KINETICS OF BONE MINERALIZATION AND ALLOMETRIC CHANGES IN RESPONSE TO CA AND P DEFICIENCY IN BROILER CHICKENS

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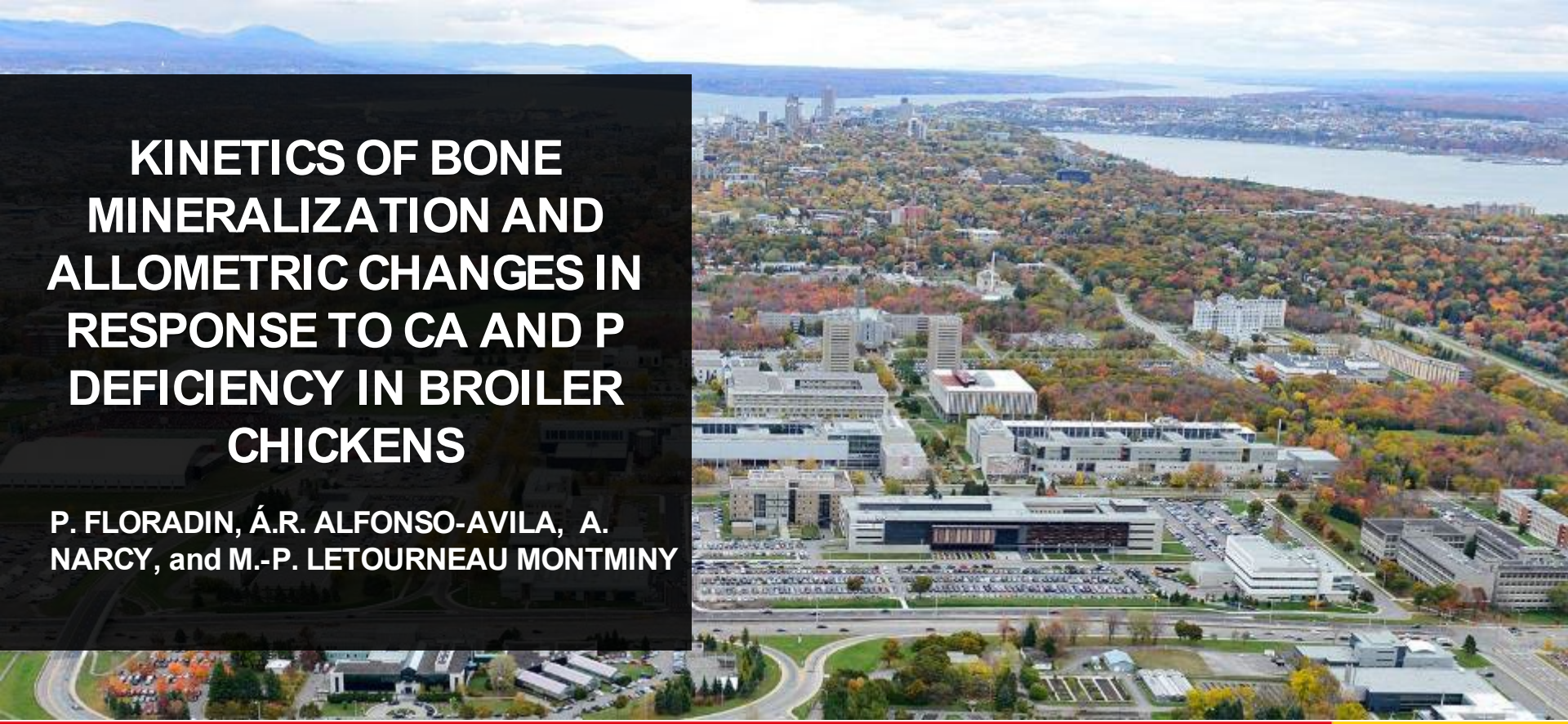

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Introduction

P is essential for growth performance and bone mineralization of animals and for crop production

