Factors affecting effectiveness of micronutrient supplementation in crop and animal production

Emphasis on Selenium in terrestrial animals

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Engineering your feed solutions

1 Introduction: Intake, metabolic pathways and presence of Se

Fortification targets

2 Factors affecting effectiveness of fortification in animal production

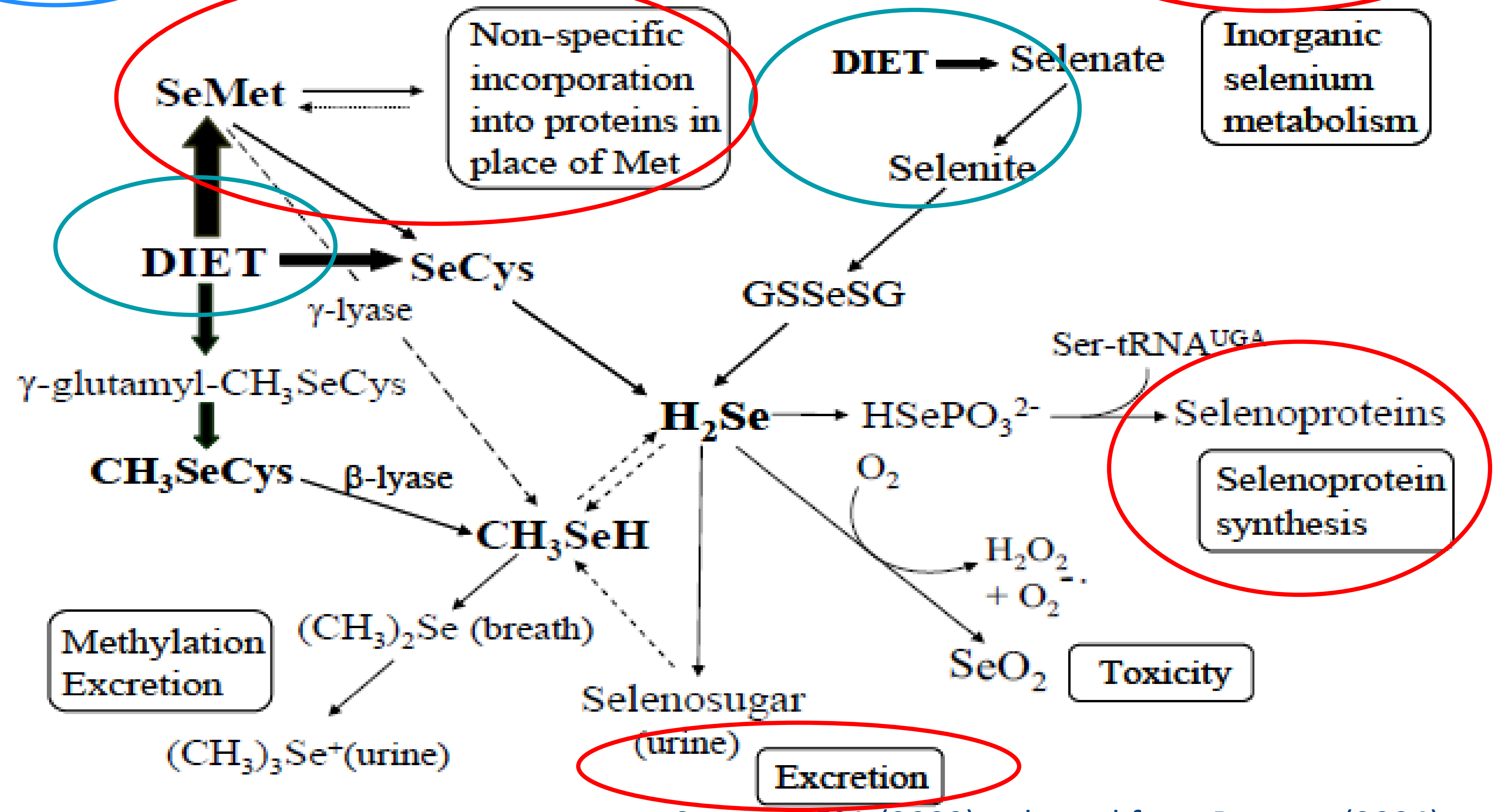
3 Summary

1 Introduction: Introduction: Intake, metabolic pathways and presence of Se in different tissues

Intake, metabolic pathways and presence of Selenium

Fortification targets

1 Intake, metabolic pathways and presence of Se



Source: EFSA (2009), adapted from Rayman (2004) and Combs (2001)

Fortification targets of Se through the diet

Se in the diet

L-Selenomethionine
(Excential Selenium4000 preparation EU 3b815 (2014))

