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Evaluation of HP-DDG and DDGS in high protein or low protein diets for rainbow trout *Onchorhynchus mykiss*

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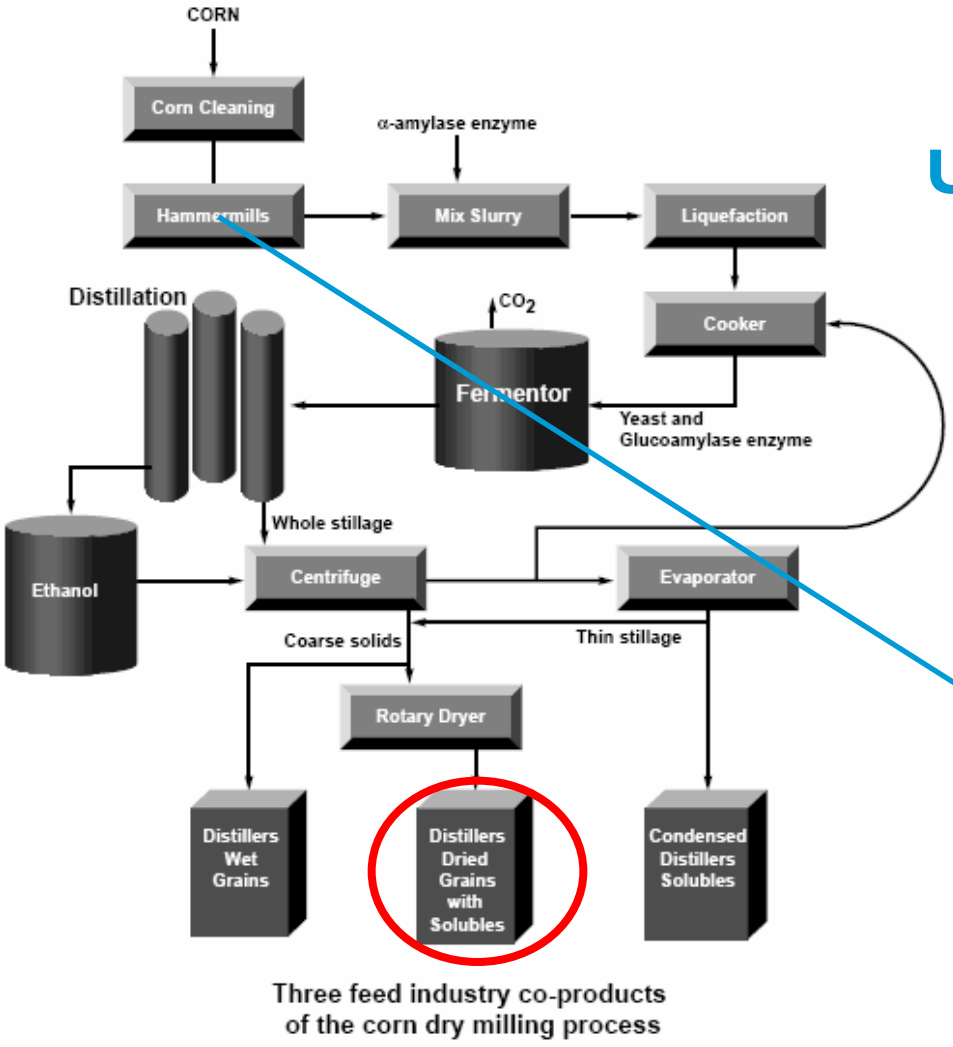
Nofima

