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Dietary zinc:copper ratios and net postprandial portal appearance of these minerals in pigs

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Trace minerals: nutrition vs environment perspectives

- **For the nutrition aspect of livestock, “trace minerals” are essential nutrients**
- **From an environmental perspective, “trace minerals” are “heavy metals”**

Zn and Cu: dietary incorporation

- **Strategies to better control trace minerals bioavailability / the debate around organic vs inorganic forms of trace minerals**
- **Lack of knowledge on the metabolic fate of these minerals and the related physiological mechanisms in pigs.**
- **Beyond classical (intestinal or metabolic) balance trials.**

Cumulative portal appearance of Cu and Zn according to their dietary levels during 12 h post-meal period

Period after bolus (min)	Dietary levels (mg)			
	Adequate		Adequate × 2	
	Zn (200)	Cu (20)	Zn (400)	Cu (40)
	Cumulative portal appearance, % of intake			
0-240	4.1	33.9	3.0	-3.1 (0)
0-360	6.4	40.3	4.3	-3.6 (0)
0-720	10.8	32.6	6.6	-3.6 (0)

Interpretation

- **For high dietary Zn and Cu, possible impairment of Cu transit towards liver**
 - **uptake by the intestinal mucosa and/or intracellular transport within enterocytes**
 - **according to literature in other species, Zn would be the key factor as high dietary Zn are believed to saturate intracellular transporter and traps Cu within enterocytes**
- **Optimal absolute and relative levels of dietary Zn and Cu for maximizing intestinal absorption has never been assessed in pigs.**

Hypothesis

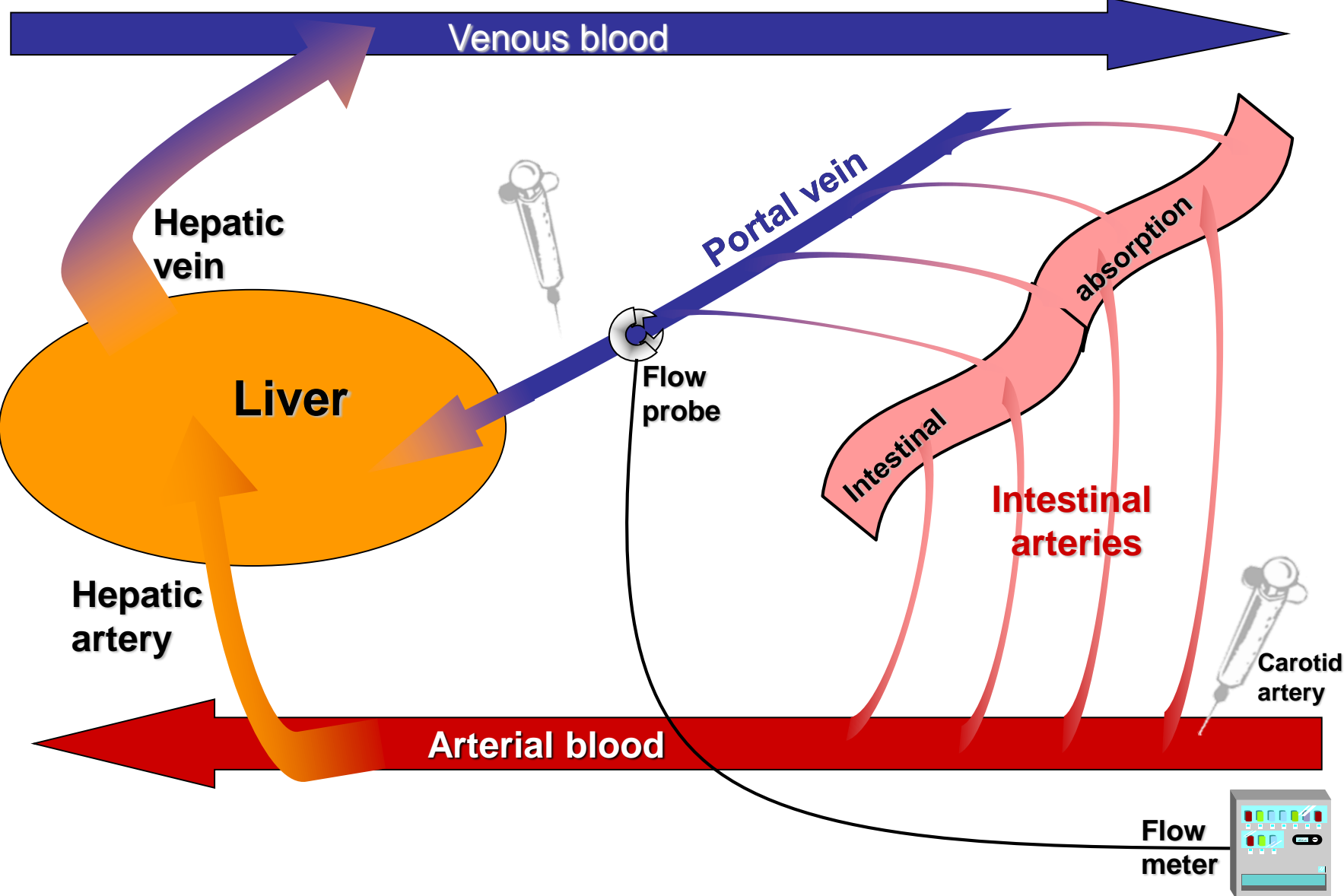
Intestinal fates Zn and Cu in pigs are dependent upon levels of dietary incorporation and/or dietary ratios between these trace minerals

