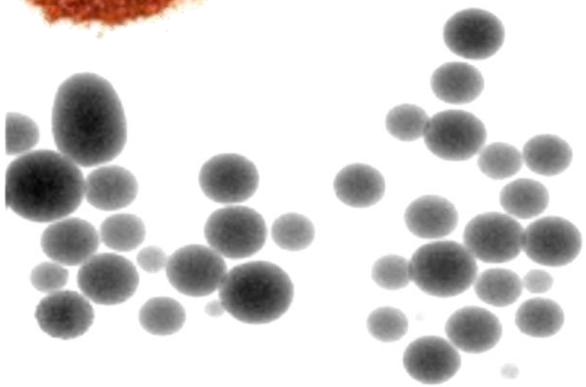
73rd Annual Meeting of EAAP - Porto

September 2022

Session 43: Challenges in poultry nutrition, health and welfare | Abstract number: 39386

Efficacy of dietary selenium-loaded chitosan nanoparticles in rabbits and broiler chickens



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Background

Selenium (Se) nanoparticles (SeNPs) have attracted attention as alternative dietary Se source in animals. A form of elemental Se nanoparticles (SeNP) stabilized in chitosan microspheres (**CS-SeNPs**) is under investigation in biomedicine as Se carrier with very promising results, but their potential as dietary Se source in livestock has not been extensively investigated.

Research question 1:

a) Can CS be degraded in the digest tract thereby releasing SeNP?

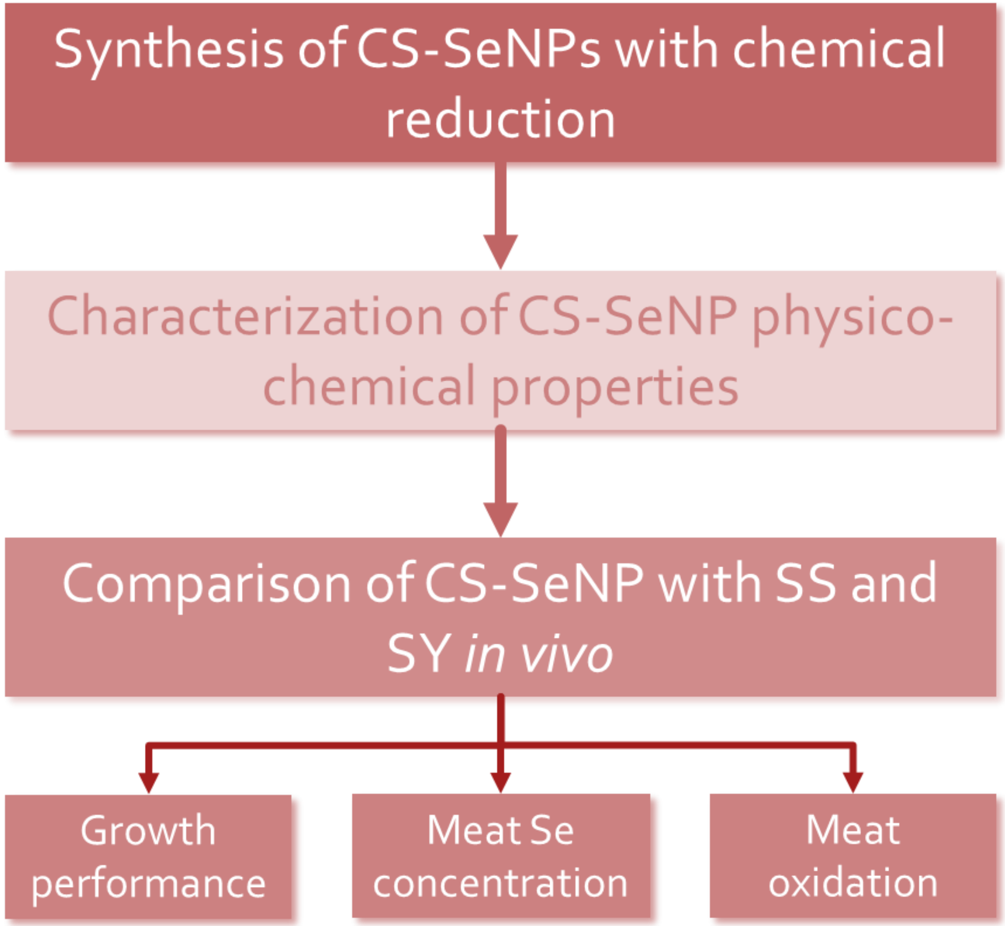
b) Is the released Se bioavailable?

