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Dietary PUFA intervention affects fatty acid- and micronutrient profiles of beef and related beef products

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Advancing Beef Safety and Quality through Research and Innovation
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LEIBNIZ INSTITUTE
FOR FARM ANIMAL BIOLOGY

Meat consumption - Germany

German Society of Nutrition (DGE)

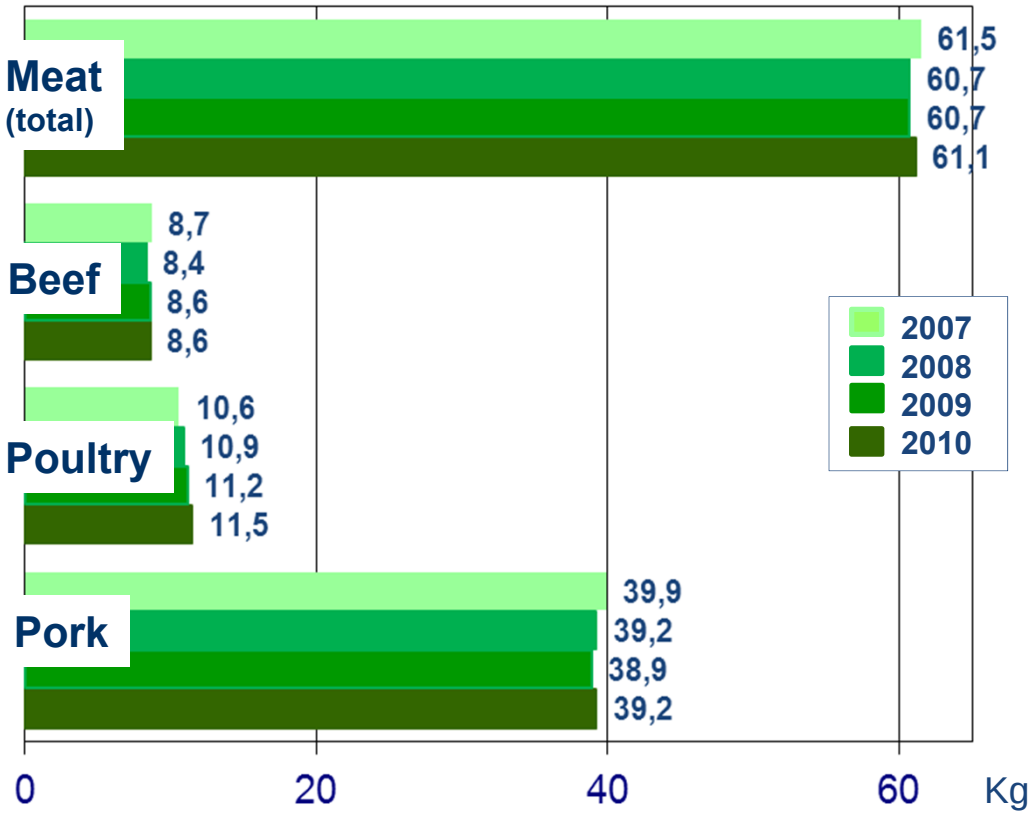
(10 rules of full-value food and drinking, www.dge.de)

....

4. Daily milk and dairy products; one to two times per week fish; moderate consumption of fresh- and processed meat

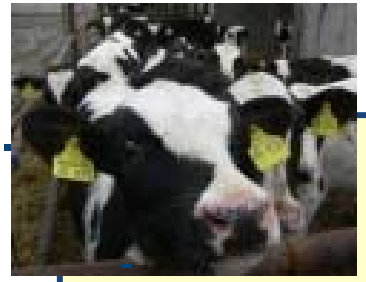
   - no more than 300-600 g meat (fresh+processed) per week
   - mainly lean products

Meat consumption* kg/head/year



*without industrial utilization and losses, without bones and diet
Bundesanstalt für Landwirtschaft und Ernährung (BLE), 2011

Experiment



German Holstein bulls
Control group (n=15)
Experimental group n=14)

Diets

Control diet: maize silage, concentrate (2.5 kg) based on soybean meal (41%), wheat (40%), maize (10%) straw and minerals

Experimental diet: grass silage, concentrate (2.5 kg) based on triticale (40%), wheat (28%), rapeseed cake (13%) and rapeseed oil (2%)

The bulls were fed indoor (group keeping) for approx. 240 days and slaughtered at a live weight of 630 kg.