Bioethanol co-products



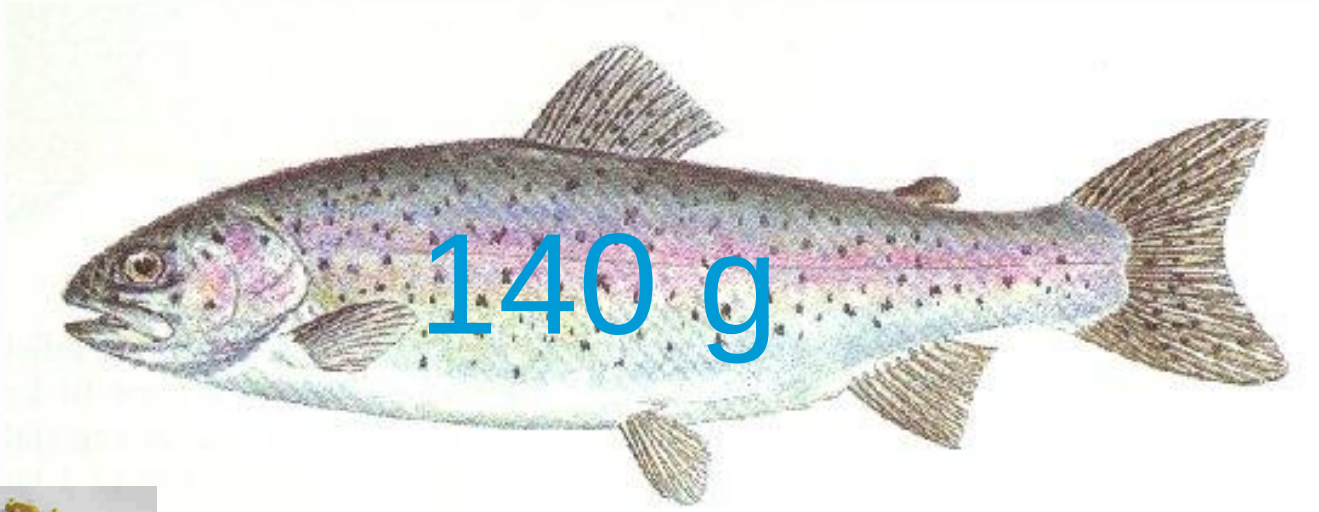
Three feed industry co-products of the corn dry milling process

Used in our study (DM basis):

- DDGS
  - Crude protein: 29.7%
  - Crude lipid: 14.4%
- HP-DDG
  - Crude protein: 47.4%
  - Crude lipid: 5.7%

Fractionation:
- Germ
- Endosperm
- Pericarp

The protein requirement



LT-FM
65-70% CP

43-45% CP

DDGS
23-28% CP

Aims

- To replace typical plant ingredients with HP-DDG and DDGS in high or low protein diets for rainbow trout, and
  - To evaluate the effect of protein level (high or low) on fish performance
  - To investigate the nutritional value of both co-products
  - To determine whether HP-DDG or DDGS affect gut health

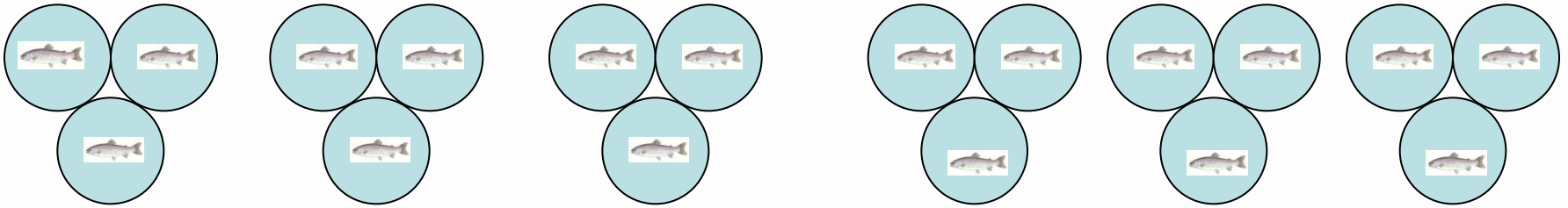
- General remarks
  - FM inclusion levels were kept constant
    - DDGS or HP-DDG can not replace FM
  - Lys and Met were supplemented to meet/exceed requirements