P losses in agricultural systems lead to severe eutrophication problems in many regions of the world

As a limited and non-renewable resource, P supply dictates our capacity to produce food *(Cordell D and White S. 2013).*

Crucial to optimize the use of P by broilers

Introduction

Precise P system to feed broilers is crucial

- Precise estimation of the P value of feedstuffs
- Optimisation of P utilisation by birds
- Precise establishment of requirement

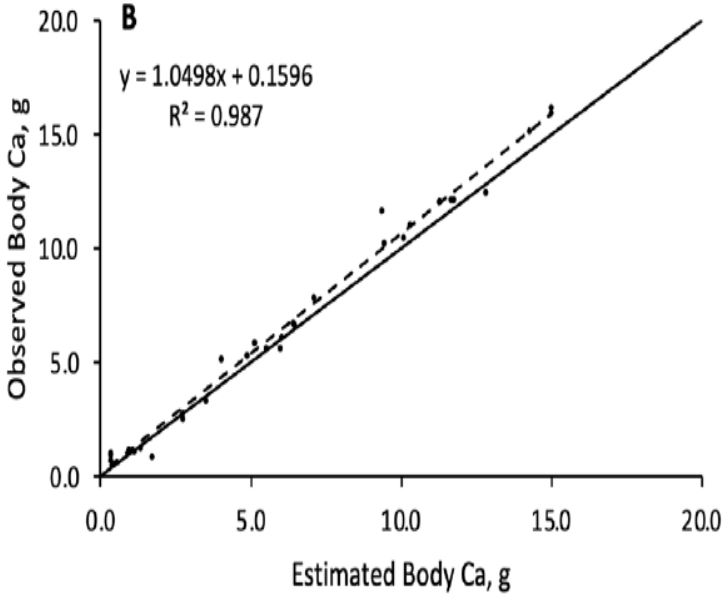
Introduction

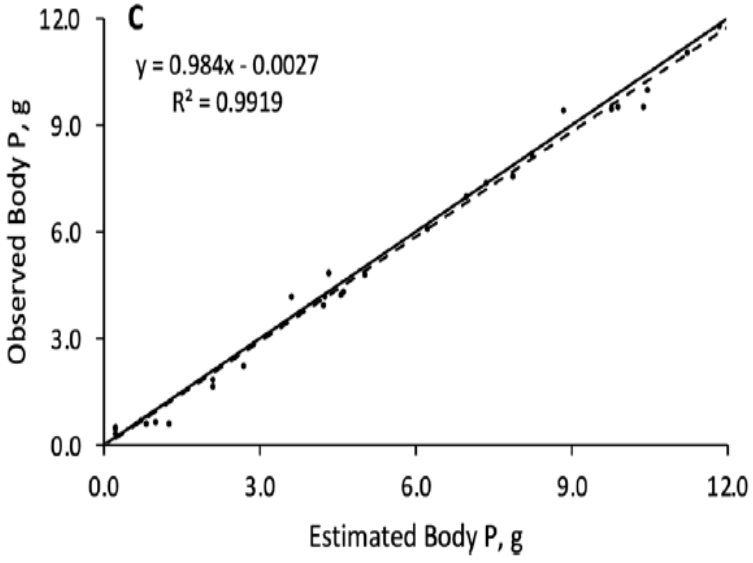
A first model of the fate of Ca and P in broiler was developed (Reis et al., 2023)

- Digestion module
  - ✓ *P and Ca absorption*
- Soft-tissue module
  - ✓ *Broiler growth model*
- Body ash module
  - ✓ *Bone ash + soft tissue ash*