Sampling - beef

M. *longissiumus* d., 12th -13th rib, right carcass side

	TMR control	TMR Treatment
Chemical composition		
Metabolic Energy (MJ/kg)	11.4	11.1
Crude protein	15.3	14.9
Crude fat	3.1	4.0
Crude ash	7.0	12.3
Fatty acid profile		
12:0	0.2	0.2
14:0	0.8	0.4
16:0	20.5	16.7
18:0	2.6	2.6
18:1*cis*9	19.1	15.7
18:2*n*-6	40.0	21.5
18:3*n*-3	10.8	35.5
n-6/*n*-3 fatty acid ratio	3.7	0.6

Beef products (sausages)

Corned Beef
(n=29)

- **58 % Beef, (lean meat from joint and bug)**
- **5 % Beef rind**
- Drinking water, gelatin, spices salt, celeriac, corn, soy a.o.

Procedure
- Cooked until 68°C (int. temp.)
- Cooled minced and mixed with spices
- Filled in sausage casing
- Scalded again, and cooled down

Tea sausage spread
(feine Streichmettwurst)
(n=29)

- **30 % Beef, hindquarter**
- **flank**
- **20 % Beef, neck**
- **Pork**
- Pickling salt, spices, sugar, antioxidants a.o.

94 % Beef + pork

Procedure
- Fine grinded (2 mm)
- Filled in sausage casing
- Ripening
- Cold smoked (35°C)

Scalded sausage (‚Feuerli')
(n=29)

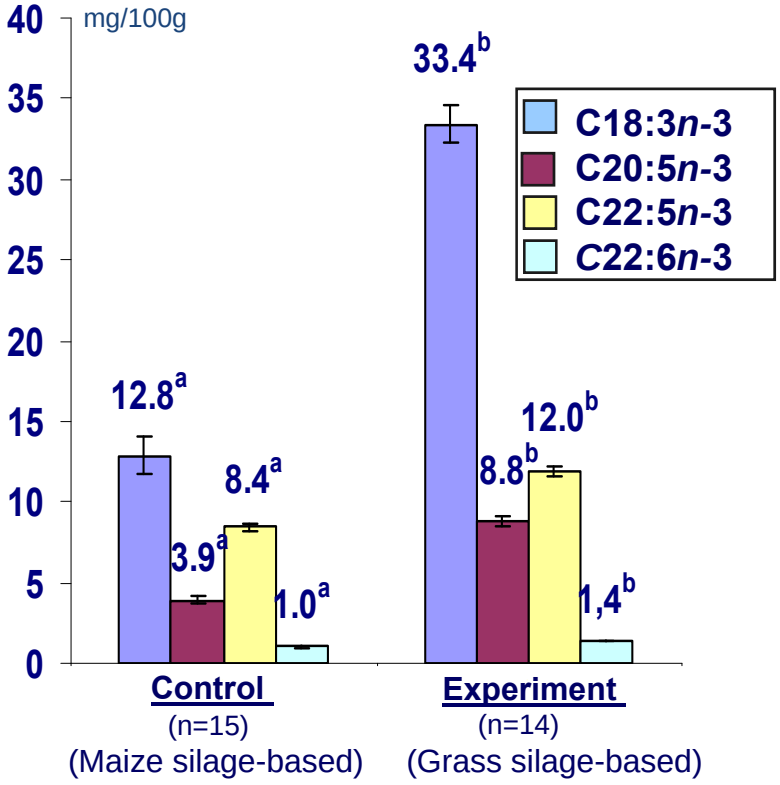
- **28 % beef, hindquarter and neck**
- **Pork**
- Pickling salt, spices, antioxidants a.o.