[meat Se content]

Research question 2:

If so, is the Se bioactive?
[performance, meat oxidative stability]

Objectives



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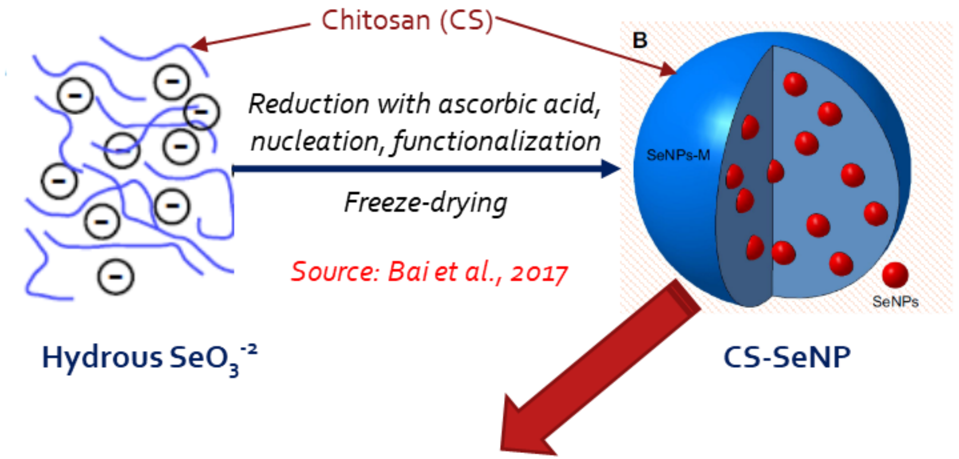
Materials & Methods

CS-SeNP synthesis



- **Dynamic light scattering (DLS):** size distribution
- **X-ray diffraction (XRD):** structure of Se
- **X-ray photoelectron spectroscopy (XRD):** composition of CS-SeNP
- **Hydride vapour generation (AA):** Se content

Feeding trials

200 Ross broiler chickens in a 3-phase feeding (starter, grower, finisher) experiment

Control (C) (*n*= 50, 5 rep.)	Group T1 (*n*= 50, 5 replic.)	Group T2 (*n*= 50, 5 replic.)	Group T3 (*n*= 50, 5 replic.)
Basal diet (BD) with no additional Se	BD+0,4 mg Se/kg: 0,2 mg from SS + 0,2 mg from SY	BD+0,4 mg Se/kg: 0,2 mg from SY + 0,2 mg από CS-SeNP	BD+0,4 mg Se/kg: only from CS-SeNP

96 New Zealand × California weaned rabbits (age 35 days)

Control (C) (*n*= 24)	Group T1 (*n*= 24)	Group T2 (*n*= 24)	Group T3 (*n*= 24)
Basal diet (BD) with no additional Se	BD+0,4 mg Se/kg: 0,2 mg from SS + 0,2 mg from SY	BD+0,4 mg Se/kg: 0,2 mg from SY + 0,2 mg από CS-SeNP	BD+0,4 mg Se/kg: only from CS-SeNP