Introduction

Body Ca and P predictions of the model are **good**

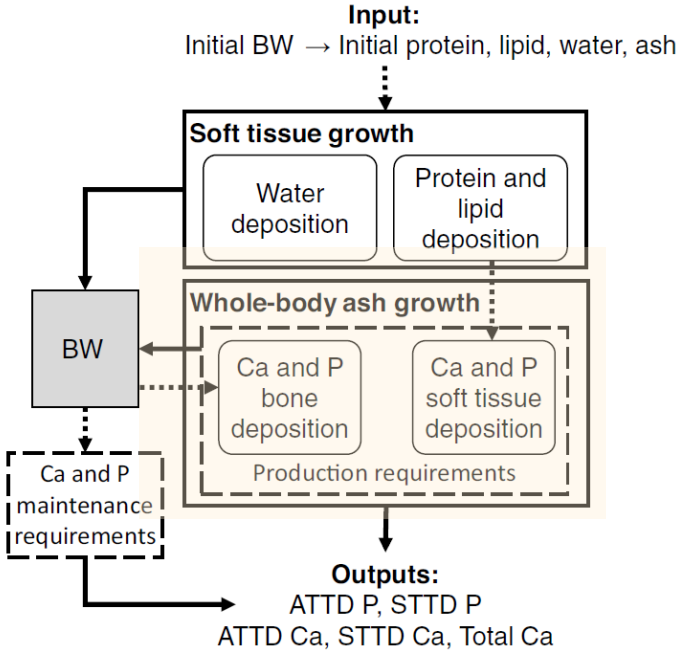




(Reis et al.. 2023)

Introduction

It was inversed to predict requirements



- Ca requirement is independent of protein
- P depends on Ca deposited into bone (fixed ratio) and protein deposition (fixed concentration)

The model needs validation especially about kinetic of bone and protein retention

Narcy et al. (2024). Reis et al. (2024)

Objective

Evaluate the effect of different levels of Ca and P on the growth performance and kinetics of soft tissues and bone deposition into the skeleton of broilers

M&M

- 360 1-day-old male broilers Ross 308, 5 birds/cage, 10 cages/trt

M&M

- **Treatments**
  - ✓ *L diet with 75% Ca and nPP requirements*
  - ✓ *M diet with 85% Ca and nPP requirements*
  - ✓ *H diet with 100 %Ca and nPP requirements*

Estimated from Reis et al. (2023) model's

Treatments	100%	85%	75%
0-9 days			
P dig. g/kg	5.3	4.6	4.0
Ca. g/kg	12.2	10.37	7.0
10-21 days			
P dig. g/kg	4.3	3.7	3.3
Ca. g/kg	9.2	7.8	6.0
22-35 days			
P dig. g/kg	3.3	2.9	2.9
Ca. g/kg	6.4	6.4	5.0

No phosphate

M&M

- 3 phase feeding (0-9, 10-21, 22-35 d)
- Growth performance measured per phase
- Dual-X-ray (DXA) was used to obtain total mass and its proportion of lean, fat and bone mineral content (BMC) in one anesthetized bird/cage (always the same) at d 9, 21 and 35

M&M

- Body Protein, Ca and P from DXA
  - ✓ Body Protein = -10.4+0.21*LeanDXA
  - ✓ Body Ca = -0.218+0.38*BMCDXA
  - ✓ Body P = -0.086+0.29*BMCDXA

According to Hamdi et al. (2018)

- Data were analyzed as a complete block design with SAS

Results – Growth performance

Criteria	Treatments			SEM	P-value
	75%	85%	100%		
ADFI (g/d)					
Day 9-21	73.33	80.57	77.18	2.686	0.122
Day 21-34	136.3^{ab}	131.8^{b}	140.5^{a}	2.654	0.088
ADG (g/d)					
Day 9-21	**44.70^{b}**	**48.95^{a}**	**49.41^{a}**	**1.309**	**0.028**
Day 21-34	82.19	77.32	85.7	5.483	0.211
FCR (g/d)					
Day 9-21	1.715	1.665	1.602	0.038	0.106
Day 21-34	1.697	1.759	1.740	0.114	0.700
BW (g)					
Day 9	158.4	158.3	160.7	8.185	0.972
Day 21	695.1^{b}	762.2^{ab}	822.7^{a}	40.12	0.093
Day 35	**1865^{b}**	**1928^{ab}**	**2140^{a}**	**5**	**0.028**