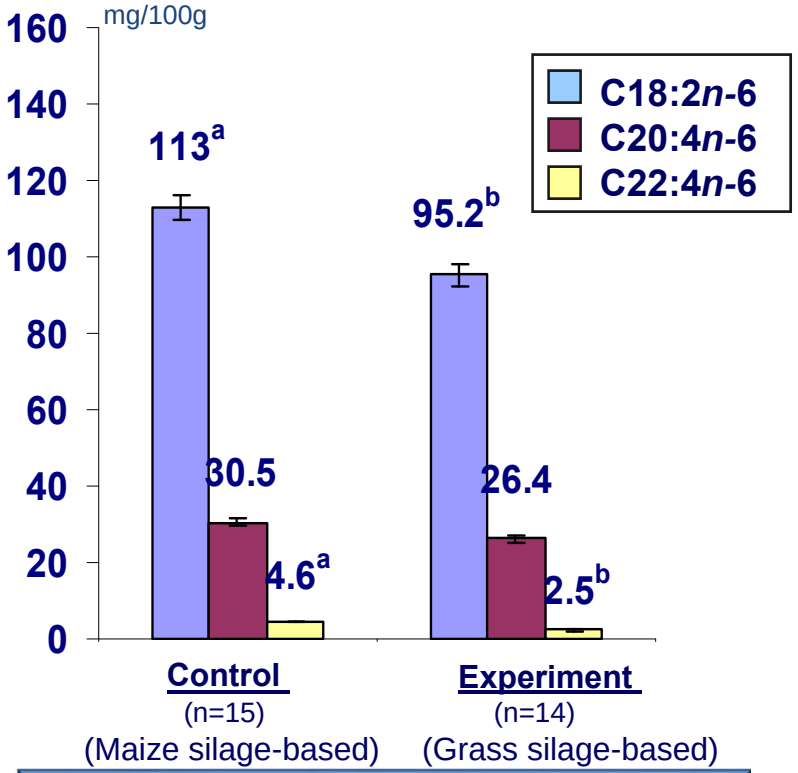
83 % Beef + pork

Procedure
- Fine grinded (3 mm)
- Filled in sausage casing
- Hot smoked and scalded (78°C)
- Cooled down (7°C)

From each animal (each carcass) single sausages were produced

Fatty acid concentrations *longissimus* muscle (mg/100g)