Experimental diets

	High CP			Low CP		
	HPDDG 0%	HPDDG 50%	HPDDG 100%	DDGS 0%	DDGS 50%	DDGS 100%
Sunflower expeller	144	72	0	125	67,5	0
Soy protein conc	162	81	0	0	0	0
Rapeseed meal	144	72	0	125	67,5	0
Peas	0	0	0	250	125	0
DDGS	**0**	**0**	**0**	**0**	**250**	**500**
HPDDG	**0**	**225**	**450**	**0**	**0**	**0**
Fishmeal	214	212	210	190	190	190
Fish oil	166	162	161	160	137	115
Analysed						
N*6.25, %	**45.4**	**45.0**	**44.9**	**36.9**	**37.1**	**36.7**
Gross energy, MJ/kg	22.1	22.6	22.4	21.6	21.9	22.3
Total P, g/kg	11.2	10.8	10.4	9.9	10.2	10.8

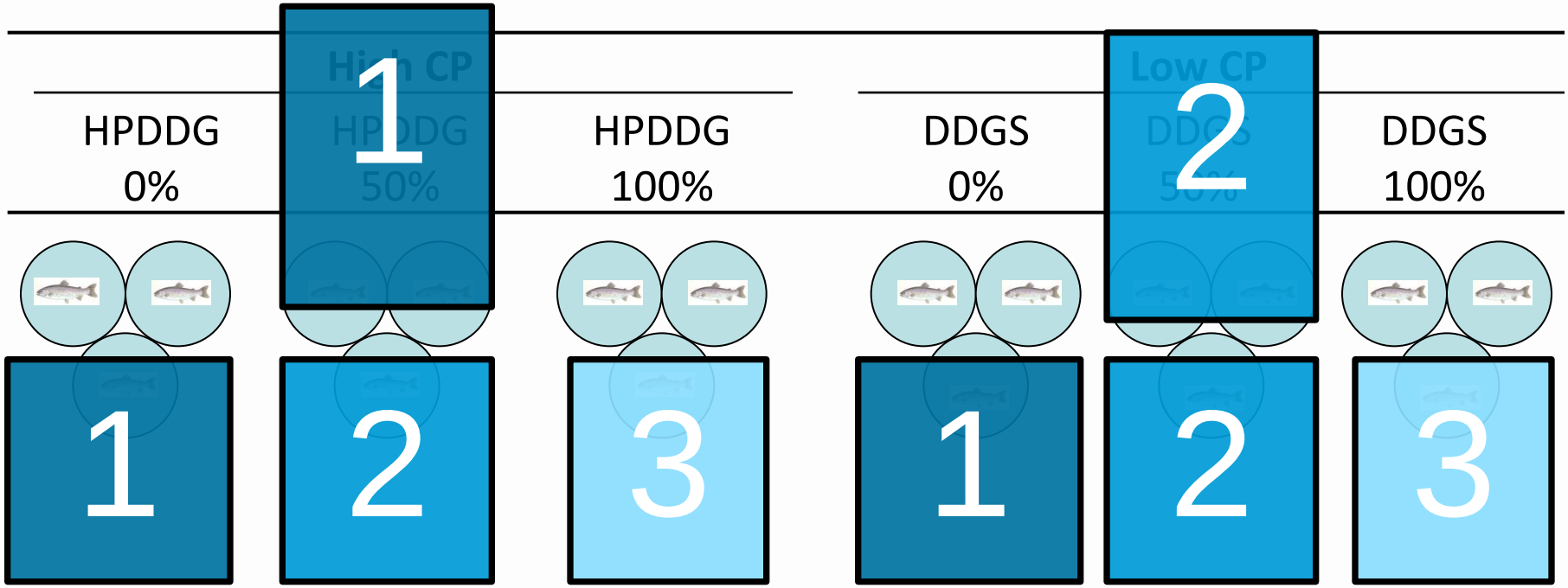
Fish and husbandry

High CP			Low CP		
HPDDG 0%	HPDDG 50%	HPDDG 100%	DDGS 0%	DDGS 50%	DDGS 100%



- Rainbow trout, intitial weight 142 g
- Fresh water, 9-13°C
- 3 tanks per diet, 20 fish per tank
- Feeding 5-10% in excess
- 77 days, 152-194% weight gain