Objectives

Determine portal appearance of Zn and Cu in pigs according to dietary levels (confirmation) and dietary ratios between these trace minerals

Assess the mutual impact of both dietary Zn and Cu on their optimal intestinal absorption

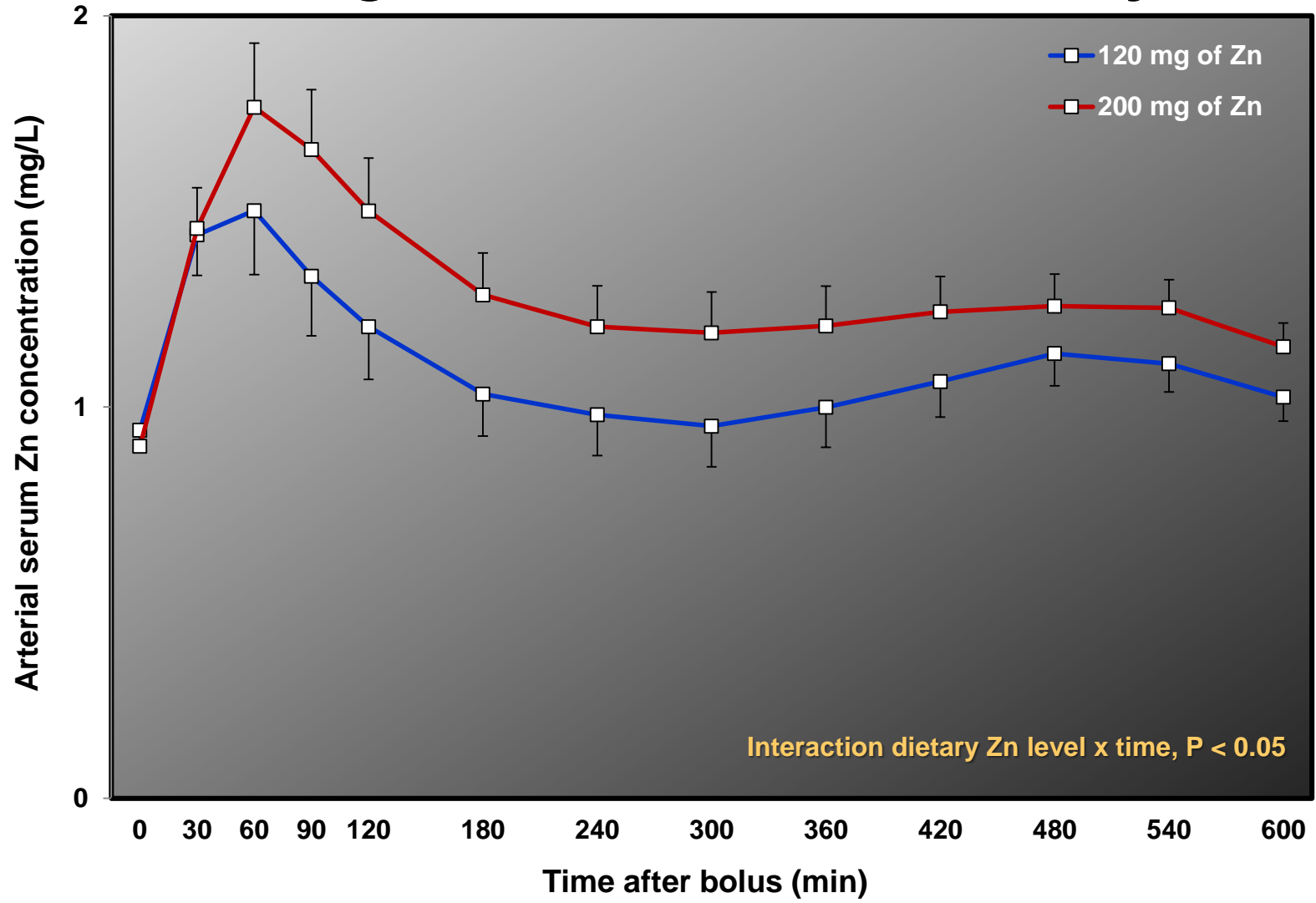
Micronutrient post-intestinal fate: arterio-venous differences at the portal vein