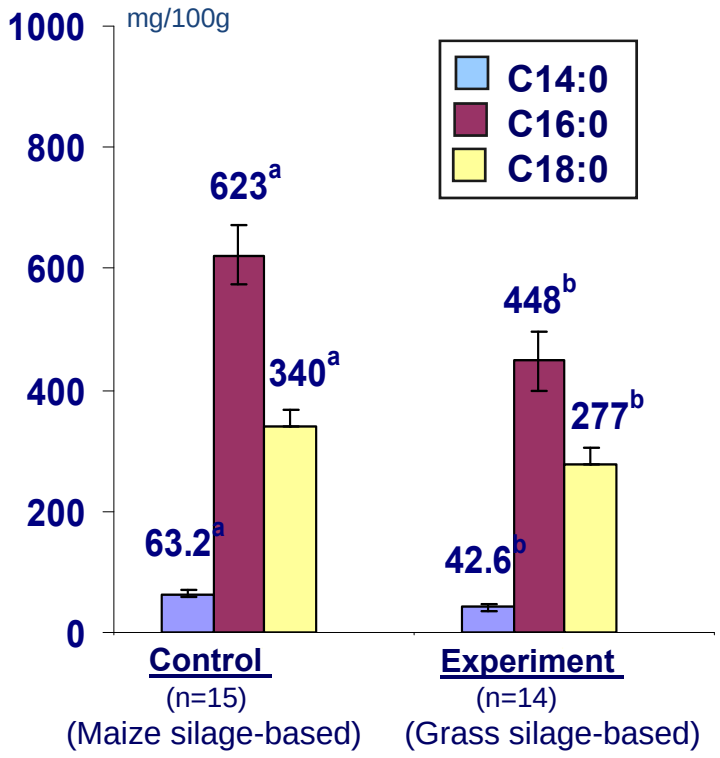
N-3 PUFA

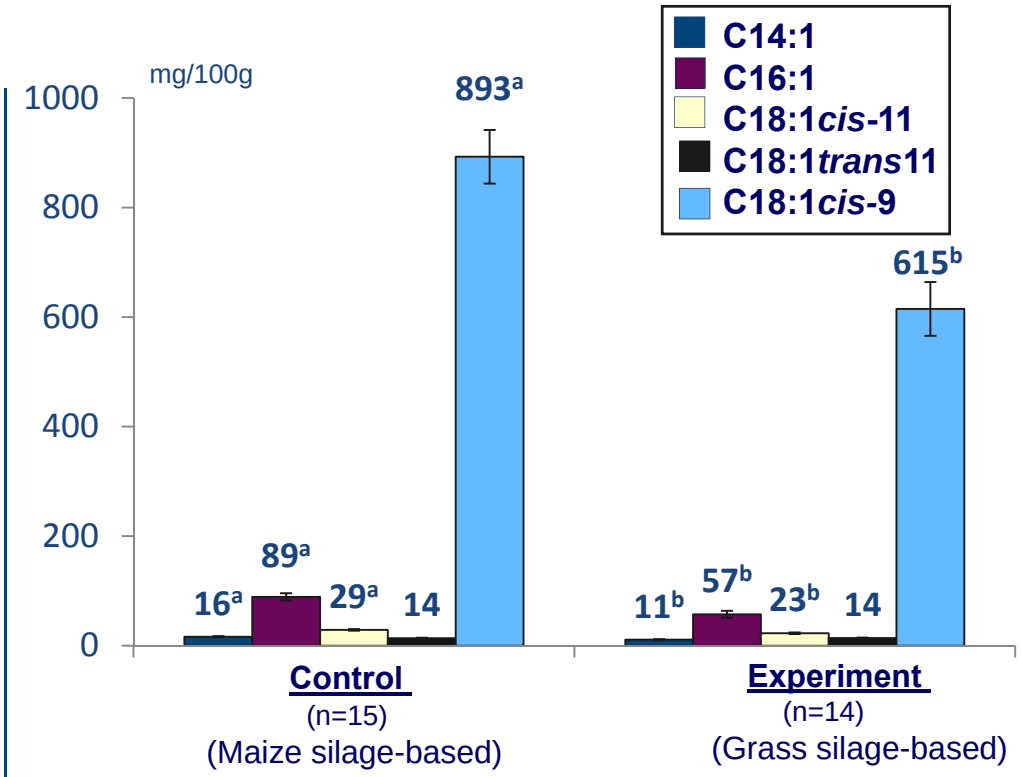
+ All single and sum *n*-3 PUFA accumulated by experim. diet

N-6 PUFA

+ single and sum *n*-6 PUFA decreased by experim. diet, (except 20:4*n*-6)

Fatty acid concentrations *longissimus* muscle (mg/100g)





Saturated FA (SFA)