Experimental design



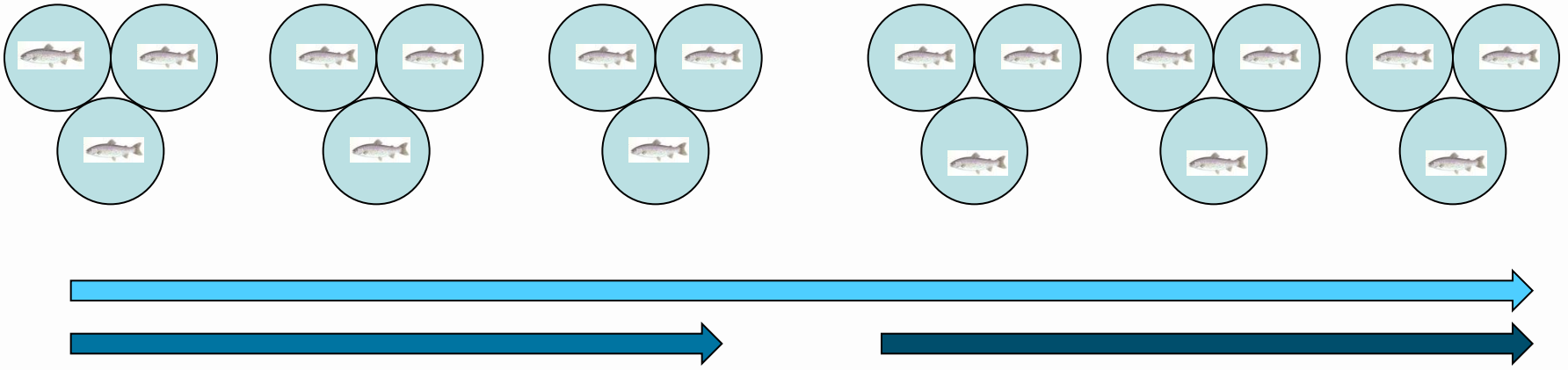
Factorial

-protein level (high or low)

-replacement level (0, 50, 100%)

Experimental design

High CP			Low CP		
HPDDG 0%	HPDDG 50%	HPDDG 100%	DDGS 0%	DDGS 50%	DDGS 100%



One-way

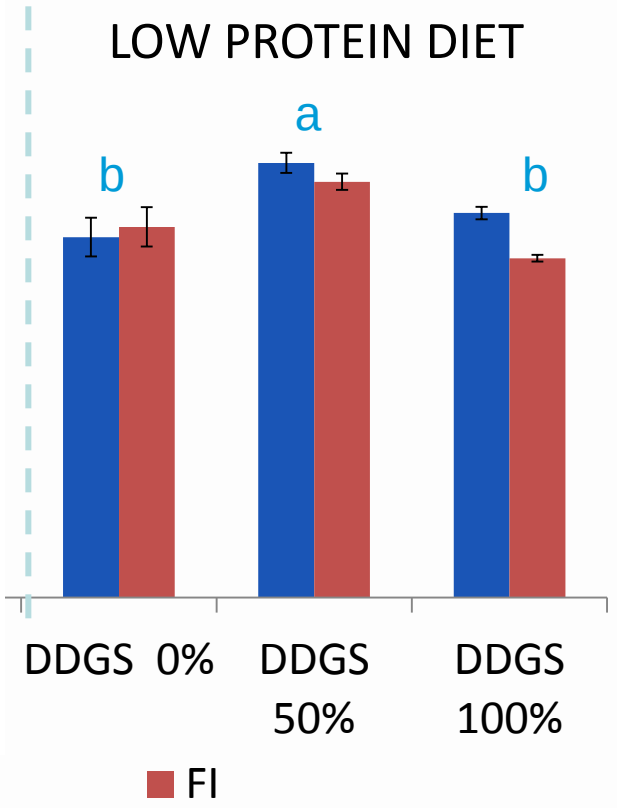
-Diets

Responses

- Performance
  - Feed intake, weight gain, feed conversion ratio
- Nutrient digestibilities
  - Main nutrients + AA
  - Phosphorus
- Gastro intestinal indicators
  - Enzyme activities (Trypsin and LAP)
- Histology (distal intestine)

