

# Partitioning of rumen-protected n-3 and n-6 fatty acids in bovine muscles with different metabolism



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# Background

## Ruminants

SFA

MUFA

PUFA

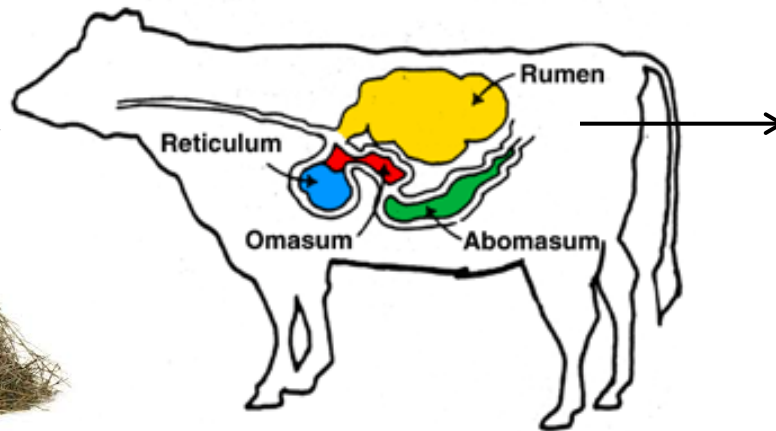
Metabolism

**Biohydrogenation**

SFA

MUFA

PUFA



Animal diet

Animal tissue

# Background

## n-3 and n-6 FA

Animal diet



Metabolism



Animal tissues



...

LA (C18:2n-6)

ALA (C18:3n-3)

...

e.g., AA (C20:4n-6)

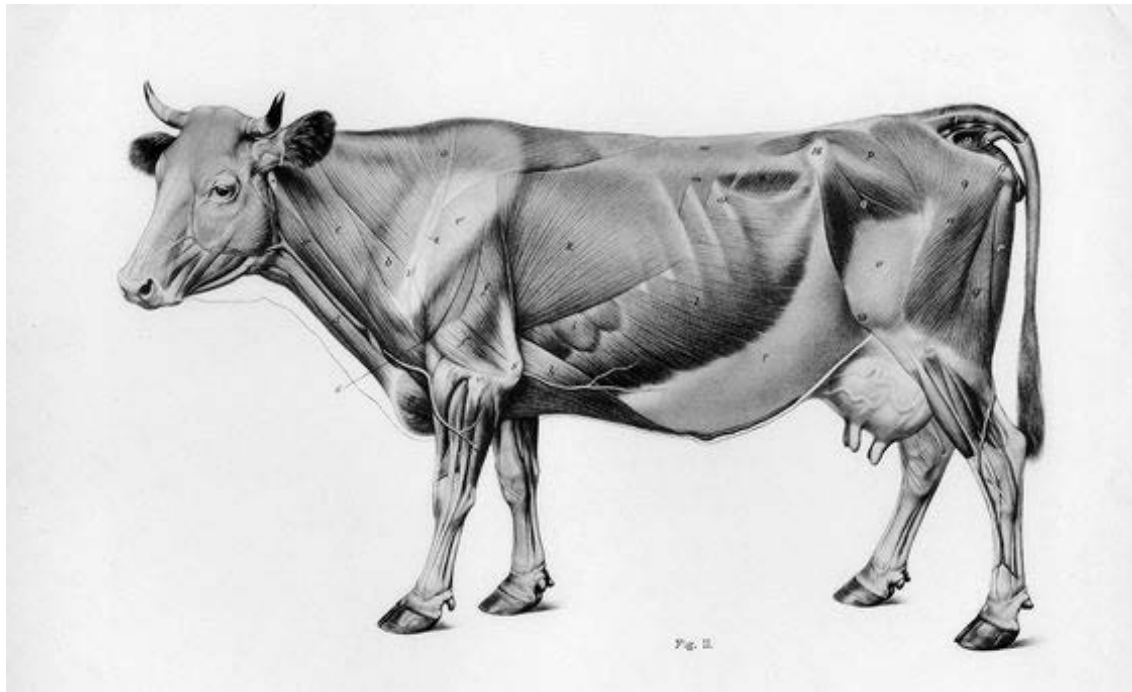
EPA (C20:5n-3)

DHA (C22:6n-3)

Low conversion rate!