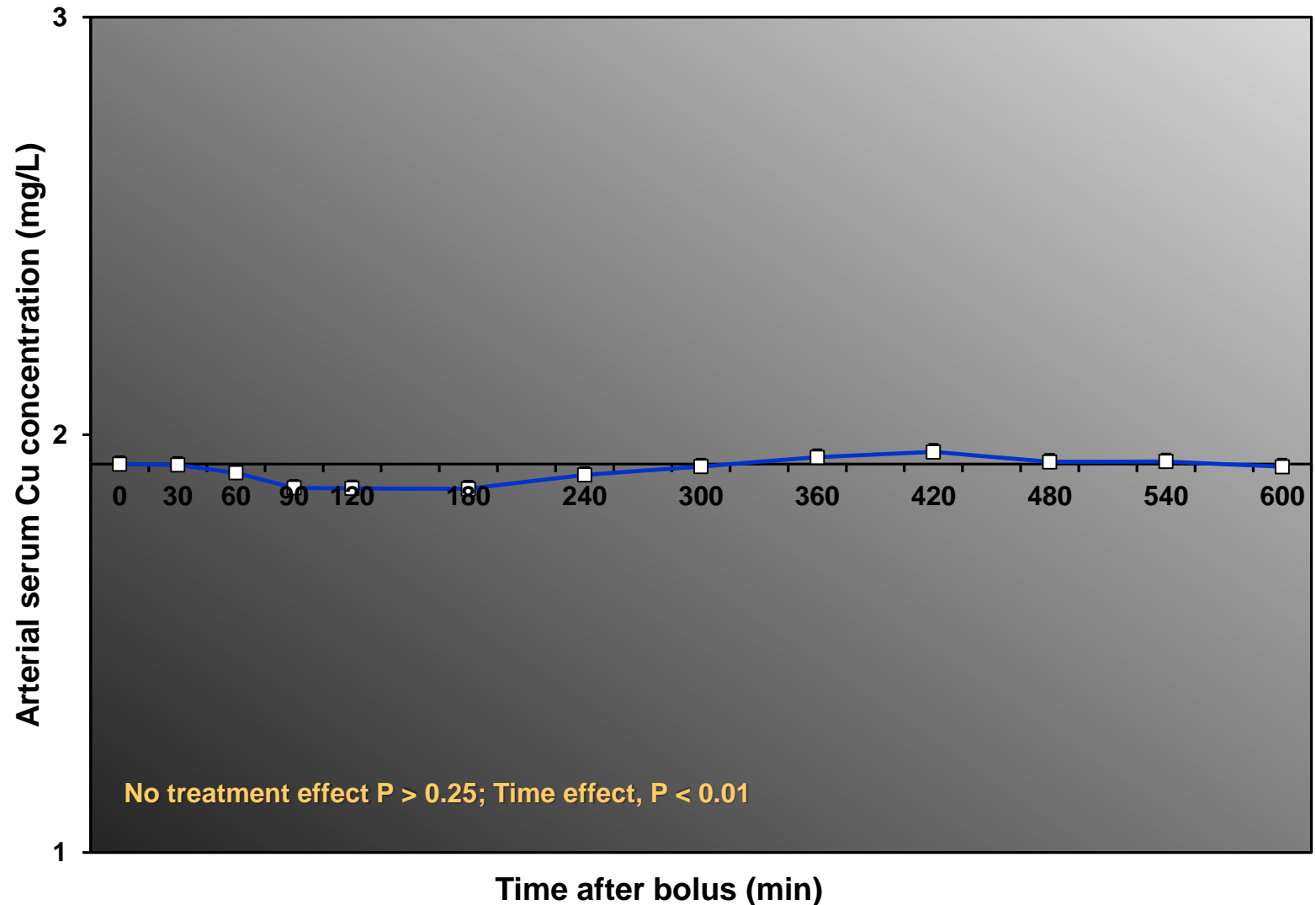
Experimental design

- In 10 pigs (46 kg, BW), blood samples from portal vein and carotid artery before and during 10 h after an experimental meal (semi-purified diet with mineral supplements). Portal blood flow was recorded continuously.
- Pigs received dietary boluses of Zn (ZnSO_4) and Cu (CuSO_4)
 - EFSA-Zn + EFSA-Cu (ratio Zn:Cu = 200:20 mg),
 - NRC-Zn + NRC-Cu (ratio Zn:Cu = 120:8 mg),