+15%

- Performances were not different at d 9
- ADG was lower in L diet in grower phase
- BW higher at d 35 in H diets

Results – Body composition

Criteria	*Treatments*			SEM	*P-value*
	75%	*85%*	*100%*		
Lean mass (g)					
Day 9	124.0	125.5	129.2	7.581	0.876
Day 21	624.8^{b}	646.1^{ab}	732.7^{a}	35.0	0.088
Day 35	**1615b**	**1652b**	**1882a**	**72.62**	**0.030**
Fat mass (g)					
Day 9	35.28	33.02	31.78	4.754	0.867
Day 21	135.7	158.9	138.0	10.74	0.254
Day 35	322.2	344.9	342.0	25.24	0.759

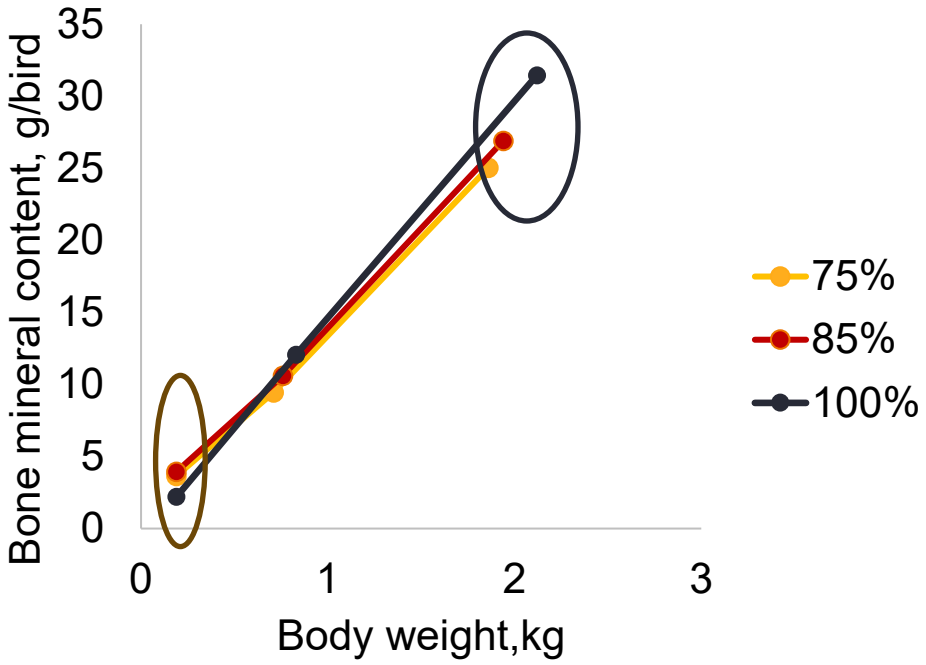
- Lean mass was higher in 100% at d35
- Fat was not modified

Results – Body composition

Criteria	*Treatments*			SEM	*P-value*
	75%	*85%*	*100%*		
BMC (g)					
Day 9	**2.91^{ab}**	**3.95^{a}**	**2.207^{b}**	**0.507**	**0.070**
Day 21	9.457	10.61	12.08	0.973	0.199
Day 35	**25.04^{b}**	**26.91^{b}**	**31.46^{a}**	**1.379**	**0.012**