# Background

- Enrichment of n-3 FA in body tissues
- Different fat and muscle tissues in cattle



# Background

## Research Questions

1. What is the efficiency of enrichment of rumen-protected n-3 FA and n-6 FA in beef lipids?
2. Do proportions of n-3 and n-6 FA in differently located beef muscle lipids vary?
3. Are there interactions between diet and muscle type for n-3 and n-6 FA?

# Material & Methods

## Angus Heifers (n = 9+9)

- $411 \pm 46$  kg live weight at slaughter
- $17 \pm 4.4$  months of age



photo by K. Giller

# Material & Methods

## Diet

- 8 weeks 7.45 kg/day
- Straw-based roughage 7.00 kg/day
- Coated fat supplements \*
  - Fish oil
  - Sunflower oil

\* Erbo Spraytec AG:

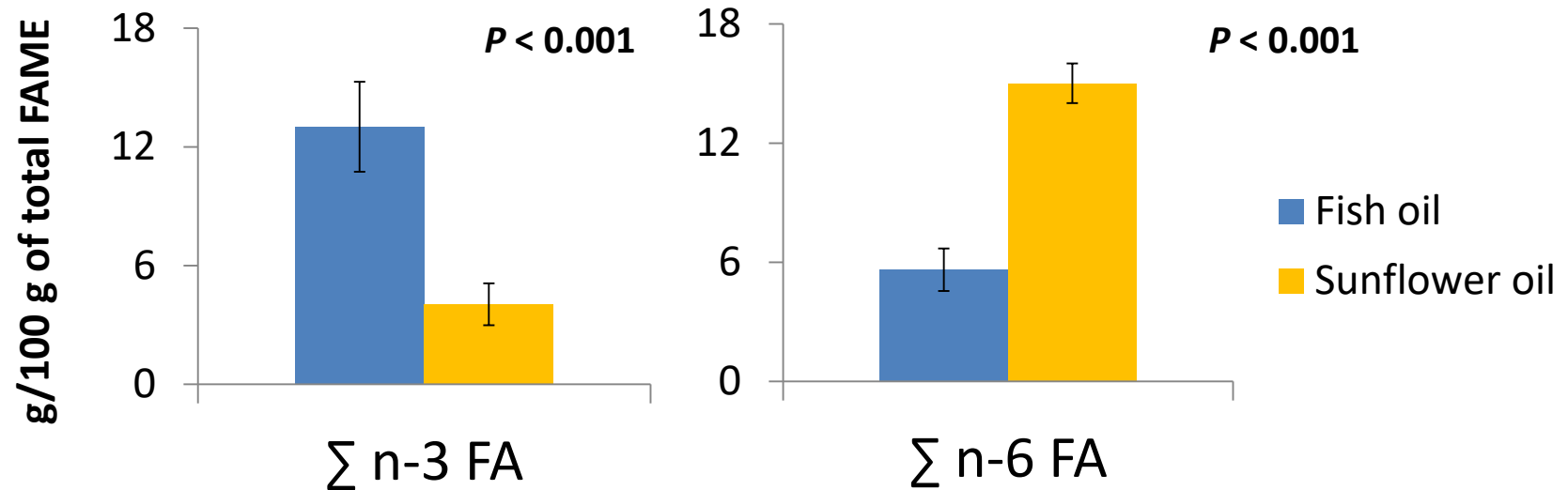
Coating matrix = hydrogenated rapeseed oil (melting point 67°C), brought into powder form by spray chilling