Target=
total dietary Se (in T1, T2 and T3)
≤ 0,5 mg/kg

CS-SeNP characterization

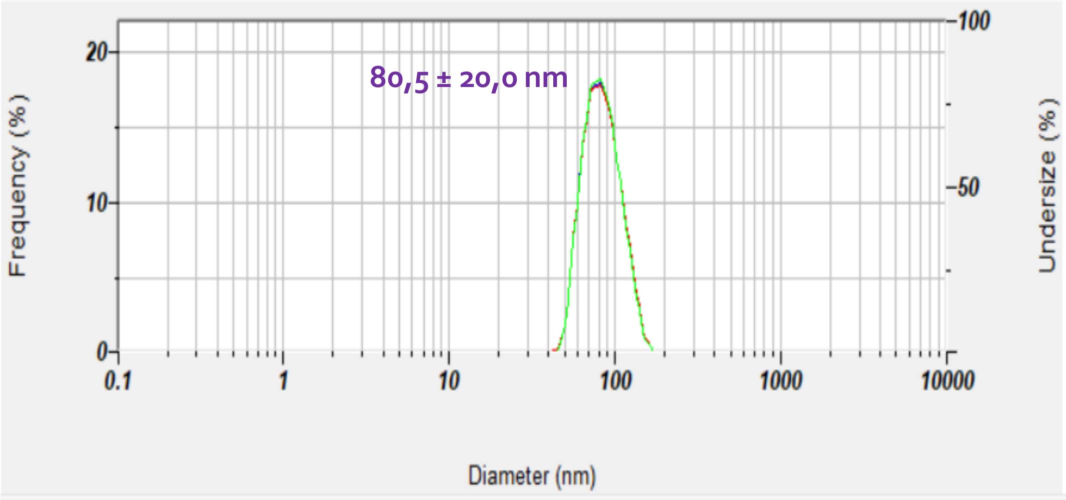


Figure 1: Size distribution of CS-SeNP using dynamic light scattering (DLS)

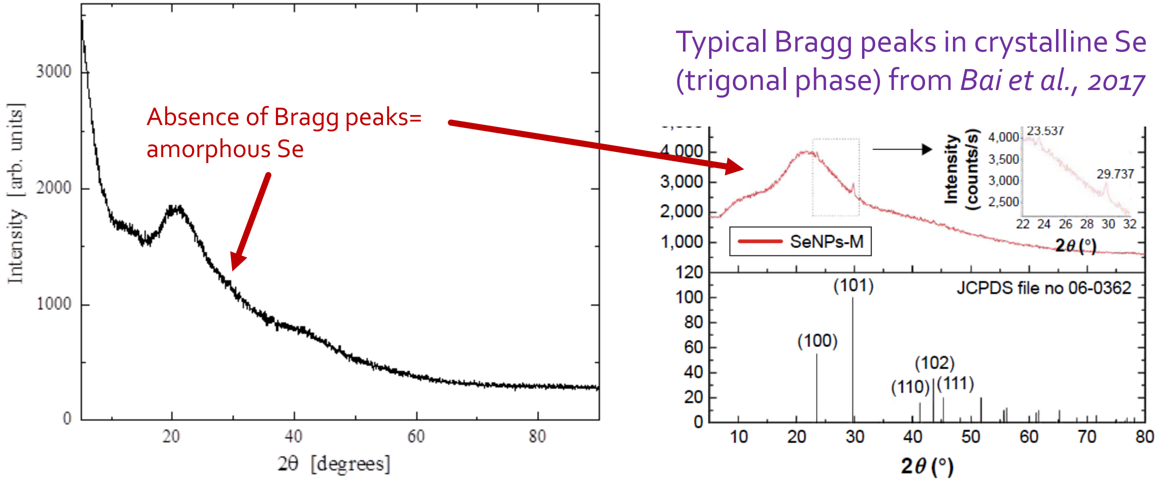


Figure 2: X-ray diffraction (XRD) patterns of CS-SeNP

Spherical monodispersed CS-SeNPs of 80.5±20 nm average diameter (DLS) were obtained (Fig. 1).

The SeNPs were exclusively composed of **amorphous** (Fig. 2)