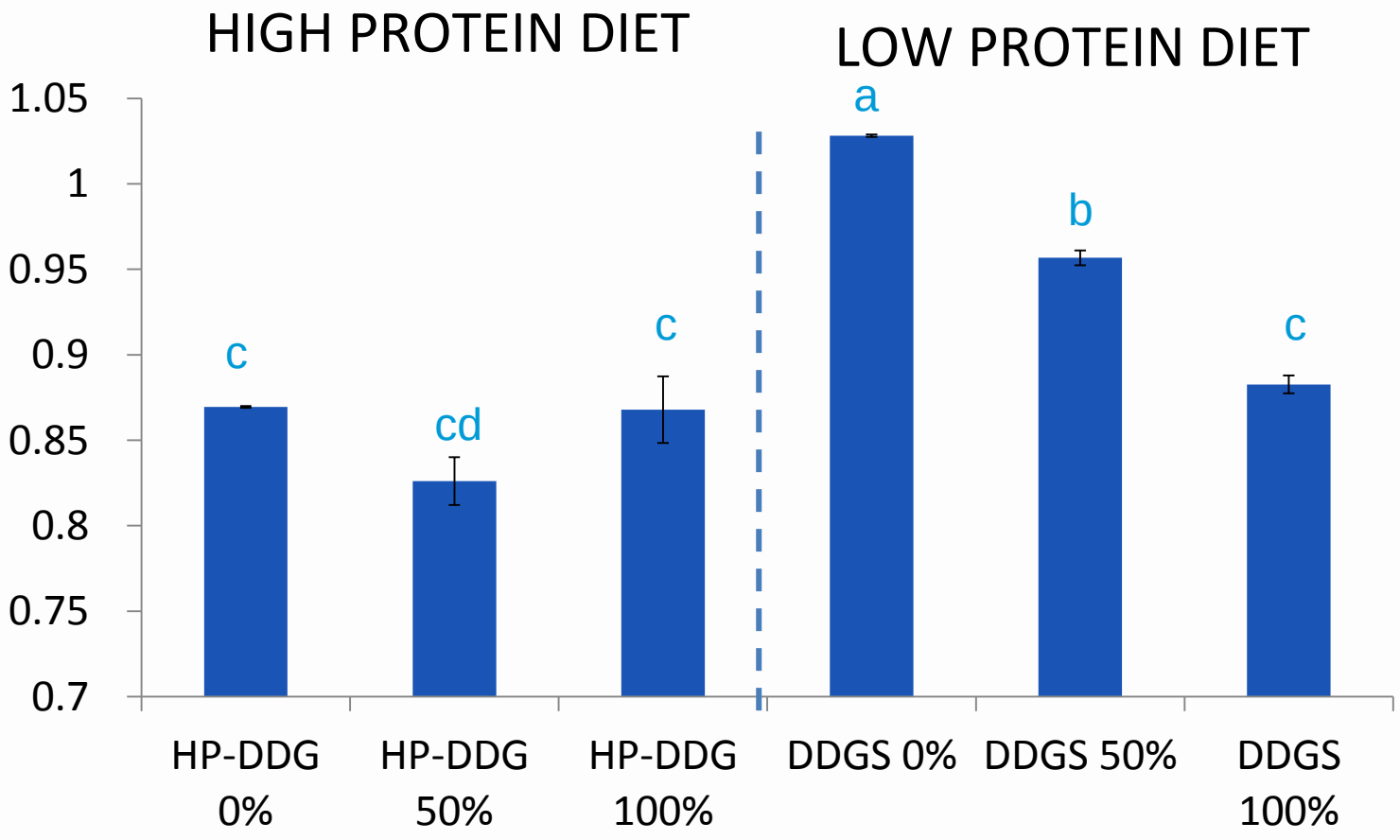
Feed intake and weight gain, g

HiPro vs LoPro: n.s.
Replacement level: n.s
Diets: n.s.