# Material & Methods

## Diet

- Fish oil rich in n-3 FA; sunflower oil rich in n-6 FA

### n-FA composition of supplements





# Material & Methods

## Muscle

Sampling

*Longissimus thoracis*

LT

*Biceps femoris*

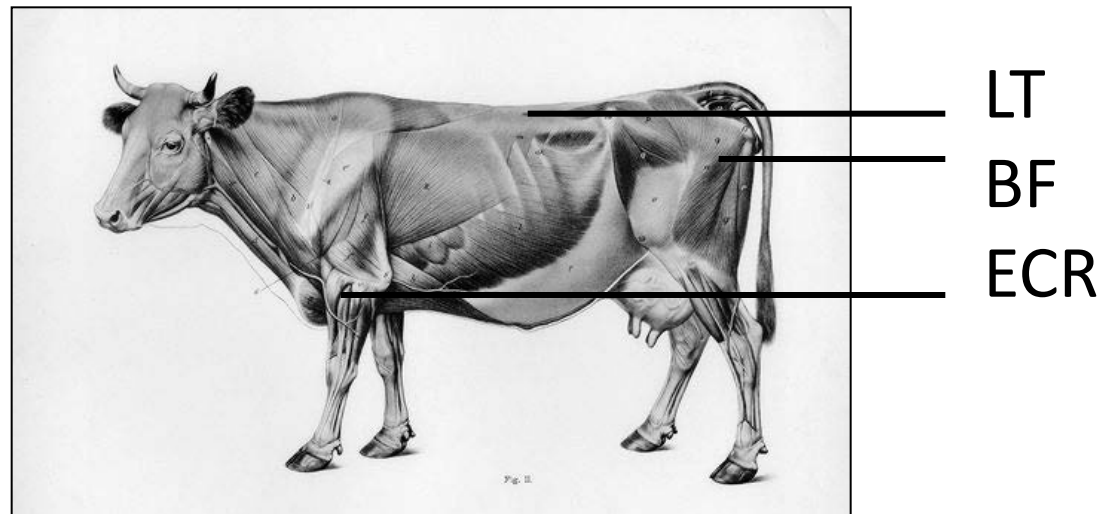
BF

*Extensor carpi radialis*

ECR