Other Se compounds

- SeYeast containing Se:
  - 63% Selenomethionin-Se
  - other organic Se-compounds
- Inorganic Selenite

Se in the metabolism

H_2S

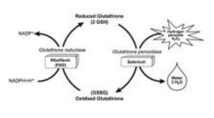
Incorporation in animal proteins

- Se status, storage in tissue, Se reserve for later mobilization (protein turnover)
- Se transfer to offspring
- Se enrichment of animal products, meat, milk, eggs

de novo Se-Cys

Seleno enzymes

- Glutathion peroxidase
- Antioxidant role
- Immunity



Excretion
Via breath and urine

Fortification targets Waegeneers et al., 2013

Food group	Mean usual intake (mg day-1)	
Bread, toast (rusk) and breakfast cereals	6,9	
Potatoes and potato products	0,6	
Pasta and rice	6,9	
Vegetables (excluding soups and juices)	1,8	
Fruit (excluding juices and olives)	-	
Meat and meat products	18,7	
Fish and shellfish	11,6	
Eggs	2,3	
Cheese	5,5	
Yoghurt and custard	0,3	
Milk and dairy drinks	2,3	
Drinks	2,8	
Total	59,6	

	n	ppm Se	Range
Pork meat	10	0,15	0,12-0,20
Beef	21	0,14	0,04-0,39
Chicken meat	5	0,21	0,16-0,29
Bovine and chicken liver	11	0,61	0,17-1,7
Bovine kidney	3	1,9	1,7-2,1
Eggs	15	0,23	0,21-0,27
Milk and dairy drinks	13	0,03	0,01-0,05

- *Wide range of contents*
- *Fortification possibilities*

Waegeneers et al., Predicted dietary intake of selenium by the general adult population in Belgium. Food Additives and contaminants (2013)

2 Factors affecting effectiveness of fortification in animal production

- Source and chemical form of Se in the diet
- Dosage of Se in the diets
- Target edible product

- Recent data in pigs, poultry, eggs and milk

Trial results fattening pigs (1)

Zhan et al, 2007

- Total 108 male castrates (60kg)
- 3 treatments with 3 replicates (12 pigs/pen) / treatment
  - Control: no suppl (0,045 mg basal Se/mg)
  - NaSe: 0,3 mg Se/mg
  - SeMet: 0,3 mg Se/kg
- Measurements at slaughter

Inorganic selenite increases Se contents
Organic selenomethionine intake increases further the Se content in liver, muscle, pancreas

(Waegeneers et al. 2013)	n	ppm Se	Range
Pork meat	10	0,15	0,12-0,20

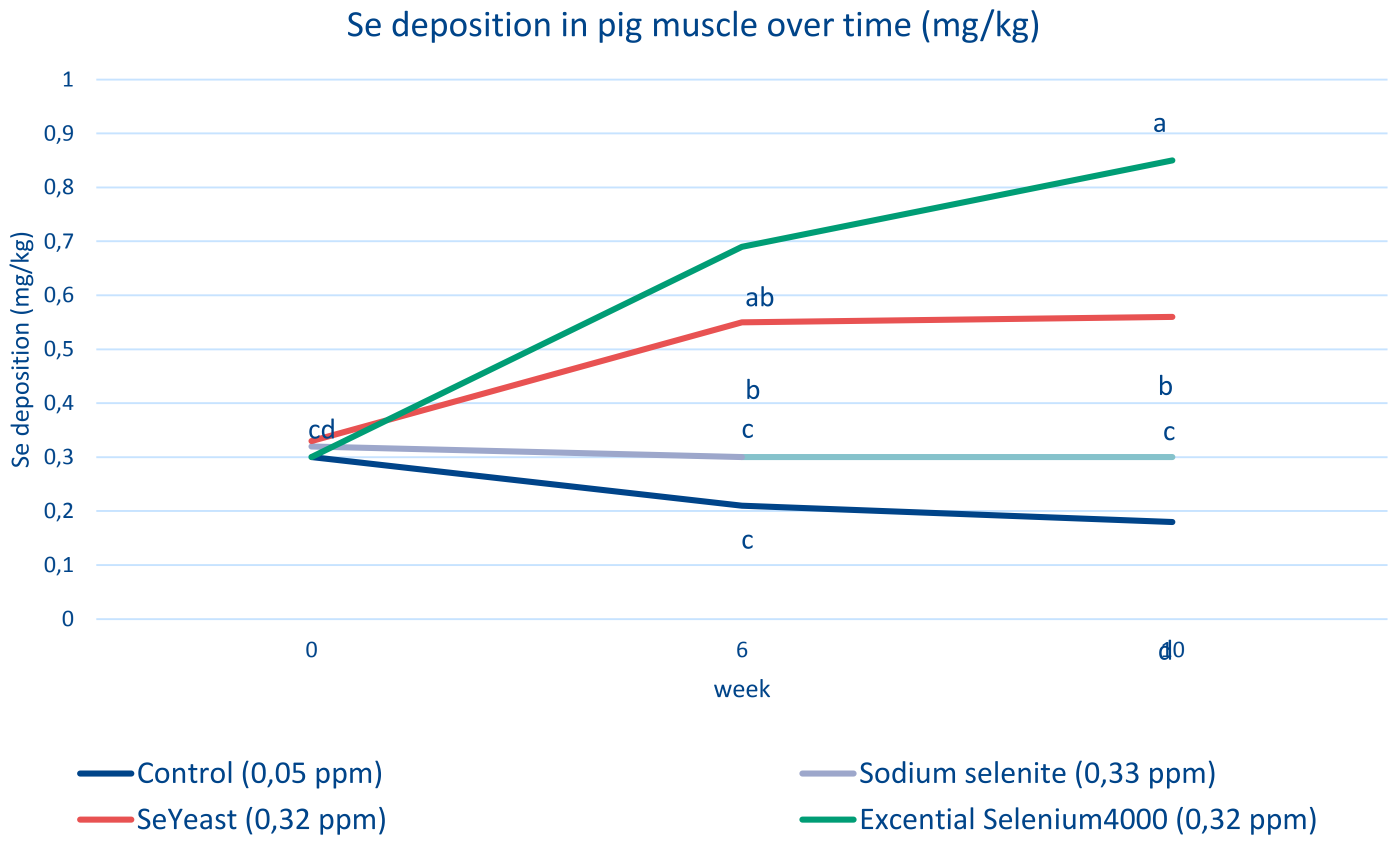
Table 2
Effects of different Se sources on Se concentration in serum, muscle, liver, pancreas, and kidney tissue of finishing pigs[a]

