaenoic acid	13,8	73,9	88,2
POV (mEq/kg)	117	134	152	docosahexanoic acid	10,7	189	275
n-3 PUFA	206	650	784	n-6/n-3 ratio	10,1	2,9	2,5
n-6 PUFA	2083	1891	1929				

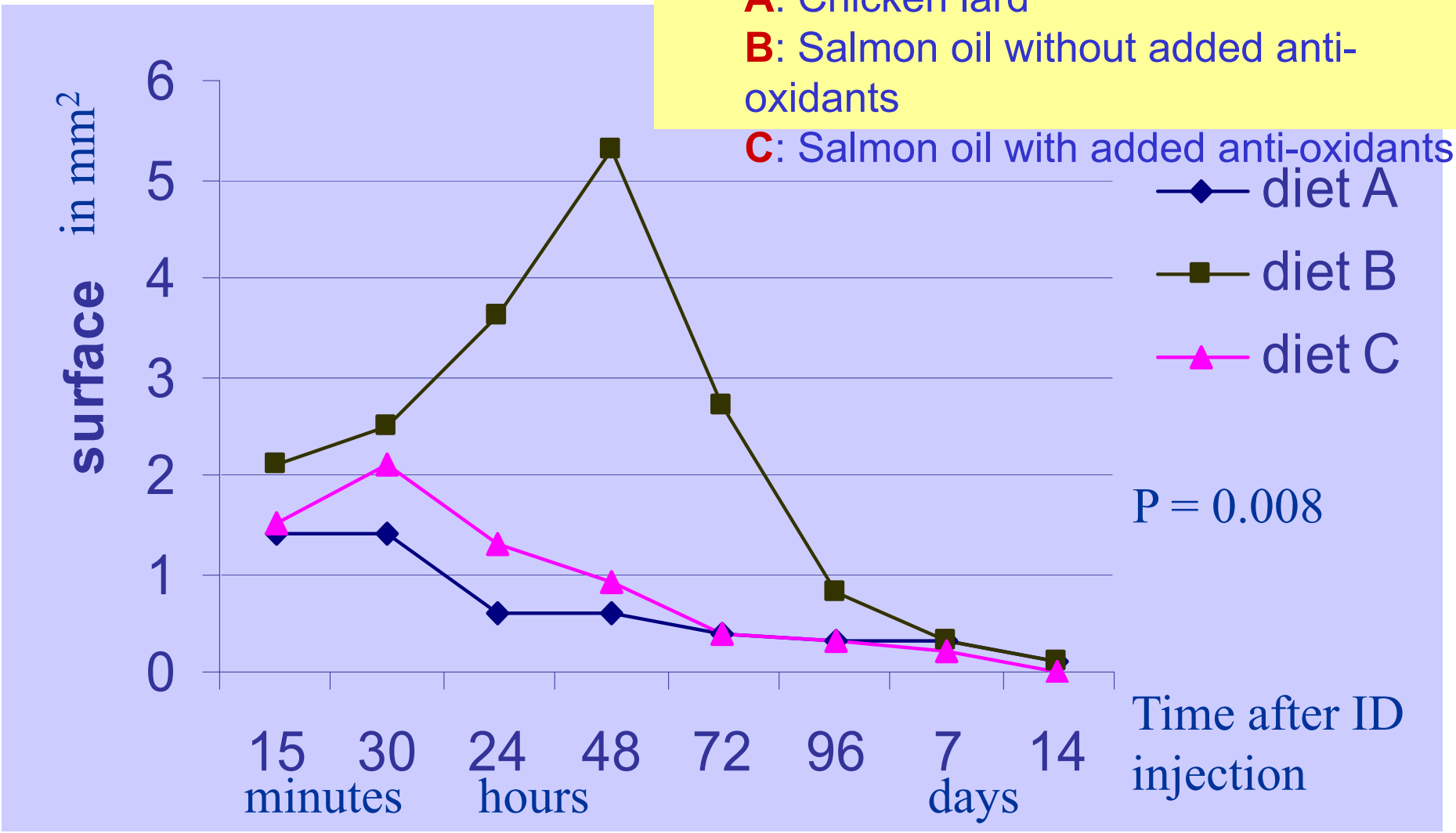

Adaptation
Test period
Wash out
8 weeks
10 weeks
3 weeks
Day 40
54,55
69
Blood sampling (B1)
B2
B3
KLH1
2
DTH