- BMC tends to be reduced in 100% at d9
- BMC was maximized in H at d35

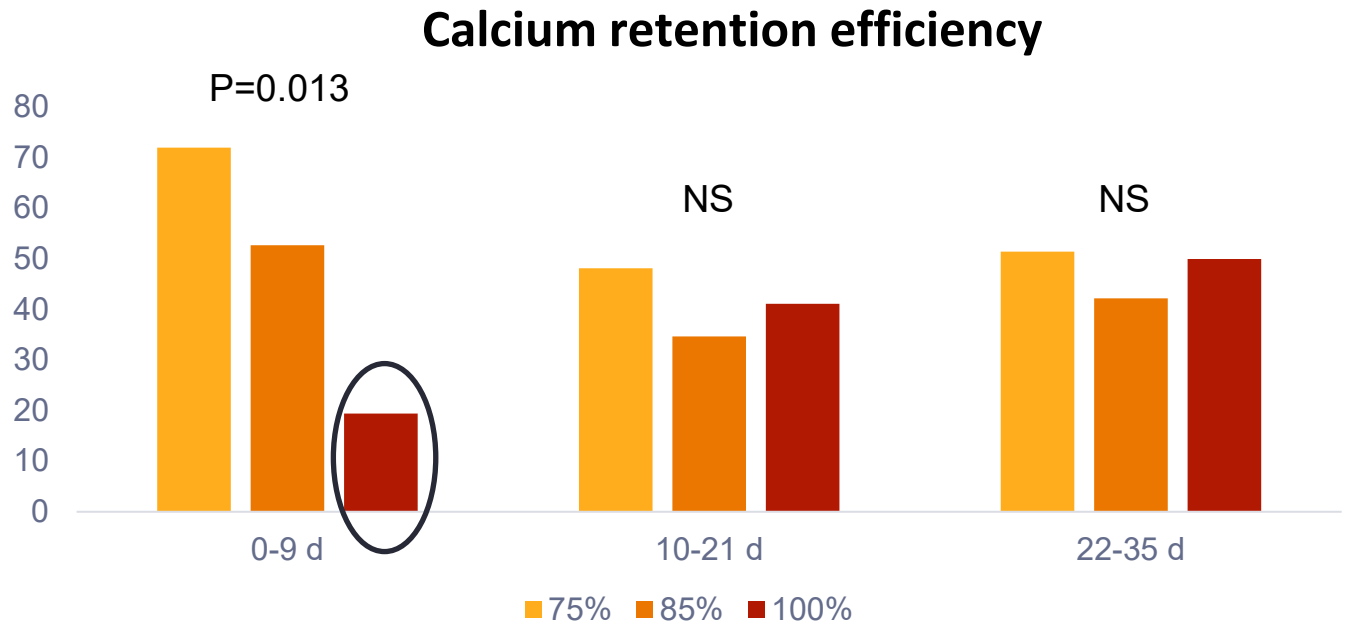
Results – Body composition



At d9 100% have lower BMC. but finish with clearer better mineralize bone =

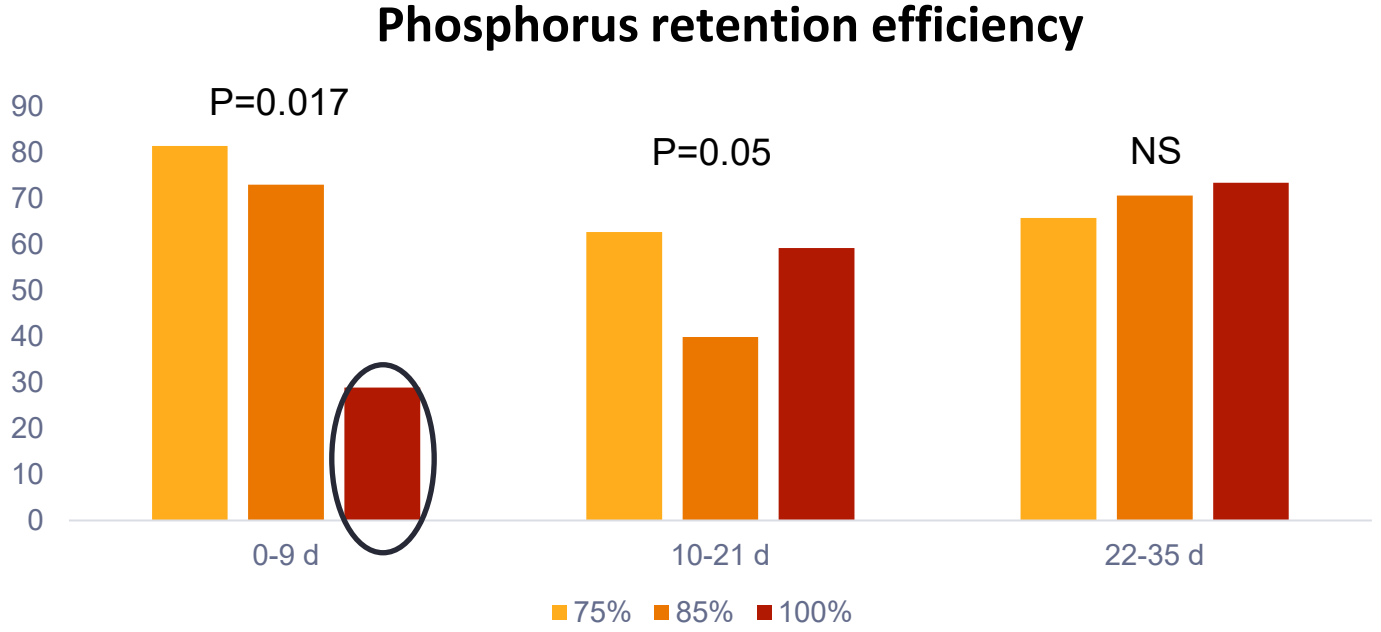
Birds have the capacity to adapt to low Ca and P (Rousseau et al.. 2016) at least momentarily