	Control	Sodium selenite[b]	Selenomethionine[b]
Serum (μg/ml)	0.06 ± 0.013 y	0.15 ± 0.011 x	0.16 ± 0.020 x
Liver (μg/g)	0.27 ± 0.027 z	0.53 ± 0.025 y	0.72 ± 0.052 x
Muscle (μg/g)	0.10 ± 0.022 z	0.14 ± 0.022 y	0.35 ± 0.036 x
Pancreas (μg/g)	0.30 ± 0.020 z	0.38 ± 0.033 y	0.58 ± 0.035 x
Kidney (μg/g)	1.7 ± 0.28 y	2.3 ± 0.32 x	2.6 ± 0.27 x

Trial results fattening pigs (2)

Falk et al, 2016

- Norwegian University of Life Sciences
- Total 24 pigs (30kg)
- 8 treatments, 3 pigs per treatment (total 24 pigs)
- Different Se sources, varying levels
- Results for comparable Se levels shown in graph (analyzed total Se levels in feed between brackets)



Results published at IPVS 2016 (Dublin)

(Waegeneers et al. 2013)	n	ppm Se	Range
Pork meat	10	0,15	0,12-0,20

Trial results dairy cows

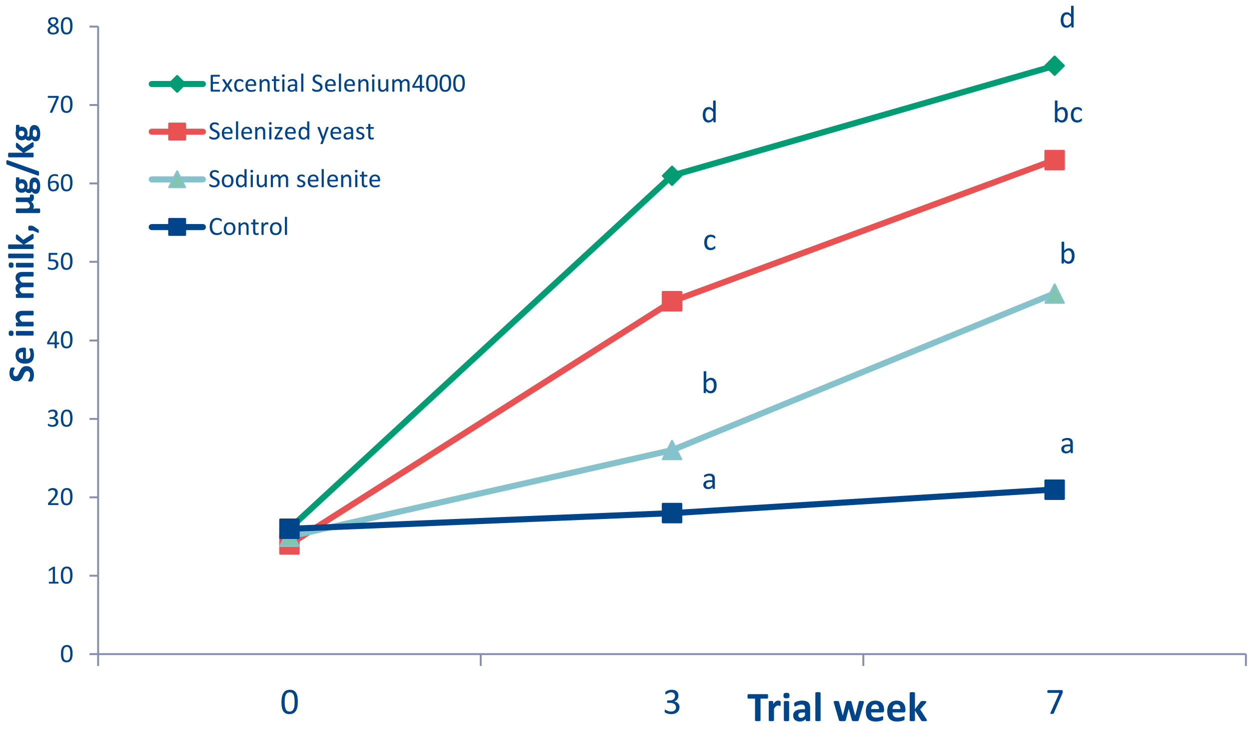
Vandaele et al, 2014

(Waegeneers et al. 2013)	n	ppm Se	Range
Milk and dairy drinks	13	0,03	0,01-0,05

- Institute: ILVO (Belgium)
- Animals: 24 high producing Holstein Friesian cows
- Treatments: 4 treatments; after pre-treatment (low Se), all cows received the same basal diet supplemented with
  Control – no Se supplementation
  0.3 mg Se /kg DM from sodium selenite
  0.3 mg Se /kg DM from selenized yeast
  0.3 mg Se /kg DM from L Selenomethionin in the preparation Excential $Selenium_{4000}$
- Duration: 9 weeks

  -2 wks pre-treatment

  -7 wks treatment



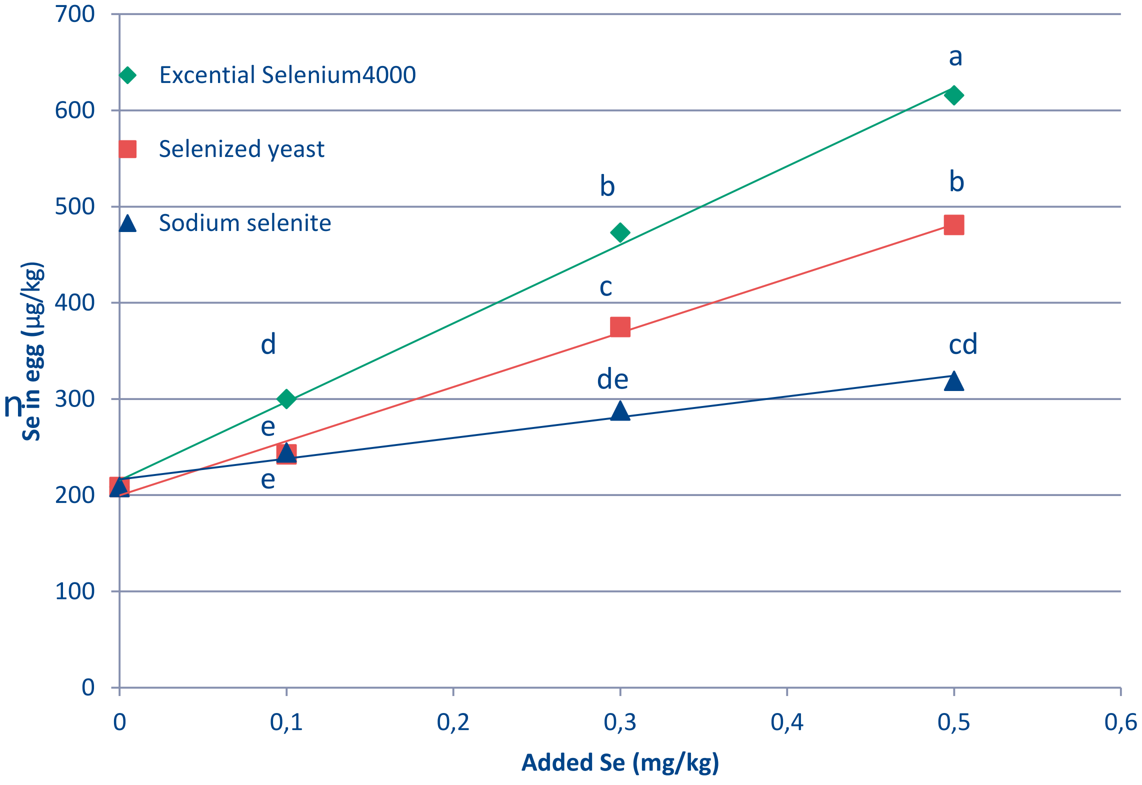
Higher Se deposition in milk for organic sources
L-SeMet higher depostion compared to SeYeast