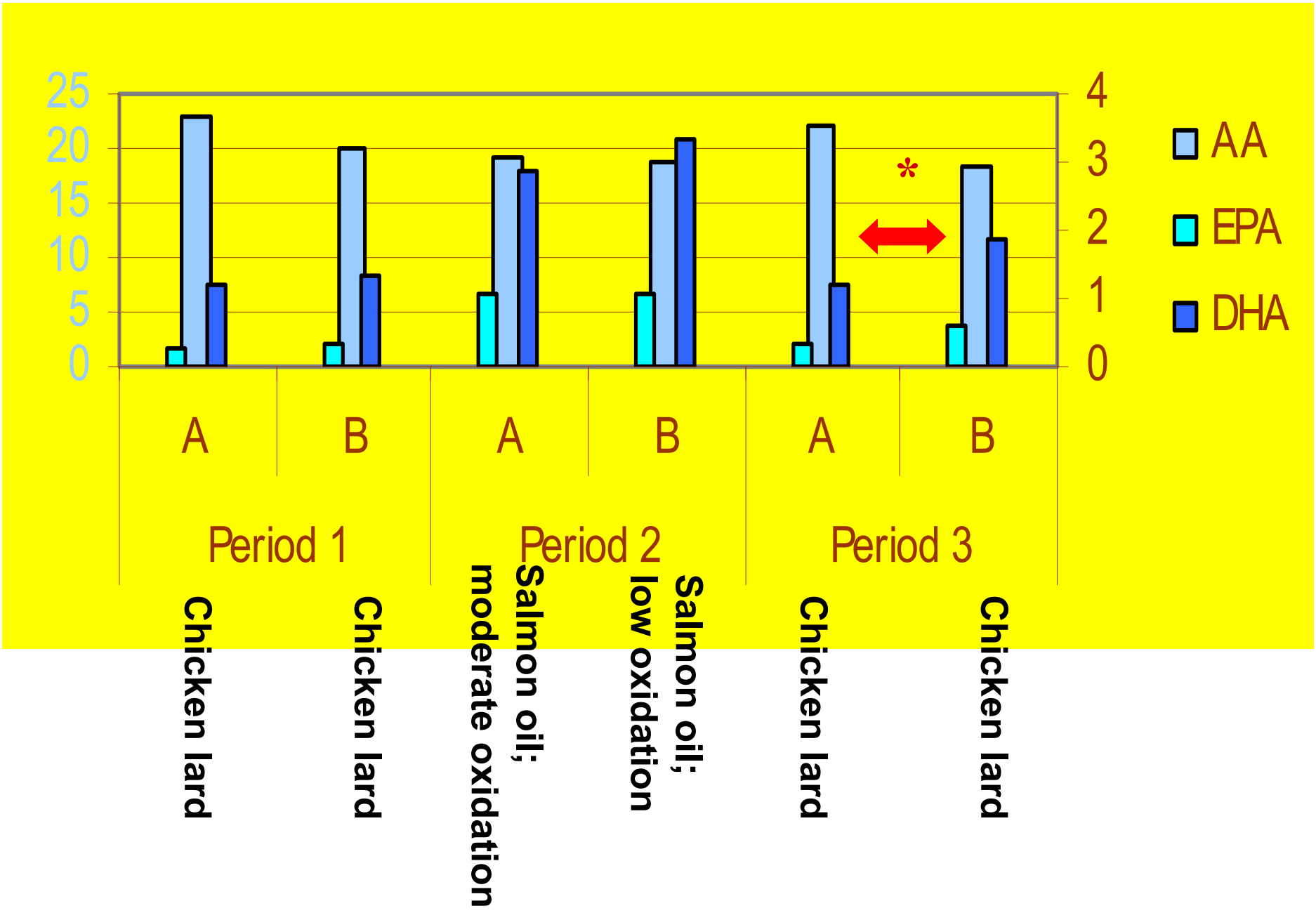
Acute phase response



Dermatologic reaction to keyhole limpet haemocyanin

A: Chicken lard
B: Salmon oil without added anti-oxidants
C: Salmon oil with added anti-oxidants





*** Long-term effects of oxidation status of fish oil in dogs ($p<0.05$)**

Potential links with aquaculture

- Fatty acid stability
- Competition for nutrients between immune system and other processes
- Also: recent finding in sows: fish oil (versus pork lard) increases higher red blood cell osmotic fragility in sows → application in fish ?
- … ?

Thanks for listening !

« You’re a quart low on fish oil ! »