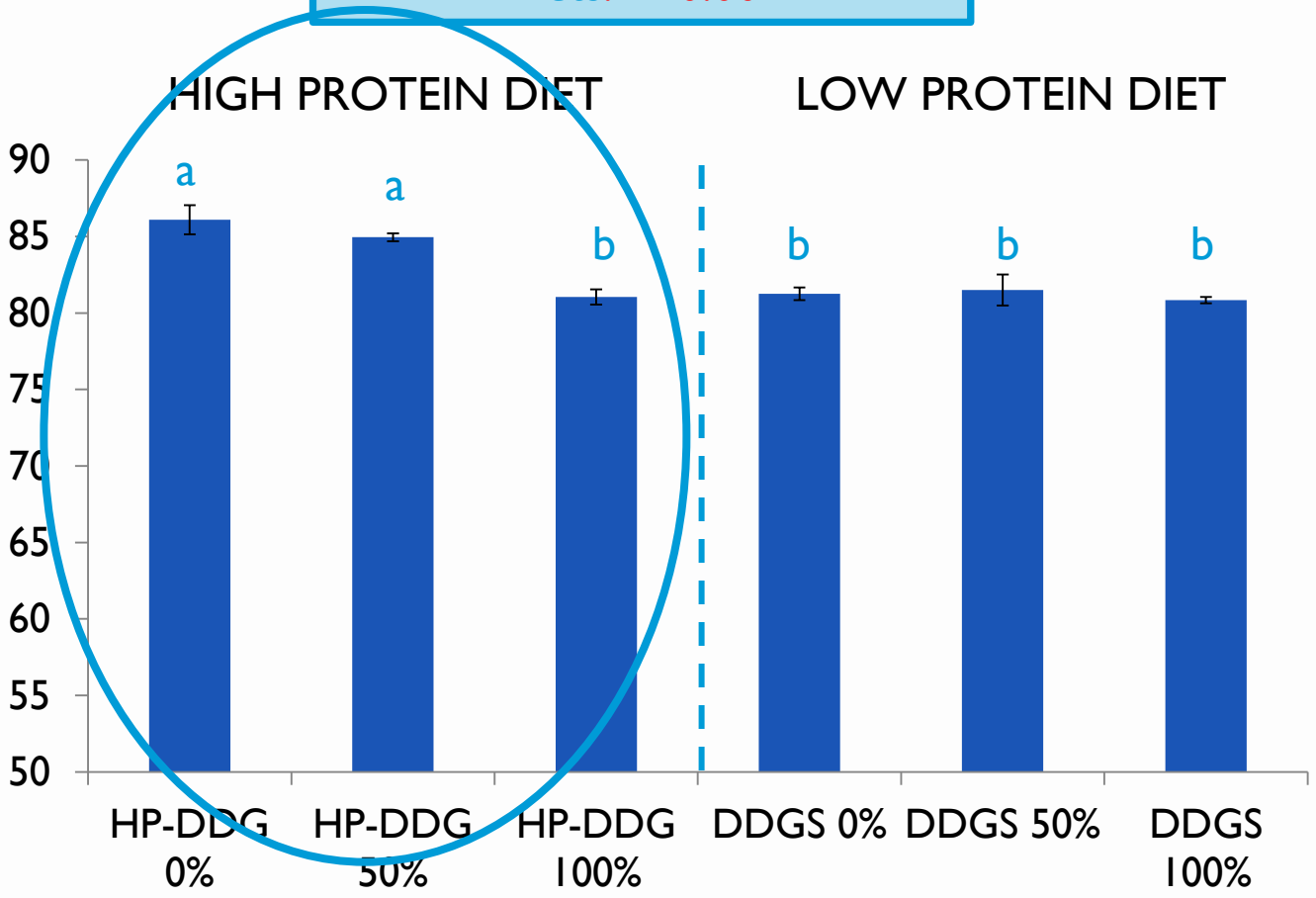
Feed conversion ratio

HiPro vs LoPro: P<0.001
Replacement level: P<0.001