 - NRC-Zn + EFSA-Cu (ratio Zn:Cu = 120:20 mg),
 - EFSA-Zn + NRC-Cu (ratio Zn:Cu = 200:8 mg).
- Treatments 200:20, 120:8, 120:20 and 200:8 were given to each animal and distributed according to a cross-over design.

Post-prandial profiles of Zn in arterial blood serum according to levels of Zn in dietary boluses



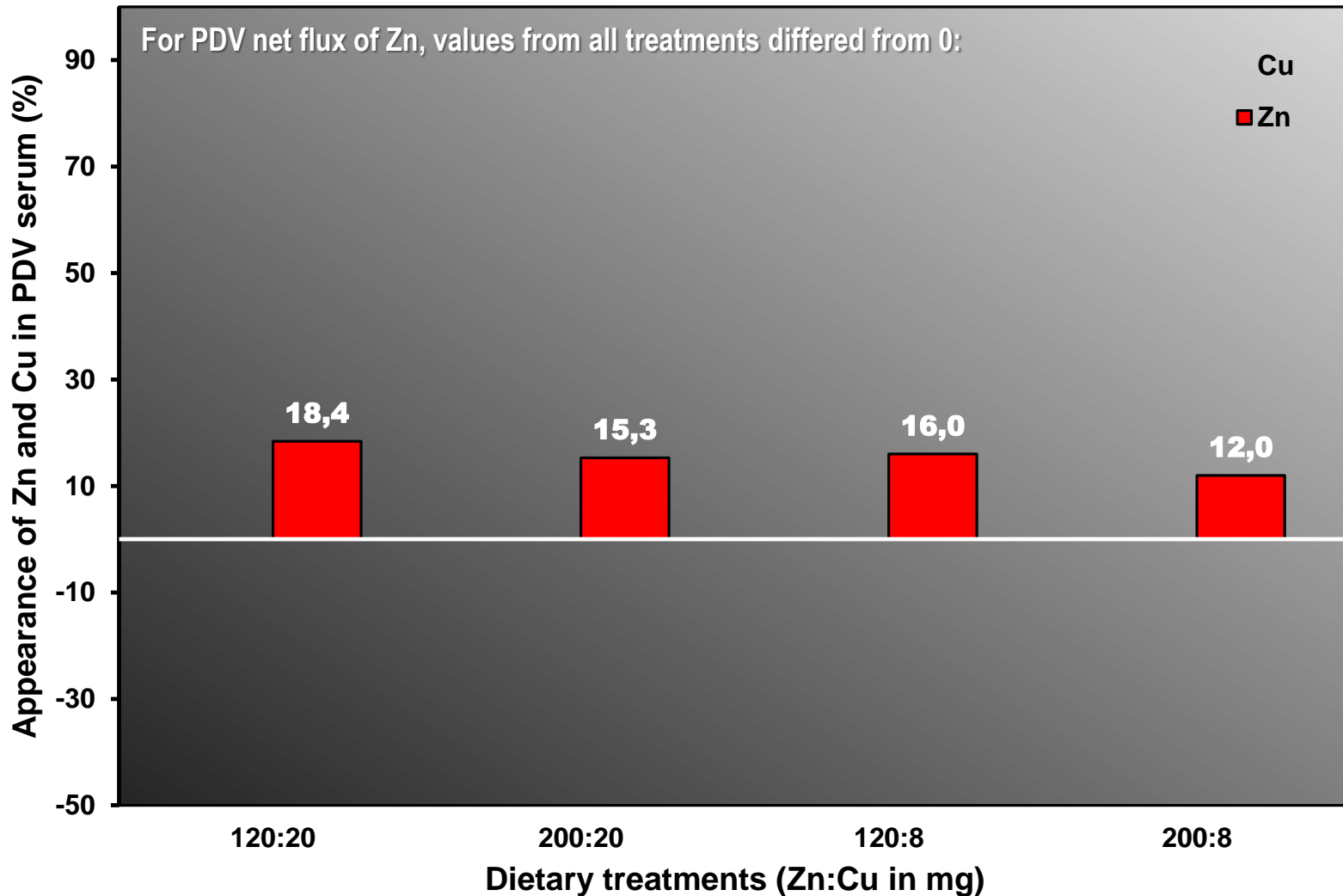
Post-prandial profiles of Cu in arterial blood serum according to levels of Cu in dietary boluses