Results published at EAAP 2014 (Copenhagen) and JAM 2014 (Kansas City)

Trial results laying hens

Delezie et al, 2014

- Institute: ILVO (Belgium)
- Animals: 180 Laying hens (Lohmann brown), 55 wks
- Treatments: 10 treatments
  - -Control (no added Se)
  - -Sodium Selenite; 0,1; 0,3; 0,5 mg Se/kg
  - -Selenized yeast; 0,1; 0,3; 0,5 mg Se/kg
  - -Excential Selenium4000; 0,1; 0,3; 0,5 mg Se/kg
    preparation based on L Selenomethionin
- Duration: Pre-treatment of 4 weeks (Se deficient) followed by 8 weeks trial period

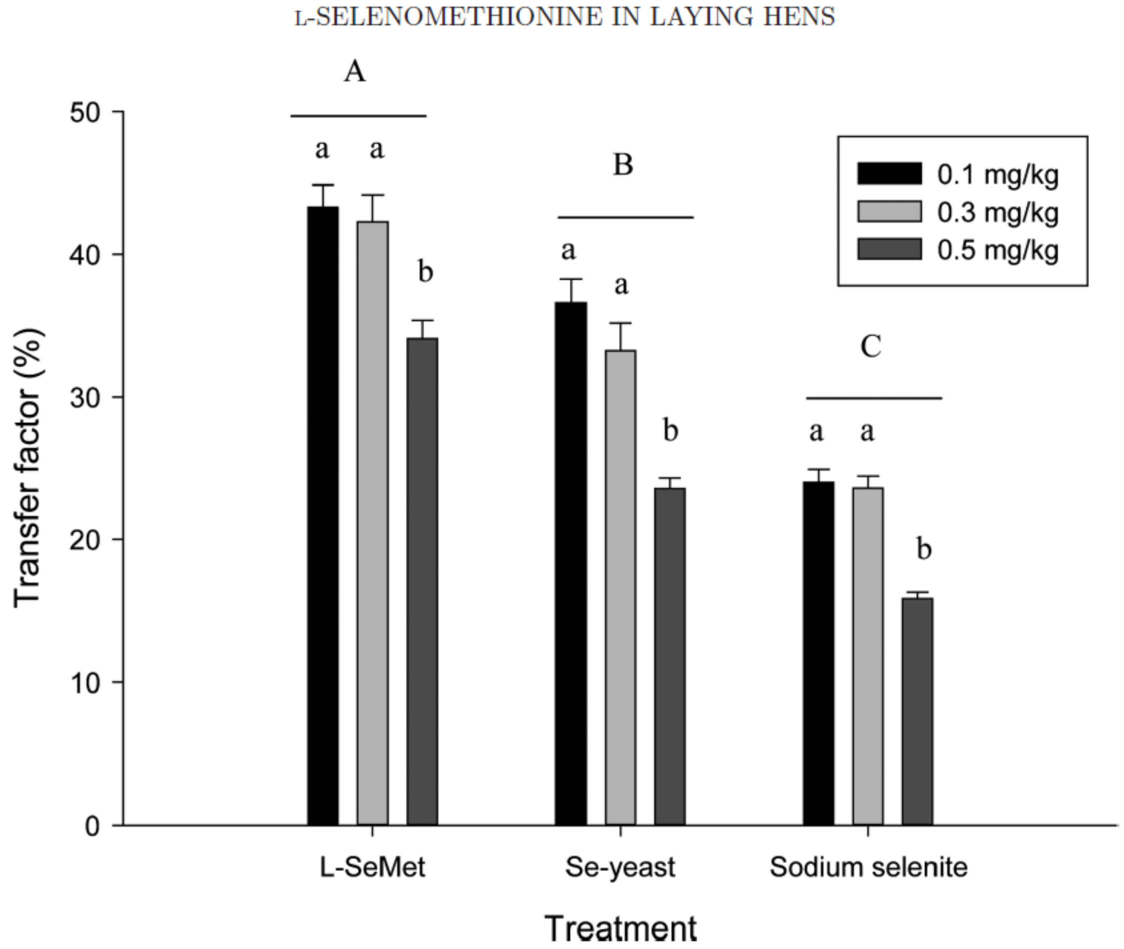


Results published in Poultry Science: Delezie (2014), PS 93 :3083–3090

(Waegeneers et al. 2013)	n	ppm Se	Range
Eggs	15	0,23	0,21-0,27

Trial results laying hens – transfer data