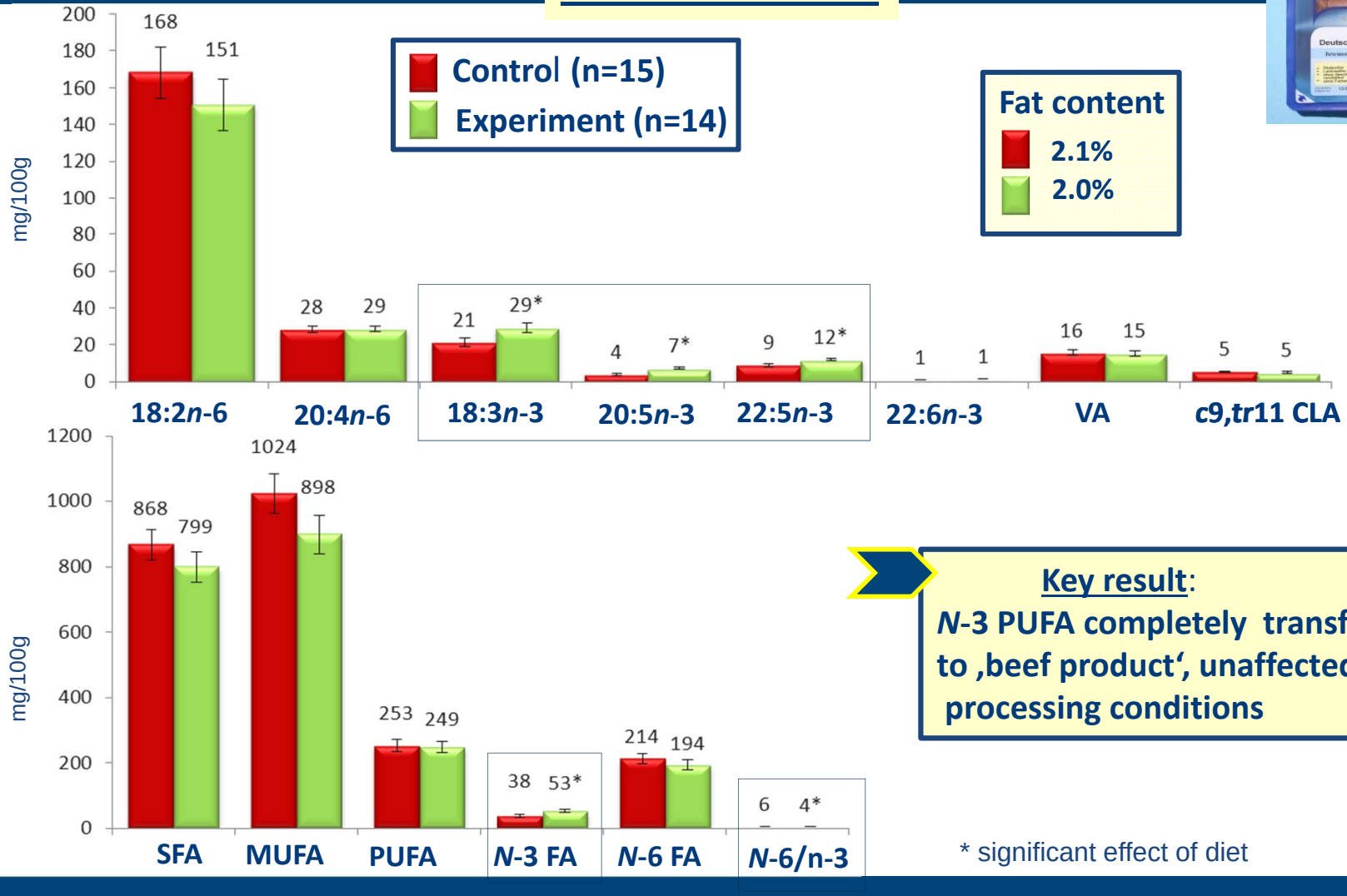
+ single and sum SFA decreased by experim. diet

Monounsaturated FA (MUFA)

+ single and sum MUFA decreased by experim. diet, except VA

Beef products (sausages)