CS-SeNP characterization

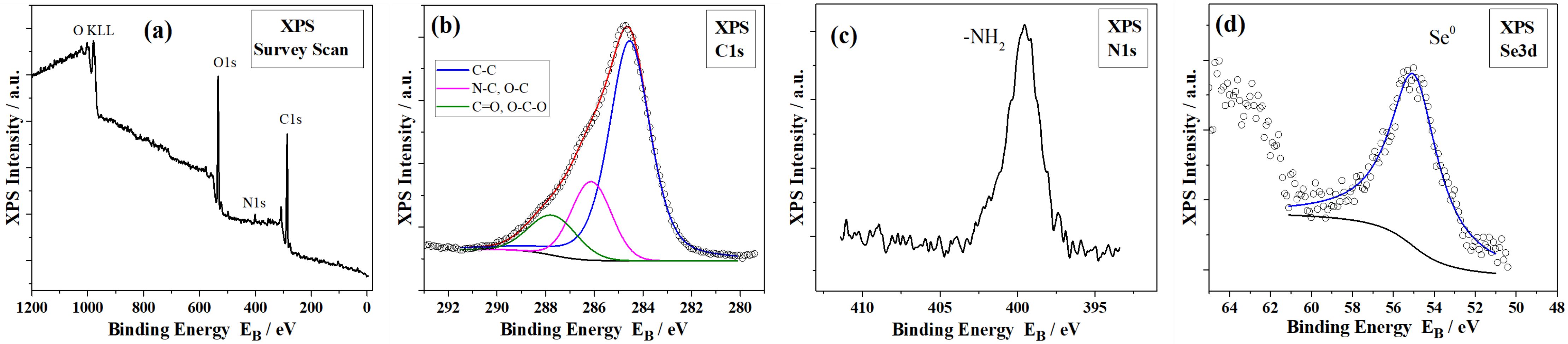


Figure 3: (a) Survey X-ray photoelectron spectroscopy (XPS) spectrum of the CS-SeNP. (b) Deconvolution of the C1s XPS spectrum (c) N1s XPS spectrum. (d) Se3d XPS spectrum.

Element	Binding energy (eV)	Concentration (%)	Assignment
O1s	532.53	28.67 ± 0.05	C-O
C1s	284.75	67.97 ± 0.06	C-C, C-N, O-C
N1s	399.55	3.12 ± 0.04	-NH_2, -NH
Se3d	55.28	0.25 ± 0.01	Se (0)

The Se3d peak centered at 55.3 eV (Fig. 3d) confirmed that the valence state of Se in CS-SeNP was zero (Se0)= **elemental Se (Se0).** The Se was **totally encapsulated in CS** (only traces could be found on the CS-SeNP surface)

Feeding Trials

Broiler chickens

Group	Dietary Se (mg/kg)	
	Added	Determined
C	- (naturally occurring)	0,117 ± 0,020
T1	**0,40** (0,2 SS+0,2 SY)	0,492 ± 0,049
T2	**0,40** (0,2 SY+0,2 SeNP-CS)	0,504 ± 0,056
T3	**0,40** (από SeNP-CS)	0,488 ± 0,045

Duration: 42 d
During trial: average daily feed intake (ADFI), average daily weight gain (ADWG) and feed conversion ratio (FCR) were determined
End of trial (42 d of age): 2 broilers/replicate (10/group) were sacrificed to determine dressing percentage, meat Se content (hydride generation atomic absorption spectroscopy) and meat oxidative stability (iron-induced lipid oxidation) in breast

Rabbits

Group	Dietary Se (mg/kg)	
	Added	Determined
C	- (naturally occurring)	0,093 ± 0,018
T1	0,40 (0,2 SS+0,2 SY)	0,508 ± 0,055
T2	0,40 (0,2 SY+0,2 SeNP-CS)	0,516 ± 0,060
T3	0,40 (από SeNP-CS)	0,478 ± 0,058

Duration: 42 d
During trial: average daily feed intake (ADFI), average daily weight gain (ADWG) and feed conversion ratio (FCR) were determined
End of trial (77 d of age): 12 rabbits /group were sacrificed to determine dressing percentage, meat Se content (hydride generation atomic absorption spectroscopy) and meat oxidative stability (iron-induced lipid oxidation) in *Longissimus lumborum*

Results | Performance

Broiler chickens

	C	T1	T2	T3	SEM	P-value
Initial BW, g (1 d)	46,9	46,8	46,9	46,8	0,46	0,989
Final BW, g (42 d)	3355,6	3299,4	3246,0	3144,7	134,70	0,555
ADFI, g/d	125,8	123,2	123,6	119,5	3,82	0,542
ADWG, g/d	78,8	77,4	76,2	73,8	3,21	0,554
FCR, g feed/g gain	1,60	1,59	1,63	1,62	0,032	0,672
Carcass wt, g	2558,0	2674,0	2471,5	2537,5	79,37	0,121
DP, %	76,3	77,0	76,5	75,7	0,66	0,308