Results -



High dietary Ca and nPP has detrimental effects on the retained Ca from 0 to 9 d

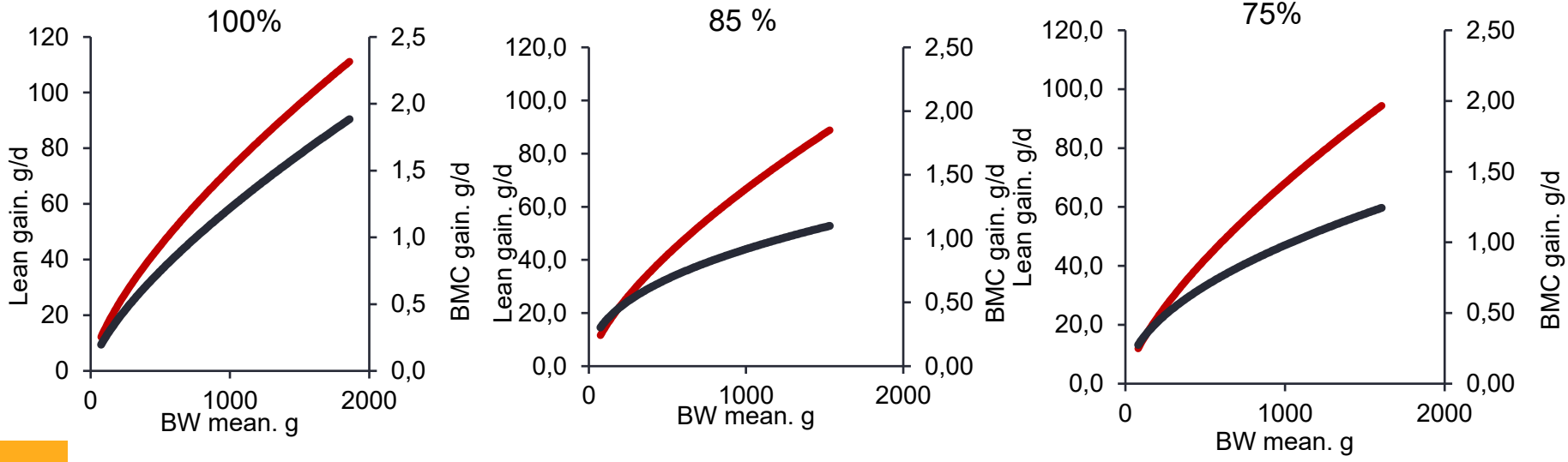
Results and discussion



High dietary Ca and nPP has detrimental effects on the retained P from 0 to 9 d

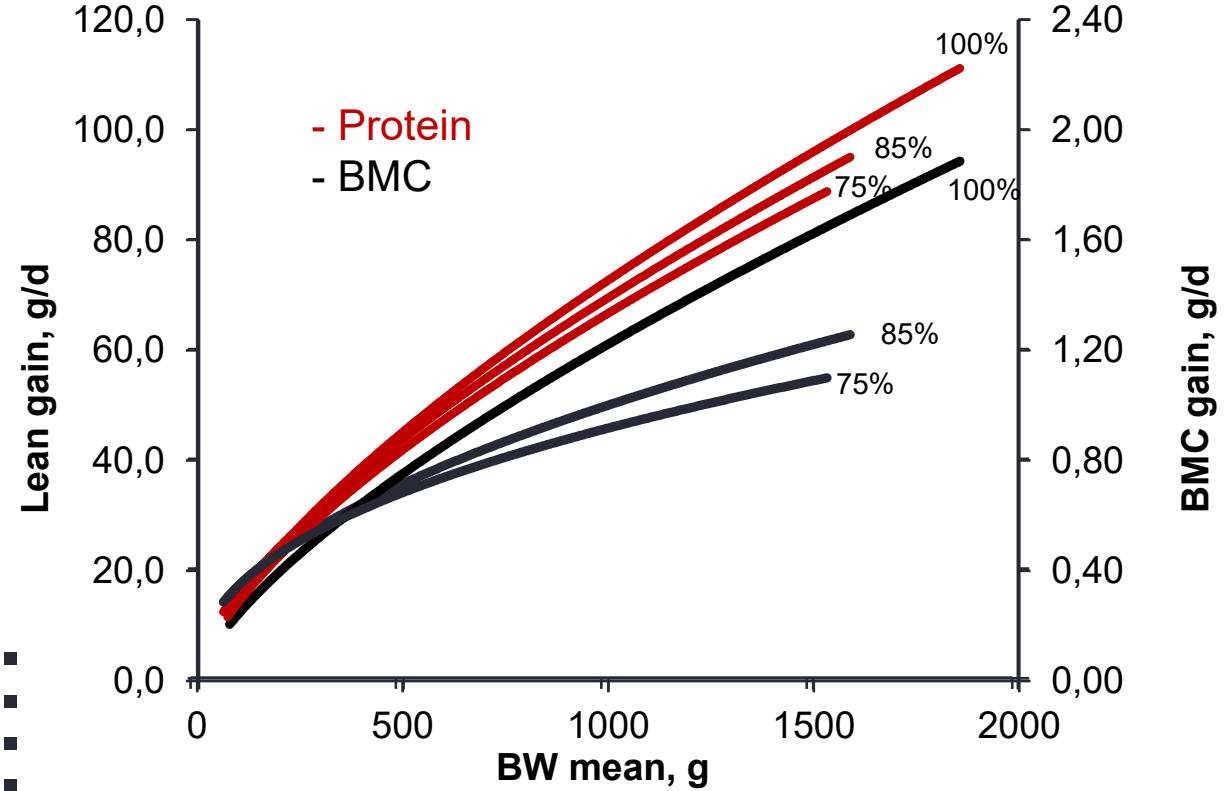
Results – Lean and BMC gain

- **Bone mineral content**
- **Lean**



Dynamic of gain of BMC changes with Ca and P supply

Results – Lean and BMC gain



Protein/ BMC ratio in the body change with dietary Ca and P

Conclusions

- Modifying dietary Ca and nPP while keeping a similar ratio affects growth performance and bone mineralization to the same extent expect during the starter phase.
- Higher levels of Ca and nPP in the diet promote greater performance and bone mineralization.
- These data will be used to validate Reis et al. (2023) requirement model.

Merci!

Questions?

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