Corned Beef

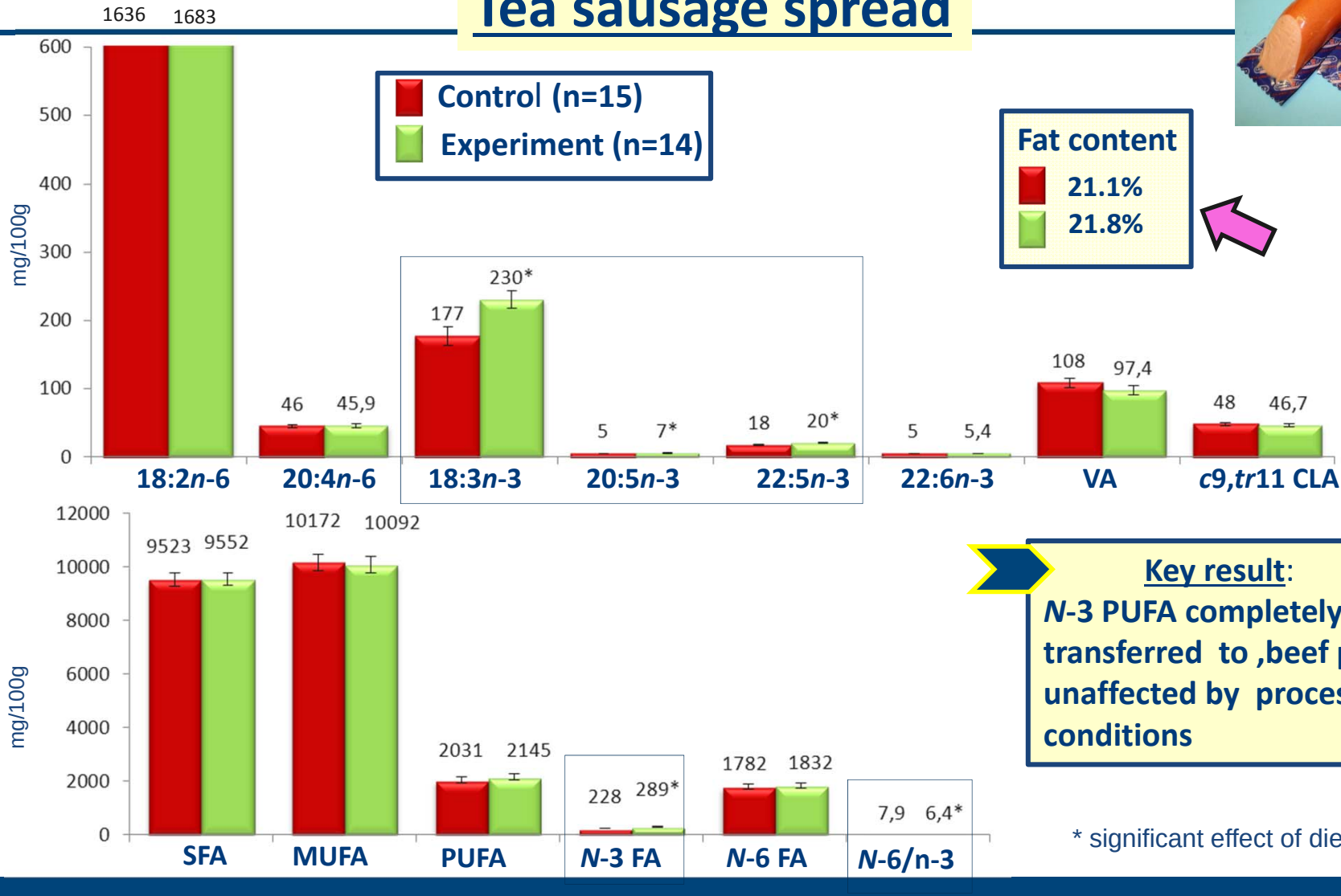


Key result:
***N*-3 PUFA completely transferred to ‚beef product', unaffected by processing conditions**

* significant effect of diet

Beef products (sausages)

Tea sausage spread



Fat content
- 21.1%
- 21.8%

Key result:
***N*-3 PUFA completely transferred to ‚beef product', unaffected by processing conditions**

* significant effect of diet

Beef and beef products (sausages)
- *n*-3 PUFAs -

EFSA (2010) determined that 250mg should be the labelling reference intake value for long-chain omega-3 fatty acids –most notably eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

250mg/day EPA + DHA:

‚Source of'	15% = 37.5 mg (EPA+DHA)
‚High in'	30% = 75 mg (EPA+DHA)

or 2g of alpha-linolenic acid (ALA)

‚Source of'	15% = 300 mg
‚High in'	30% = 600 mg

A 250 g serving supplies:

EPA+DHA = max. 38 mg (Experiment gr
→ Steak of grass silage-based bulls is
‚source of' *n*-3 PUFA (37.5 m

Recommended daily intake (RDI) of tota
(adults, age: 25-51, DGE, Germany, 2012

1000 mg/total n-3 PUFA/day
Steak (250 g) = 152 mg total *n*-3 PU
(= 15% of RDI)

Beef and beef products (sausages)
- *n*-3 PUFAs -

20 g Tea sausage spread supplies:

➧ **1000 mg/total n-3 PUFA/day**

Tea sausage spread (20 g) = 58 mg total n-3 PUFA (= 7 % of RDI)