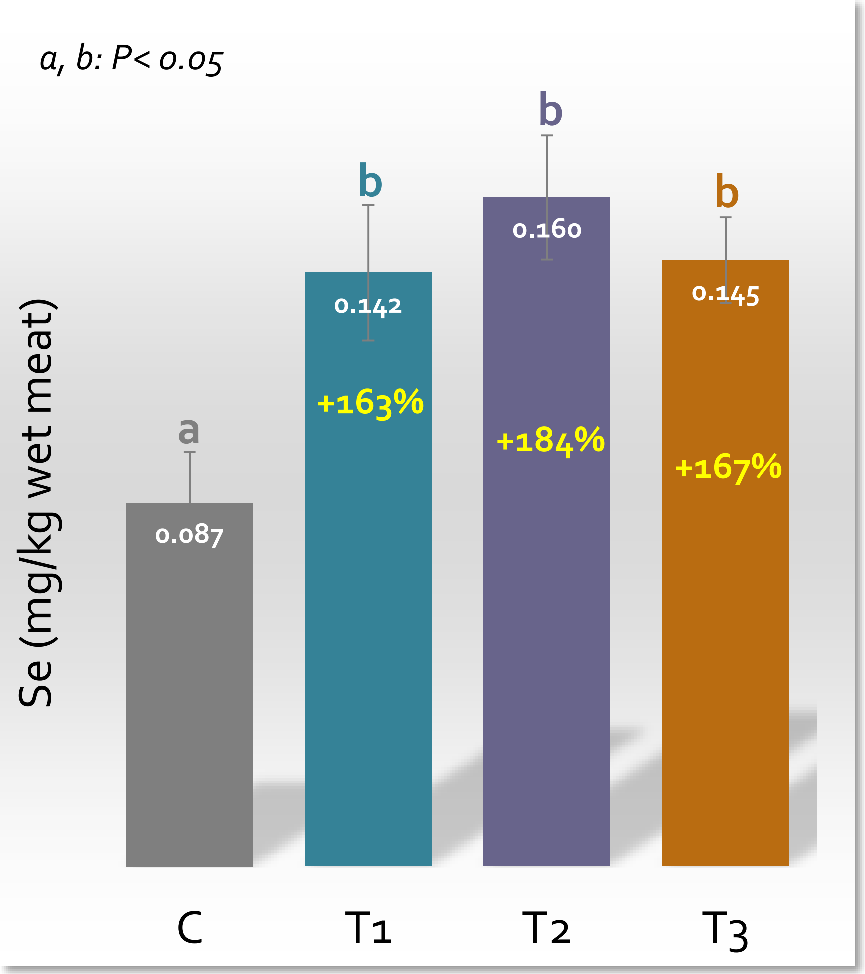
Rabbits

	C	T1	T2	T3	SEM	P-value
Initial BW, g (35 d)	1005	1000	1013	1012	34,3	0,793
Final BW, g (77 d)	2952	3010	2943	2975	100,1	0,916
ADFI, g/d	157,9	161,2	160,6	156,3	6,48	0,863
ADWG, g/d	47,8	49,6	47,8	48,0	1,83	0,740
FCR, g feed/g gain	3,31	3,27	3,35	3,26	0,071	0,537
Carcass wt, g	1763	1813	1774	1784	71,3	0,906
DP, %	62,7	63,9	63,8	63,6	0,65	0,265