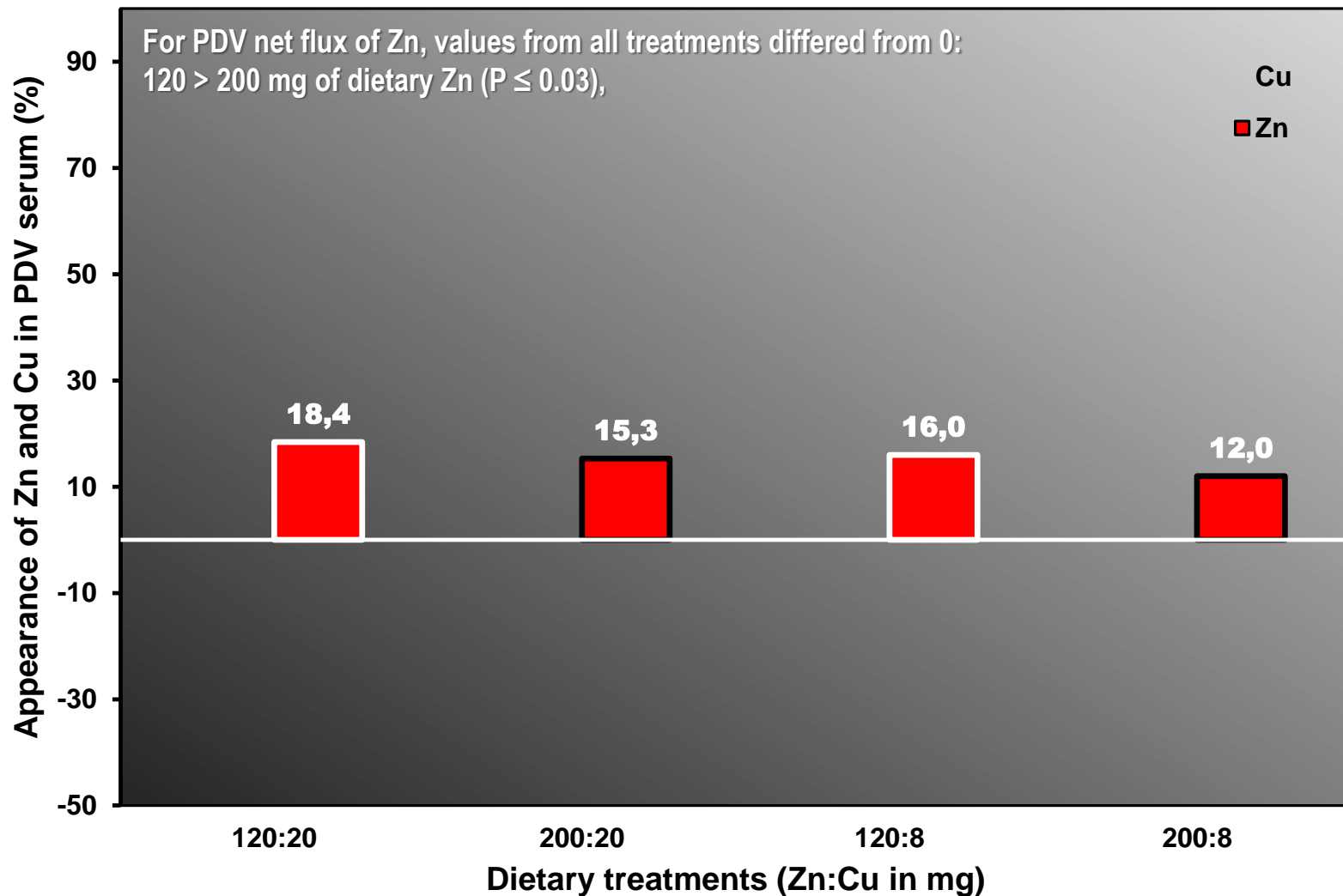
Porto-arterial differences (P-AD) of Zn concentrations and portal drained viscera (PDV) net fluxes of Zn during 10 hours post-meal according to dietary treatments

Variable	Dietary treatments (Zn:Cu in mg)				P values		
	120:20	200:20	120:8	200:8	Zn effect	Cu effect	Zn x Cu effect
P-AD ($\mu\text{g/L}$)	46.7	65.4	43.6	51.5	0.05	0.20	0.40
PDV net flux ($\mu\text{g/min}$)	37.9	54.6	34.9	41.5	0.02	0.10	0.29