Diets: P<0.001

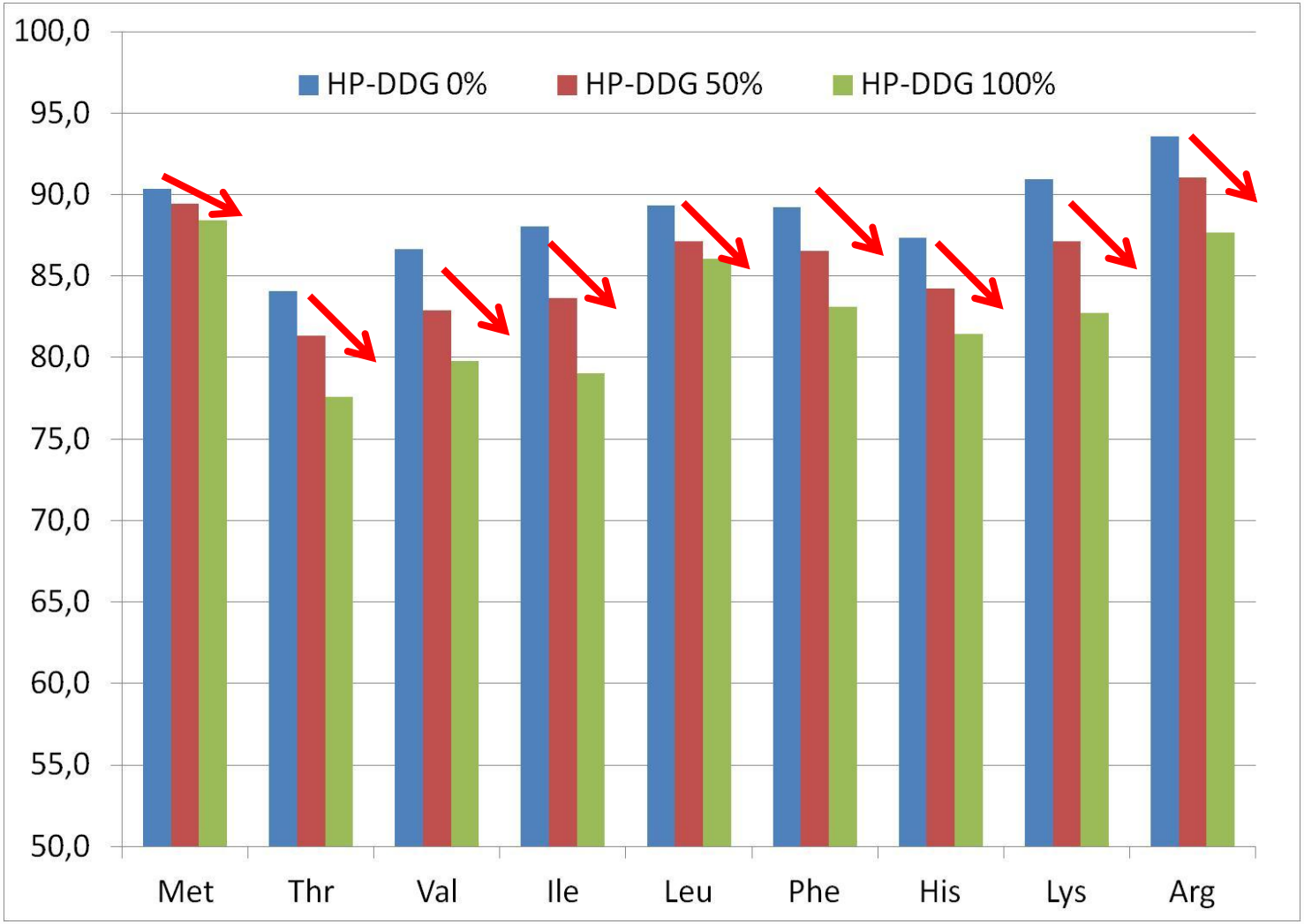


N digestibility, %

HiPro vs LoPro: P<0.001