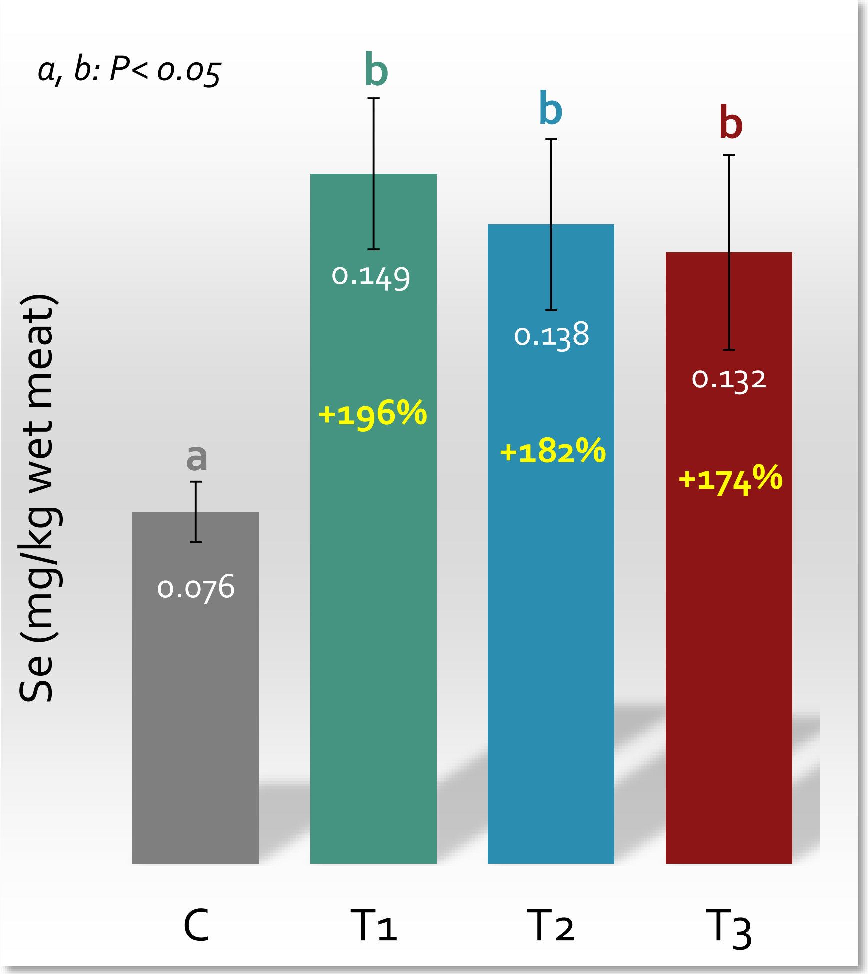
C**=** *control, no added Se;* ***T1*****=** *0.4 mg Se (0.2 from SS & 0.2 from SY),* ***T2*****=** *0.4 mg Se (0.2 from SY & 0.2 from SeNP-CS),* ***T3*****=** *0.4 mg Se from SeNP-CS per kg feed*

Results | **Meat Se content**

Broiler chickens



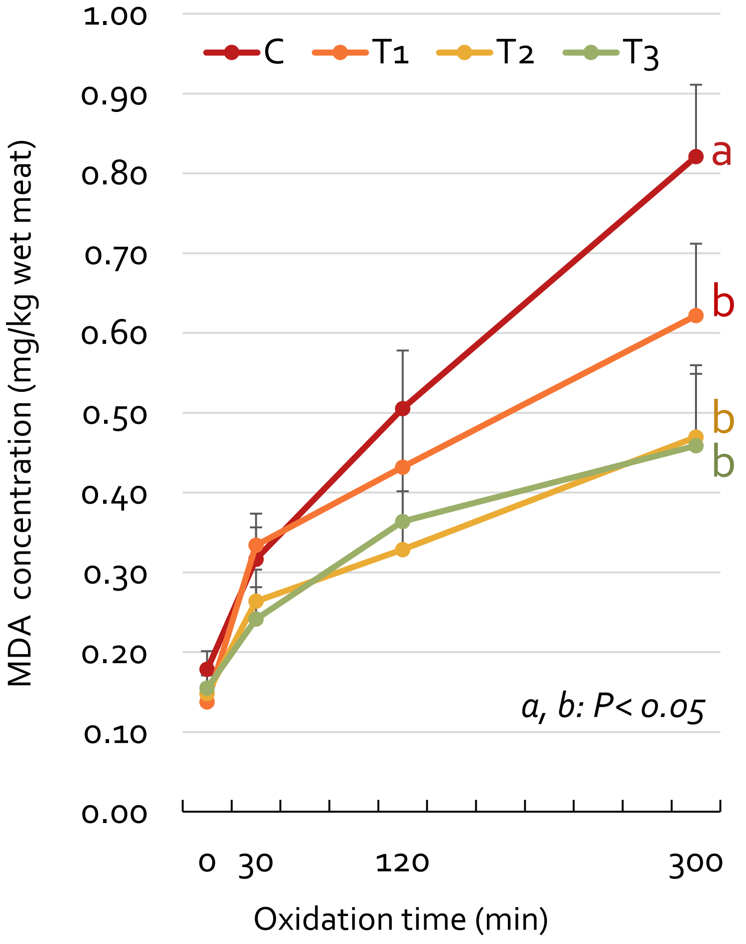
Rabbits



***C**= control, no added Se;*
***T1**= 0.4 mg Se (0.2 from SS & 0.2 from SY),*
***T2**= 0.4 mg Se (0.2 from SY & 0.2 from SeNP-CS),*
***T3**= 0.4 mg Se from SeNP-CS per kg feed*