Delezie et al, 2014



Results published in Poultry Science: Delezie (2014), PS 93 :3083–3090

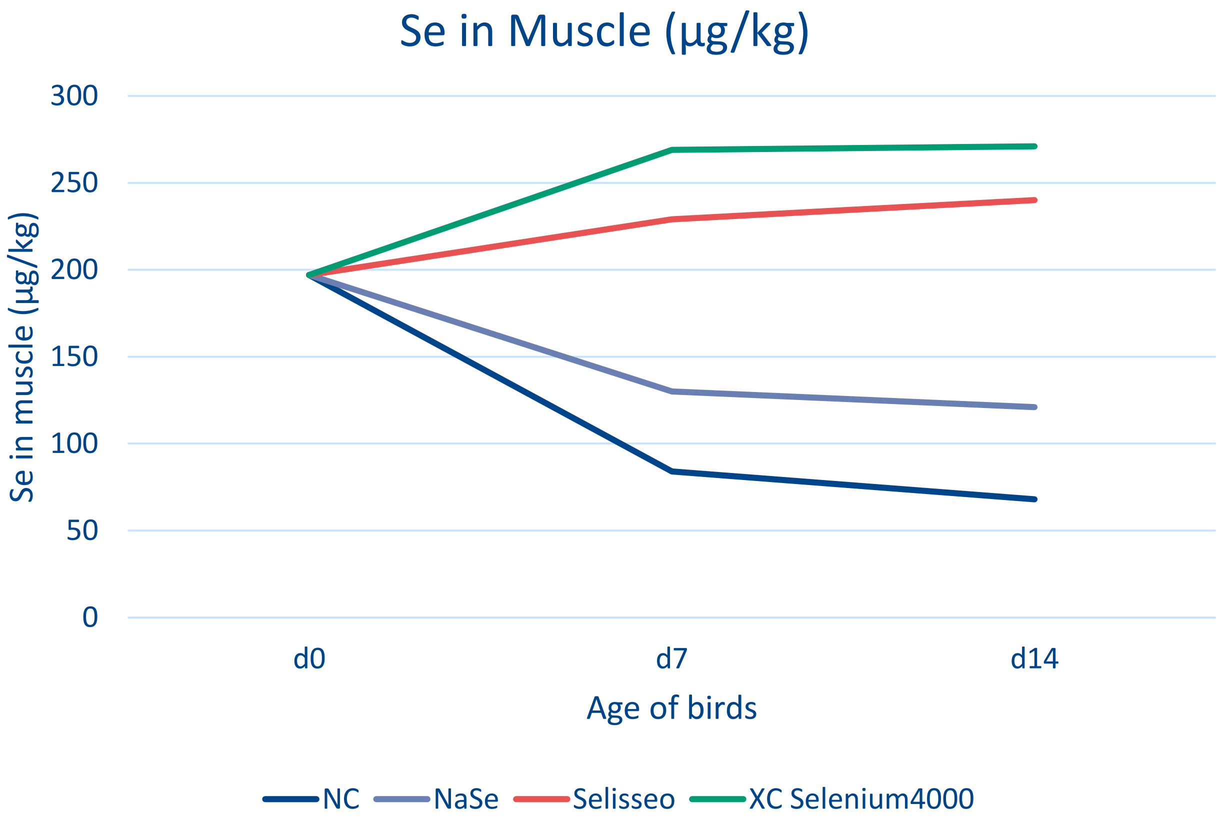
Trial results broilers (1)

Rovers et al, 2016

4 treatments with 30 birds per treatment

- 0 ppm Se (NC)
- 0,2 ppm Se from NaSe
- 0,2 ppm Se from L-SeMet (XC Selenium4000)
- 0,2 ppm Se from Se-OH-Met (Selisseo)

Se in muscle analyzed by ICP-MS at Ghent University, Faculty of Bioscience Engineering (Prof Gijs DuLaing)



(Waegeneers et al. 2013)	n	ppm Se	Range
Chicken meat	5	0,21	0,16-0,29

Results published at WPC 2016 (Beijing)

Trial results broilers (2)

Van Beirendonck et al, 2016

Location: KU Leuven, Faculty of Engineering Technology, Geel, Belgium

Animals: Broilers (Ross 308)