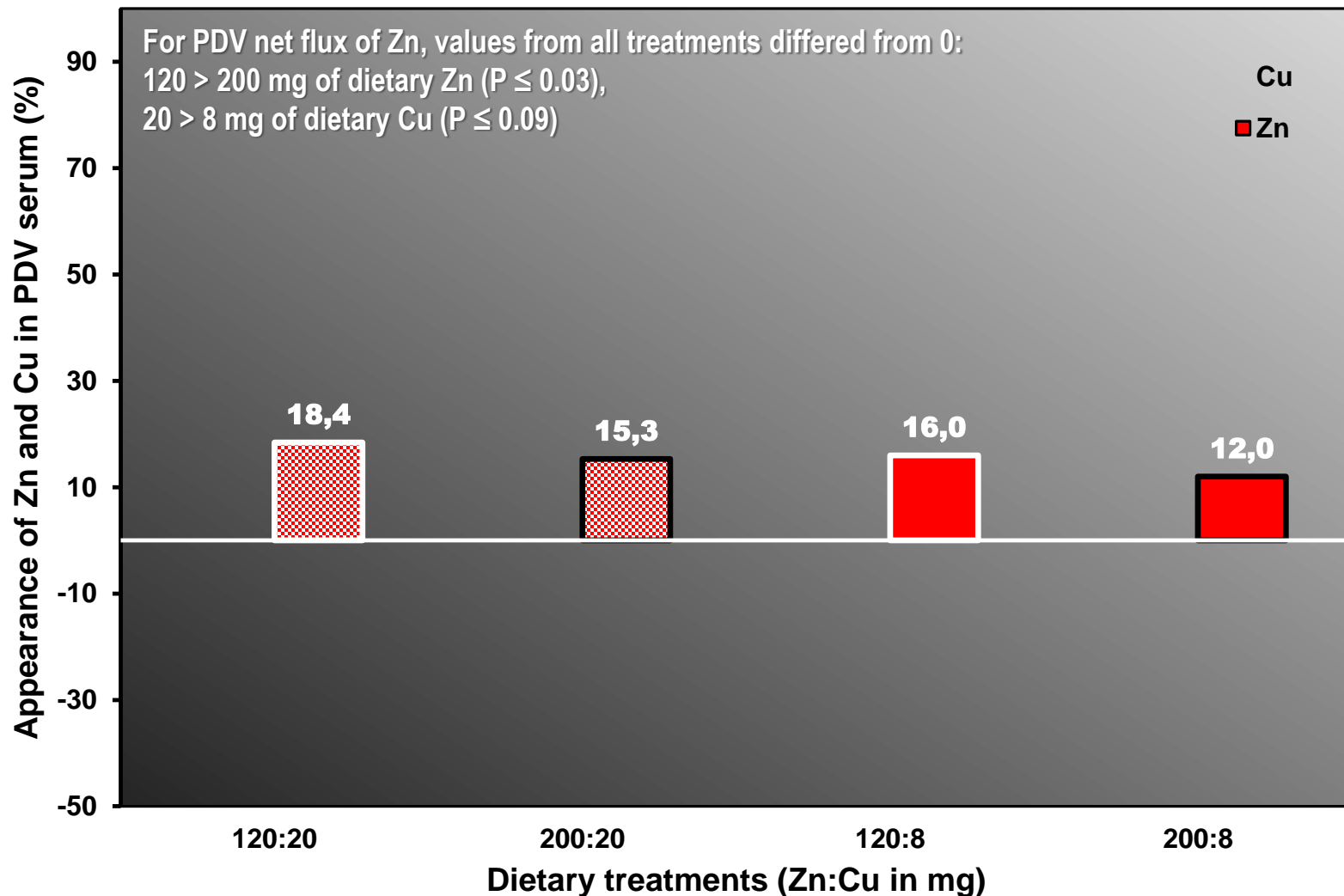
Cumulative PDV net flux of Zn and Cu (in % of dietary intake) during 10 hours post-meal according to dietary treatments



Cumulative PDV net flux of Zn and Cu (in % of dietary intake) during 10 hours post-meal according to dietary treatments