Slaughter dates

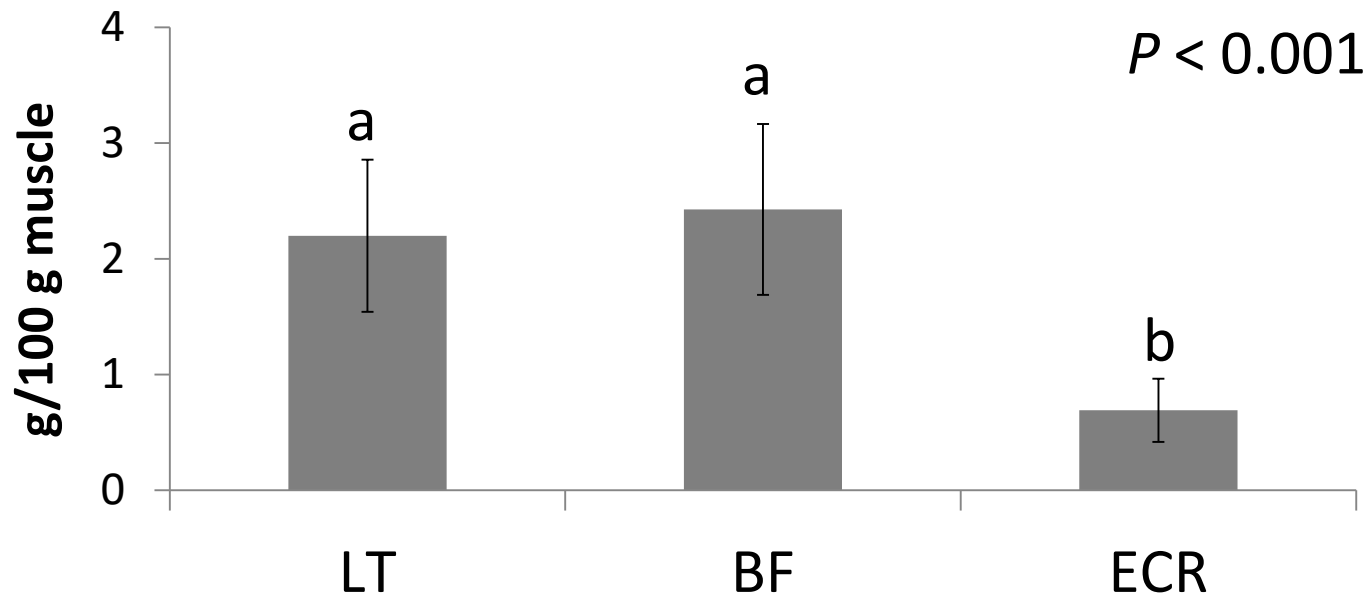
n = 3



# Material & Methods

## Muscle

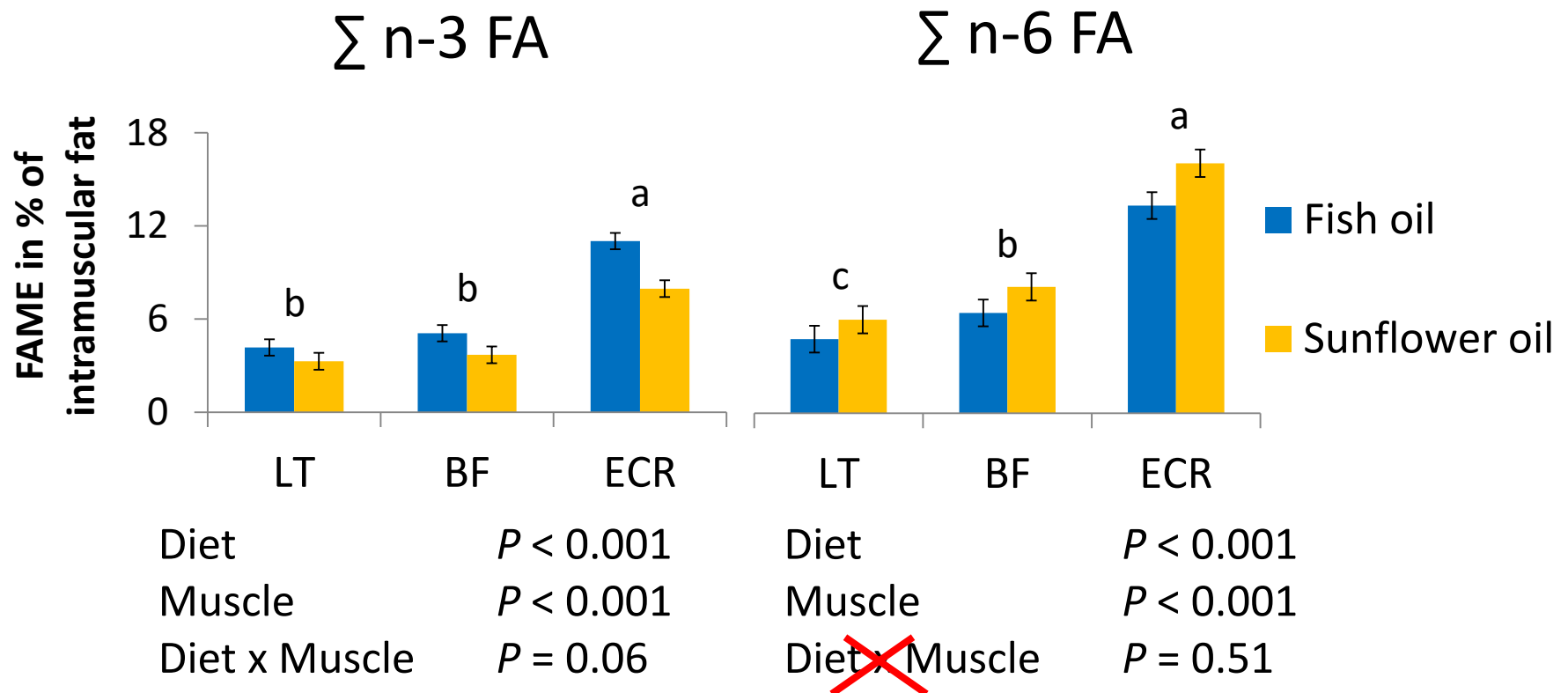
### Fat concentrations in muscles





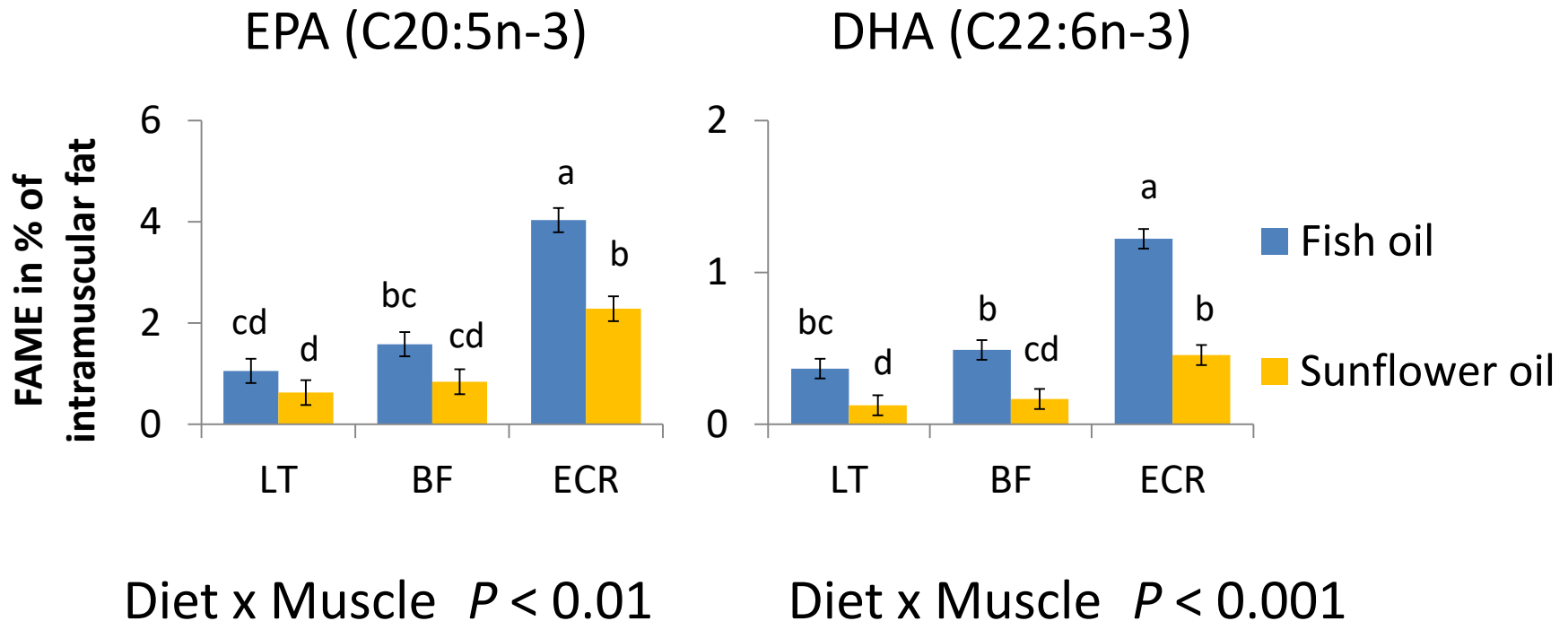
# Results

- Diet and muscle effect on intramuscular n-FA



