Selection of fatty acid composition in muscle of Atlantic salmon

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Transport

Oxidation

Uptake

Deposition

ALA

Bioconversion

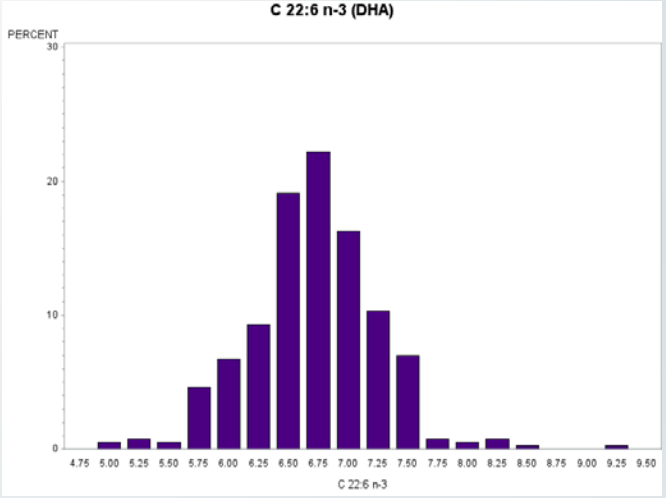
EPA DHA

AIM

- Evaluate the selection potential for increased marine omega-3 fatty acids in Atlantic salmon muscle
- Provide insight into fatty acid metabolism in Atlantic salmon muscle

Data material

- 668 slaughter-sized (3.6 kg) Atlantic salmon fed a high fish oil-diet
- 194 full-sib families (92 sires and 194 dams)
- Individual muscle fatty acid composition (% of total muscle fatty acids) measured by gas-chromatography
  - Normally distributed

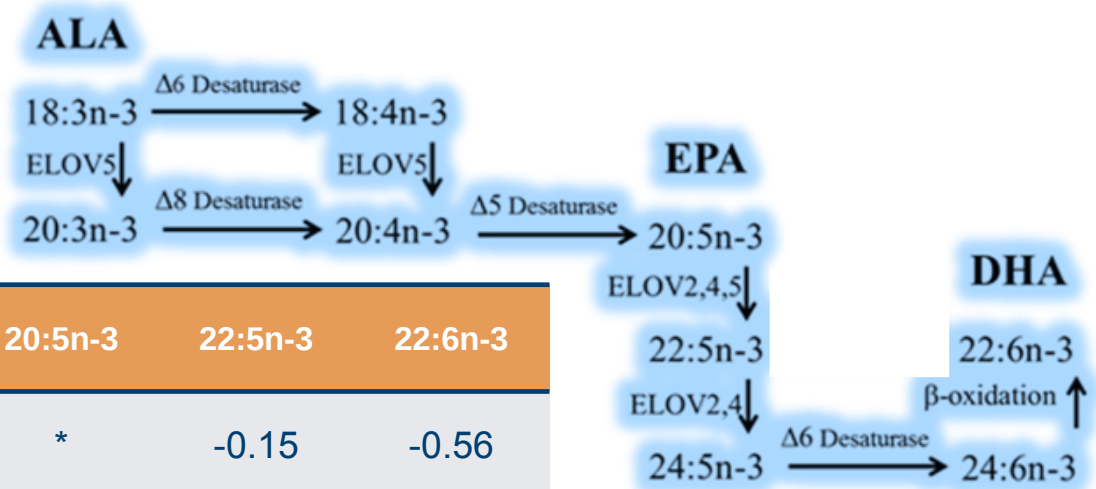


Statistical model

- Linear animal model:

  $y = X\beta + Zu + e$
- Bodyweight and sex was included as fixed effects
- Univariate analyses were performed to estimate heritabilities for all traits
- Bivariate analyses were performed to estimate (co)variances used to estimate genetic correlations

Results



	Fatty acid	18:3n-3	20:3n-3	20:4n-3	20:5n-3	22:5n-3	22:6n-3
ALA →	18:3n-3	**0.26**	0.21	-0.21	*	-0.15	-0.56
	20:3n-3	-0.03	**0.18**	-0.20	0.40	0.43	-0.06
	20:4n-3	0.03	0.07	**0.14**	-0.33	-0.14	0.25
EPA →	20:5n-3	*	0.01	-0.21	**0.09**	0.69	0.23
	22:5n-3	-0.44	0.30	0.19	0.42	**0.22**	0.32
DHA →	22:6n-3	-0.28	0.33	0.64	0.16	0.41	**0.26**

Heritability on the diagonal. Phenotypic correlations on the upper triangle. Genetic correlations on the lower triangle. *Parameters not converged

Lipid deposition

	Muscle fat		Visceral fat		Liver fat	
Fatty acid (%)	r_P	r_G	r_P	r_G	r_P	r_G
16:0	0.44	0.86	0.43	0.66	0.12	0.20
18:1n-9	-0.38	-0.67	-0.41	-0.67	-0.14	-0.17
18:2n-6						
ALA → **18:3n-3**						
EPA → **20:5n-3**						
22:5n-3						
DHA → **22:6n-3**						

Phenotypic (r_P) and genetic (r_G) correlations.

Trait definition for selection

- Quantitative content of EPA and DHA (grams per 100 grams muscle)
  - High correlation to muscle fat
  - Not desired by breeding industry
- Proportional content (percentage of total muscle FA)
  - EPA
    - Favorable genetic correlations to visceral and liver fat
    - Heritability 0.09
  - DHA
    - Positive genetic correlation to visceral fat
    - Heritability 0.26
  - EPA and DHA
    - Both are essential fatty acids

Conclusions

- Individual FAs vary in heritability and correlations to lipid deposition traits
- FAs play different roles in lipid metabolism
- It is possible to change the muscle FA composition through selective breeding
- Selection for EPA %, DHA % or both will increase the content of these essential omega-3 fatty acids in salmon muscle
  - correlated selection responses must be considered

Thank you for your attention

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