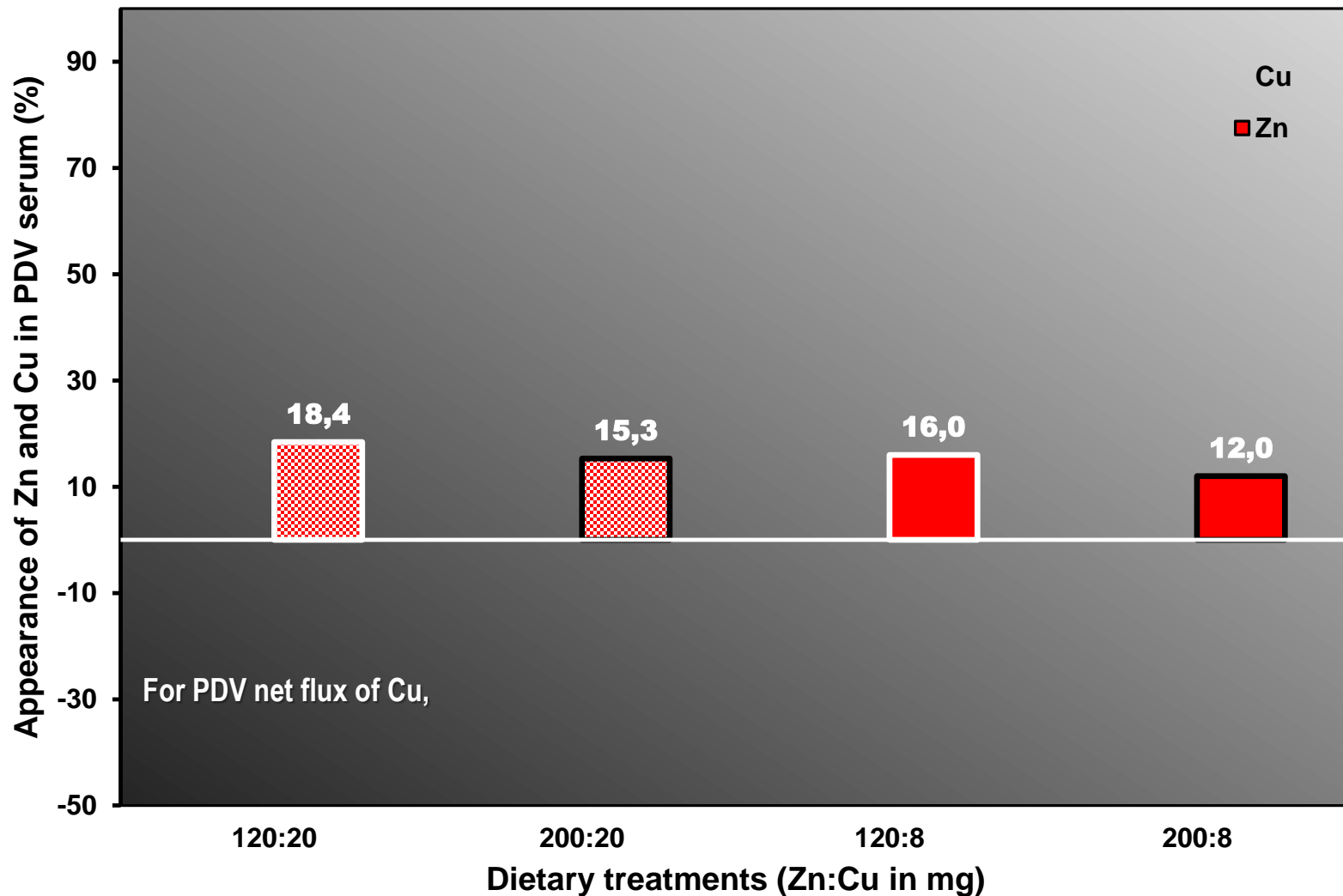
Cumulative PDV net flux of Zn and Cu (in % of dietary intake) during 10 hours post-meal according to dietary treatments