# Results

- Diet x Muscle interactions for individual n-3 FA



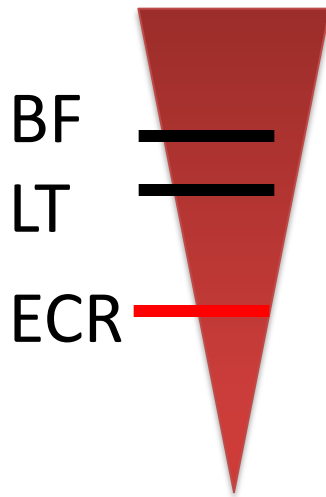
## Conclusion

- FA from rumen-protected supplements were efficiently transported into muscle tissue.
- Partitioning of n-3 and n-6 FA is different for the selected muscles.
- Only a trend for an interaction between diet and muscle was found for the sum of n-3 FA, but this was significant for EPA and DHA.

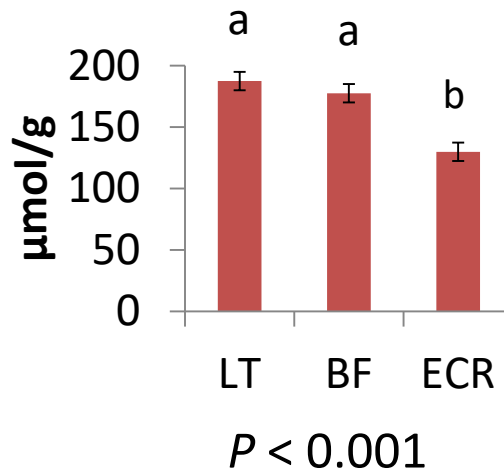
# Conclusion

## Physiological relevancy of n-3 FA distribution

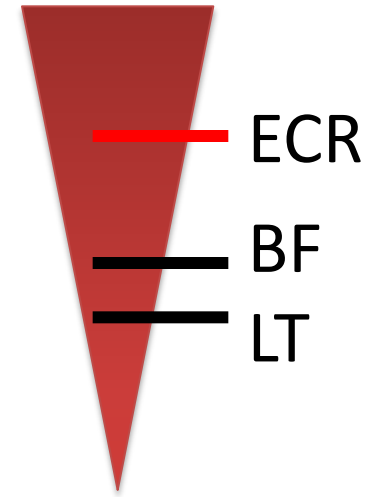
Intramuscular fat content



Glycolytic potential (GP)