Treatments: 4 replicates (pens) of 5 birds/pen

Parameters: Day 0: 10 birds were sacrified to determined initial Se in muscle

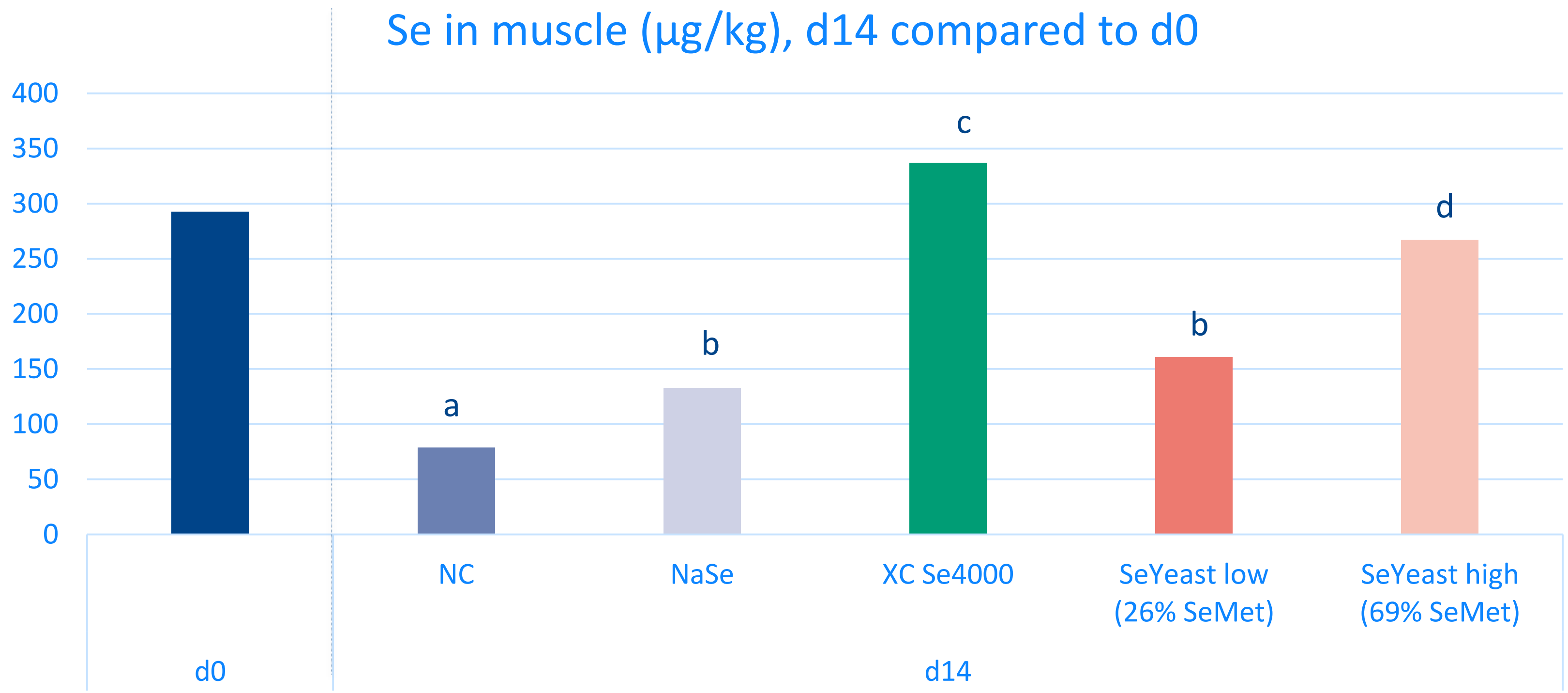
Day 14: 3 birds per pen were sampled for breast muscle.

Se in breast samples was analyzed at Ghent University (prof G. Du Laing)

Se source	NC, No added Se	Sodium selenite	XC Se4000 Based on L Seleno methionin	SeYeast low (26% SeMet)	SeYeast high (69% SeMet)
Total added Se, mg/kg	0	0,2	0,2	0,2	0,2
Added Se as SeMet, mg/kg	0	0	0,2	0,052	0,138

Trial results broilers (2)