Recommended daily intake (RDI) of total n-3 FA (adults, age: 25-51, DGE, Germany, 2012)

Beef and beef products (sausages) - Fatsoluble vitamins -

Muscle (mg/kg)	Control LSM$_{SEM}$ (n=15)	Experiment LSM$_{SEM}$ (n=14)	P*value*
α-Tocopherol	$1.15_{0.08}$	$0.93_{0.09}$	0.098
γ-Tocopherol [a]	$0.08_{0.007}$	$0.04_{0.007}$	0.001
δ-Tocopherol	$0.003_{0.002}$	$0.004_{0.002}$	0.798
Retinol (A)	$0.13_{0.01}$	$0.10_{0.01}$	0.123
ß-Carotene [a]	$1.08_{0.06}$	$2.02_{0.07}$	0.002

Corned Beef (mg/kg)	Control LSM$_{SEM}$ (n=15)	Experiment LSM$_{SEM}$ (n=14)	P*value*
α-Tocopherol	$2.16_{0.18}$	$2.11_{0.19}$	0.853
γ-Tocopherol [a]	$0.14_{0.01}$	$0.09_{0.01}$	0.031
δ-Tocopherol	$0.008_{0.001}$	$0.007_{0.001}$	0.798
Retinol (A)	$0.10_{0.01}$	$0.14_{0.01}$	0.654
ß-Carotene [a]	$1.78_{0.18}$	$2.22_{0.17}$	0.039

[a] significant effect of diet

A 250g serving supplies

	RDI* (mg)	Experiment (mg/250g)	% of RDI
Muscle			
Retinol (A)	1.0	0.025	2.5
Vitamin E	12-15	0.2	2.0
ß-Carotene	6.0	0.5	4.0
Corned Beef			
Retinol (A)	1.0	0.035	3.5
Vitamin E	12-15	0.55	5.0
ß-Carotene	6.0	0.56	9.0

***RDI – Recommended Daily Intake**
(avarage values for adults, Reference values, German Society of Nutrition, update 2012)

Beef and beef products (sausages) - Trace metals -

Muscle (mg/kg)	Control LSM SEM (n=15)	Experiment LSM SEM (n=14)	P value
Fe	23.2 1.12	21.2 1.20	0.225
Cu	1.2 0.12	1.2 0.12	0.867
Zn	61.3 2.10	60.9 2.17	0.91
Se	0.16 0.006	0.15 0.006	0.27

Corned beef (mg/kg)	Control LSM SEM (n=15)	Experiment LSM SEM (n=14)	P value
Fe	22.7 0.79	22.8 0.81	0.918
Cu	0.75 0.05	0.83 0.06	0.302
Zn	36.7 2.20	38.0 2.30	0.682
Se	0.10 0.006	0.11 0.006	0.847

A 250g serving supplies

	RDI* (mg)	Experiment (mg/250g)	% of RDI
Muscle			
Fe	12	5.3	44
Cu	1.0-1.5	0.29	24
Zn	7-10	15	150
Se	0.03-0.07	0.04	75
Corned Beef			
Fe	12	5.5	48
Cu	1.0-1.5	0.21	17
Zn	7-10	9.5	95
Se	0.03-0.07	0.03	55

***RDI – Recommended Daily Intake** (avarage values for adults, Reference values, German Society of Nutrition, update 2012)

Summary

+ Long-term feeding of *n*-3 or *n*-6 PUFA-based diets resulted in accumulation of beneficial fatty acids in fresh beef

+ Dietary *n*-3 PUFA (grass silage-based) suppress the biosynthesis of saturated fatty acid in beef and corresponding beef products

+ Trace elements (Fe, Zn, Se, Cu) were not affected in beef and beef products by the diet, however experimental diet (grass silage-based) increased ß-carotene contents

+ Dietary *n*-3 PUFA were completely transferred into beef products (Corned Beef, Tea sausage spread) uneffected by beef processing conditions

+ Beef and beef products can partly contribute to the daily consumption on *n*-3 PUFA, trace elements and vitamins.

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