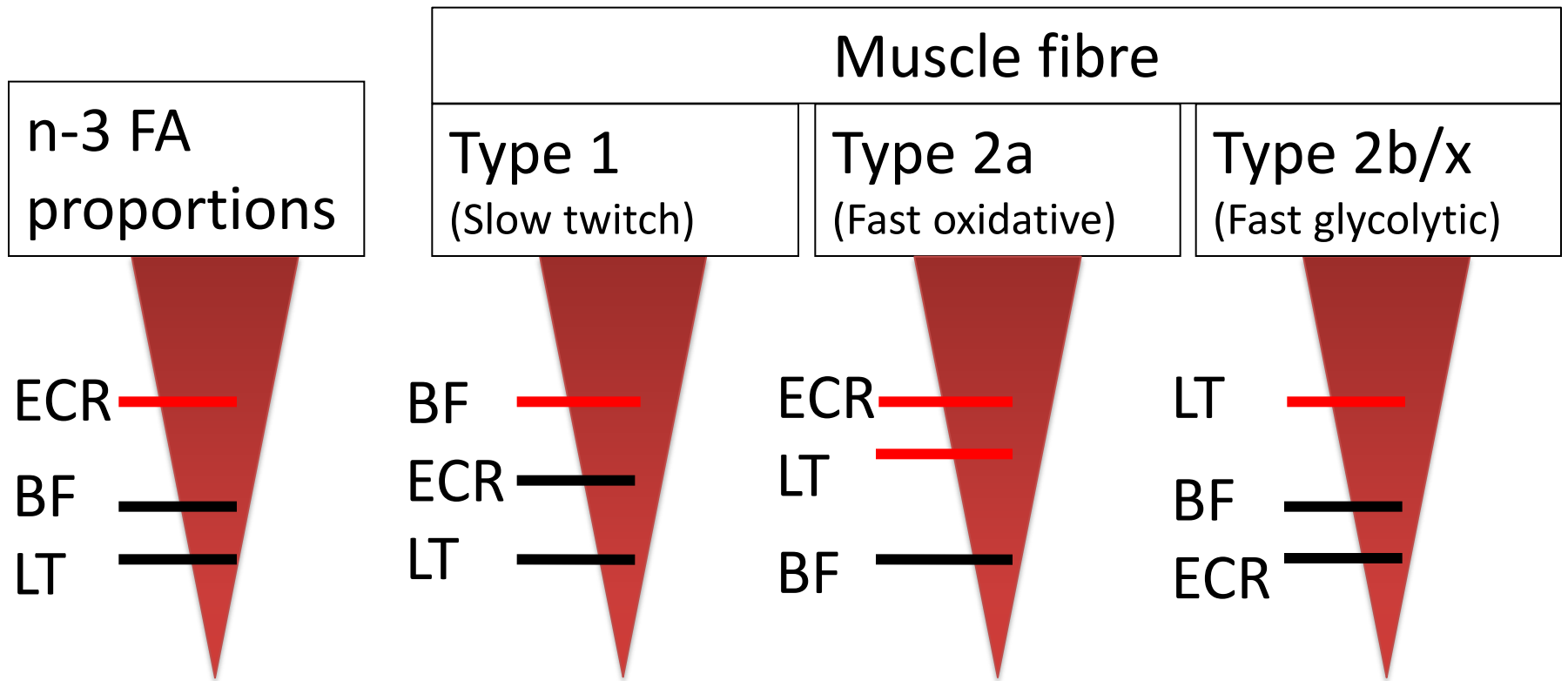


n-3 FA proportions



# Conclusion

## Physiological relevancy of n-3 FA distribution





Thanks to:

Erbo Spraytec AG

Lab Team

for providing coated supplements

Animal nutrition, ETH Zurich

A close-up photograph of a cow's nose, which is the central focus of the image. The nose is large, pinkish, and has a textured surface. The cow's fur is a light brown color. On either side of the nose, there are yellow identification tags hanging from the cow's ears. The tag on the left has the number '100945' printed on it. The tag on the right has some text, including 'CETOVNOS' and 'BLAKADIP'. The background is a blurred green field, suggesting an outdoor farm setting.

**Thank you for your  
attention!**

## Appendix – M&M

- Fat content in muscles  
Soxhlet fat extraction with HCl decomposition
- Gas chromatography of muscles  
Varian capillary column CP-7421  
HP 6890N GC 200m x 0.25mm x 0.25 $\mu$ m; Agilent Techn.  
200m column; CP-7421 autosampler;  
split injector «30:1»;  
H<sub>2</sub> flow rate: 1.7ml/min;  
air flow; 400 ml/min;  
initial oven temperature 170, increased to 250°C