Van Beirendonck et al, 2016

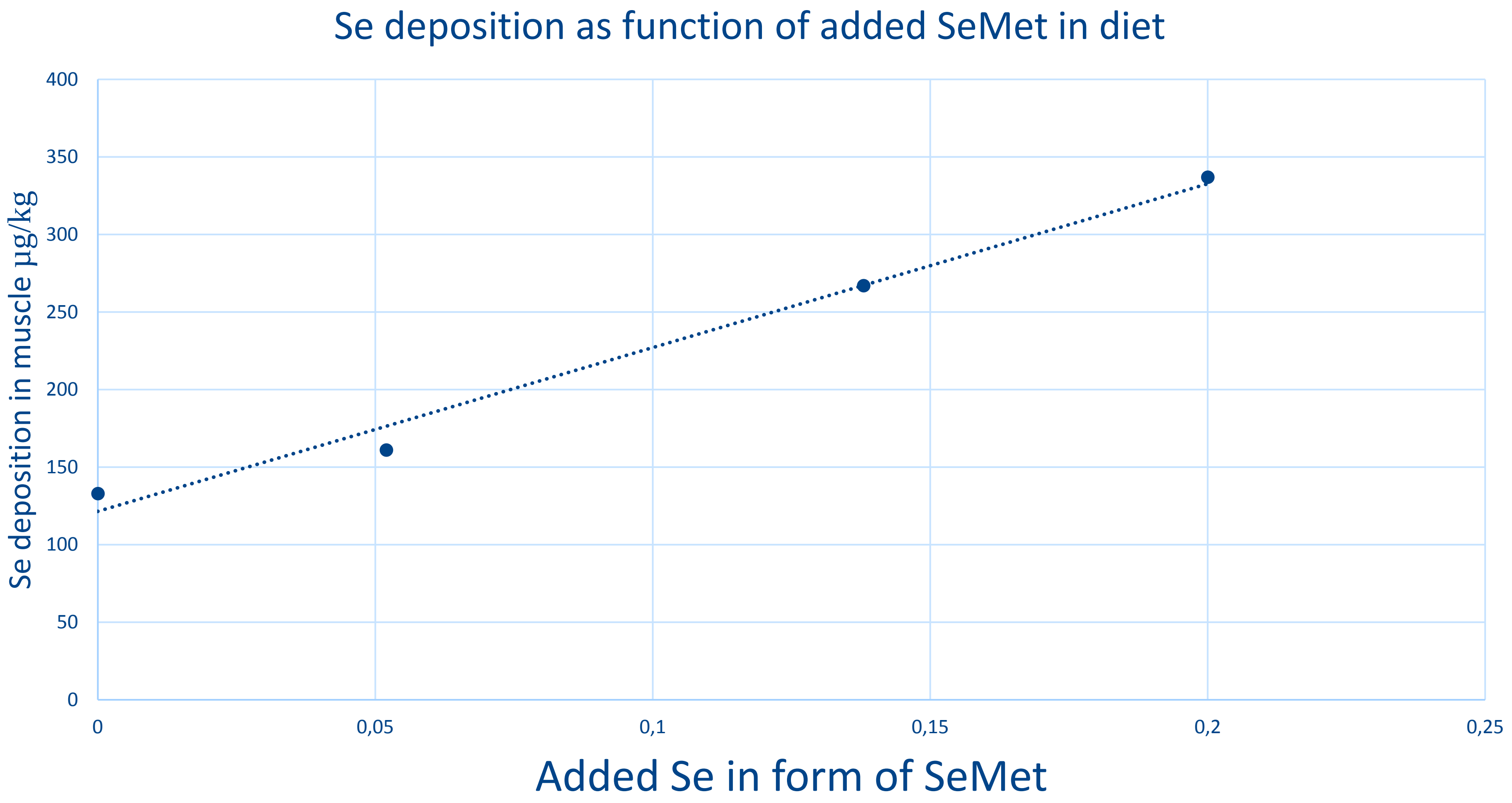


- NC or NaSe: low Se in muscle (decreases versus d0)
- L Selenomethionin based XC Se4000: Increase of Se in muscle
- Organic Se: level of SeMet is determining factor for Se deposition

Results published at WPC 2016 (Beijing)

Trial results broilers (2)

Van Beirendonck et al, 2016 *Results published at WPC 2016 (Beijing)*



Se deposition in muscle is linear correlated with the added Se as Selenomethionine in the diet (*P*<0.0001).

Summary

- Fortification of selenium in animal products through supplementation of the diet
  - Proven concept of fortification of Se in animal products
  - Dose dependent

    Attention: max level of total Se in the diet in EU: 0,5 ppm Se
  - Source dependent
    - Organic selenium sources outperform inorganic Sodium Selenite

      Attention: max level of added organic Se in the diet in EU: 0,2 ppm Se
    - Level of SeMet and preparation is the actual value of interest for fortification

Trial averages

depending

on the sources

Se level after fortification	Pig	Broiler	Milk	Eggs
Inorganic Se	X 1,5	X 1,5	X 2	X 1,5
Organic Se	X 3-4	X 3-4	X 3-4	X 3

To be evaluated case by case: genetic and environmental influences

Thank you for your attention

ORFFA

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