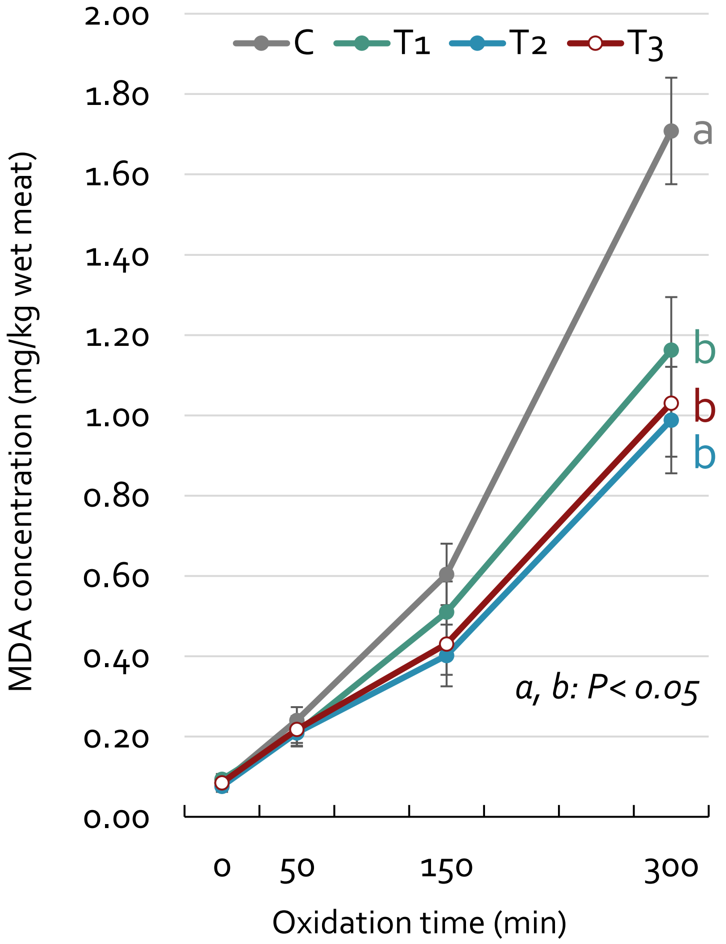
Results | Meat oxidative stability

Broiler chickens



C= *control, no added Se;*
T1= *0.4 mg Se (0.2 from SS & 0.2 from SY),*
T2= *0.4 mg Se (0.2 from SY & 0.2 from SeNP-CS),*
T3= *0.4 mg Se from SeNP-CS per kg feed*

Rabbits



Conclusions

In both broiler chickens and rabbits

- Meat Se content readily increased by the dietary supplementation with 0.4 mg Se from CS-SeNP, resulting in Se enriched meat similarly to the commonly used (SS and SY) Se sources. **Chitosan was degraded in the digestive tract, the SeNPs were released and the Se contained in these SeNPs was bioavailable**.
- The dietary CS-SeNP also improved meat oxidative stability to an extent comparable to the commonly used Se sources. **The elemental Se of the SeNPs was bioactive.**
- The present results indicated that **CS-SeNP can be a potential dietary source of bioavailable Se** with **an important protective role against meat oxidation** and merits further investigation in broiler and rabbit feeding.

Se bioavailability and bioactivity ⟷ CS-SeNP physico-chemical properties

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Thank you for your time

Questions?

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Κοινωνικό Ταμείο

Επιχειρησιακό Πρόγραμμα
Ανάπτυξη Ανθρώπινου Δυναμικού,
Εκπαίδευση και Διά Βίου Μάθηση
Ειδική Υπηρεσία Διαχείρισης
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

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