# Appendix – M&M

## Fatty Acid Profile Mean $\pm$ Standard Deviation

| Diet                 | Fish Oil       |                | Sunflower Oil   |                 |
|----------------------|----------------|----------------|-----------------|-----------------|
|                      | Forage         | Supplement     | Forage          | Supplement      |
| (g/100 g total FAME) |                |                |                 |                 |
| $\Sigma$ n-3 FA      | 13.0 $\pm$ 2.3 | 16.9 $\pm$ 1.8 | 4.04 $\pm$ 1.06 | 0.18 $\pm$ 0.03 |
| $\Sigma$ n-6 FA      | 5.6 $\pm$ 1.1  | 1.4 $\pm$ 0.1  | 15.0 $\pm$ 1.00 | 18.3 $\pm$ 2.47 |
| $\Sigma$ SFA         | 72.8 $\pm$ 1.3 | 70.2 $\pm$ 1.3 | 70.8 $\pm$ 1.21 | 67.5 $\pm$ 5.30 |
| $\Sigma$ MUFA        | 8.0 $\pm$ 0.2  | 10.8 $\pm$ 0.8 | 10.1 $\pm$ 0.19 | 14.0 $\pm$ 2.77 |
| $\Sigma$ PUFA        | 19.1 $\pm$ 1.4 | 19.0 $\pm$ 1.4 | 19.2 $\pm$ 1.05 | 18.5 $\pm$ 2.53 |
| n6/n3 FA             | 0.5 $\pm$ 0.2  |                | 3.92 $\pm$ 0.98 |                 |

## Appendix - Results

Growth performance of Angus heifers supplemented with rumen-protected fish (n-3) and sunflower (n-6) oil.

| Diet                           | n-3   | n-6   | SEM    | P-values |
|--------------------------------|-------|-------|--------|----------|
| Total weight gain (kg)         | 62.6  | 61.8  | 15.78  | 0.937    |
| Average daily weight gain (kg) | 0.464 | 0.470 | 0.0763 | 0.957    |
| Feed Conversion Rate %         | 0.062 | 0.063 | 0.0104 | 0.956    |

## Appendix - Results

Carcass characteristics and organ weights of Angus heifers supplemented with rumen-protected fish (n-3) and sunflower (n-6) oil.

| Diet                          | n-3  | n-6  | SEM   | P-values |
|-------------------------------|------|------|-------|----------|
| Carcass characteristics       |      |      |       |          |
| Life weight at slaughter (kg) | 419  | 406  | 12.8  | 0.362    |
| Hot Carcass weight (kg)       | 217  | 205  | 7.0   | 0.117    |
| Cold carcass weight (kg)      | 212  | 201  | 6.8   | 0.100    |
| Dressing percentage           | 51.7 | 50.9 | 0.55  | 0.275    |
| Organ weights (kg)            |      |      |       |          |
| Heart                         | 1.60 | 1.48 | 0.042 | 0.045    |
| Liver                         | 4.25 | 4.00 | 0.193 | 0.182    |
| Spleen                        | 0.77 | 0.66 | 0.035 | 0.017    |
| Kidney                        | 0.37 | 0.36 | 0.014 | 0.682    |
| Lungs                         | 2.42 | 2.27 | 0.108 | 0.327    |

# Appendix - Results

Chemical composition of Angus heifers supplemented with rumen-protected fish (n-3) and sunflower (n-6) oil.

| Muscle           | Longissimus thoracis |      | Biceps femoris |      | Extensor carpi radialis |       | SEM   | P-values |       |        |               |
|------------------|----------------------|------|----------------|------|-------------------------|-------|-------|----------|-------|--------|---------------|
|                  | Diet                 | n-3  | n-6            | n-3  | n-6                     | n-3   |       | n-6      | Diet  | Muscle | Diet × muscle |
| Dry matter       |                      | 25.3 | 24.6           | 24.9 | 24.4                    | 21.8  | 21.9  | 0.402    | 0.135 | <0.001 | 0.481         |
| Ash              |                      | 1.29 | 1.35           | 1.64 | 1.62                    | 1.59  | 1.53  | 0.116    | 0.923 | <0.001 | 0.423         |
| Nitrogen         |                      | 3.47 | 3.47           | 3.23 | 3.26                    | 3.13  | 3.23  | 0.047    | 0.115 | <0.001 | 0.252         |
| Fat <sup>1</sup> |                      | 2.42 | 1.97           | 2.65 | 2.21                    | 0.804 | 0.553 | 0.2381   | 0.012 | <0.001 | 0.864         |

<sup>1</sup> Soxhlet method with hydrochloric acid decomposition