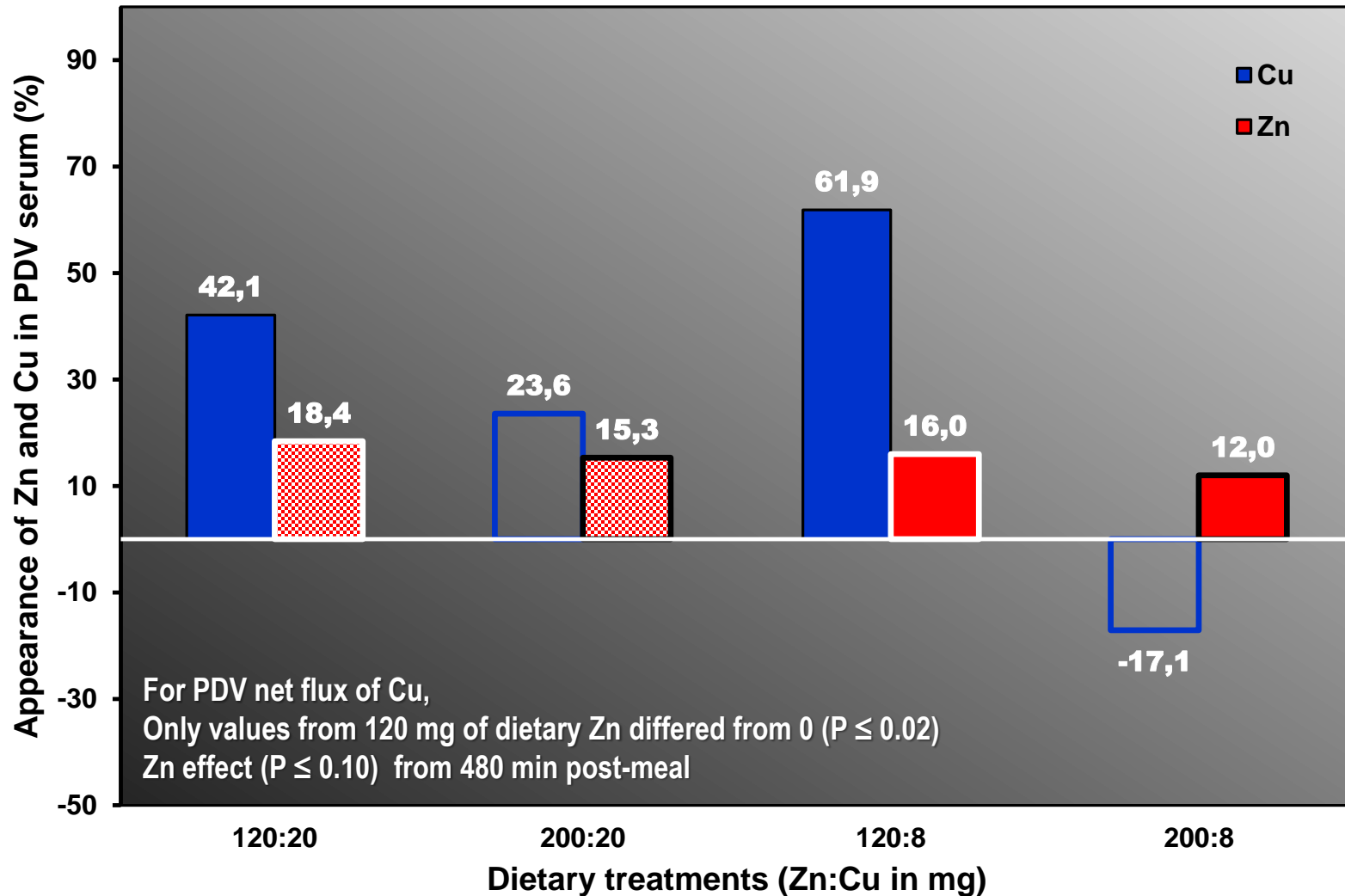
Porto-arterial differences (P-AD) of Cu concentrations and portal drained viscera (PDV) net fluxes of Cu during 10 hours post-meal according to dietary treatments

Variable	Dietary treatments (Zn:Cu in mg)				P values		
	120:20	200:20	120:8	200:8	Zn effect	Cu effect	Zn x Cu effect
P-AD (µg/L)	14.3	7.6	10.3	-1.9	0.25	0.42	0.74
PDV net flux (µg/min)	12.7	6.7	8.7	- 3.5	0.12	0.23	0.59

Cumulative PDV net flux of Zn and Cu (in % of dietary intake) during 10 hours post-meal according to dietary treatments



Cumulative PDV net flux of Zn and Cu (in % of dietary intake) during 10 hours post-meal according to dietary treatments



Conclusions

- **During the post-prandial period, portal appearance (% of intake)**
 - **for Zn,**
 - **greater for 120 than for 200 mg of dietary Zn**
 - **greater for 20 than for 8 mg of dietary Cu.**
 - **for Cu,**
 - **impaired with 200 mg of dietary Zn, enterocyte sequestration of Cu after mucosal absorption?**

- **Dietary equilibrium between Zn and Cu for optimal intestinal absorption? Here, 120:8**

Perspectives

- **Need to revisit the interaction between Zn and Cu in post-weaning diet ?**
 - **in the context of pharmacological dietary levels of ZnO**
 - **in the context of preliminary results showing severe post-weaning depletion of Cu storage**



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Thank you for your attention

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