Replacement level: P<0.001
Diets: P<0.001

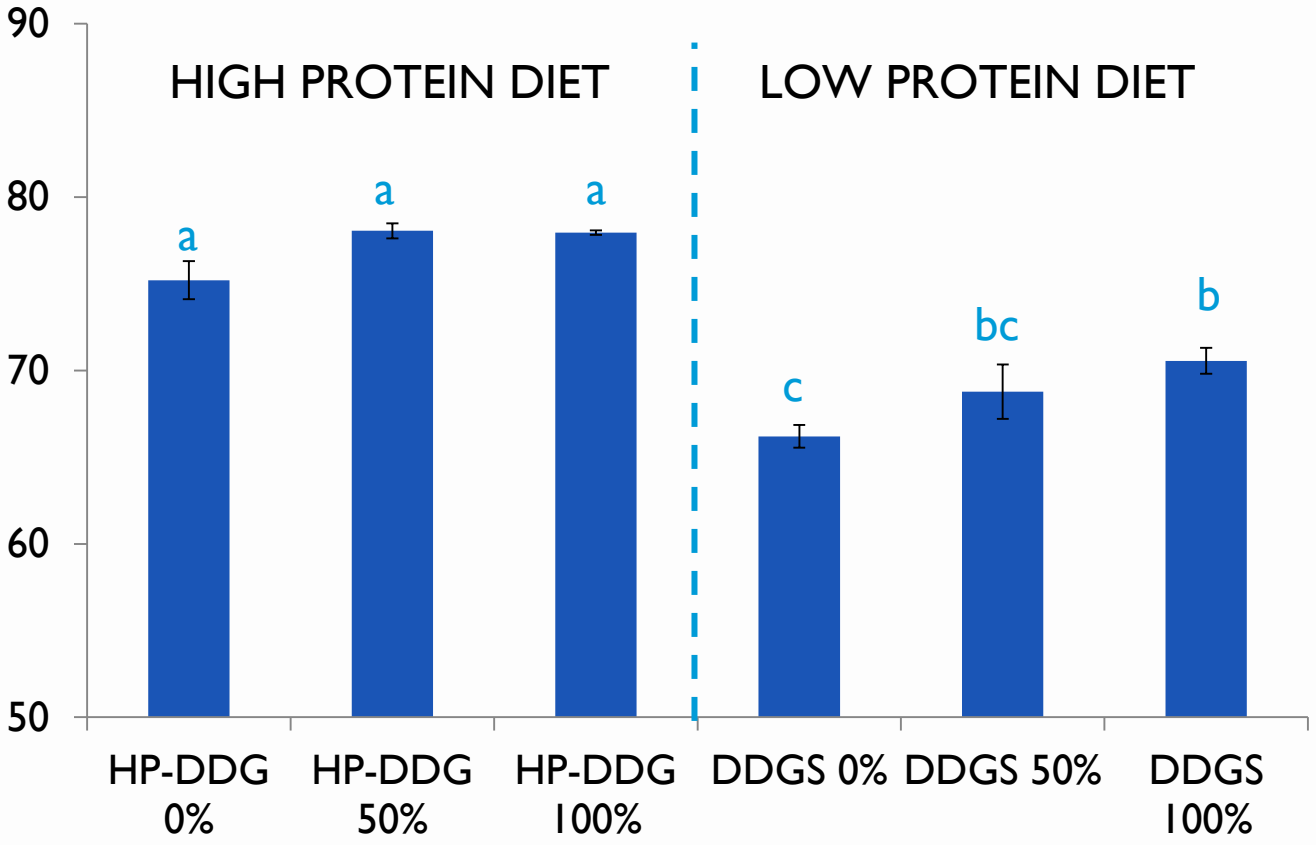


AA digestibilities, %



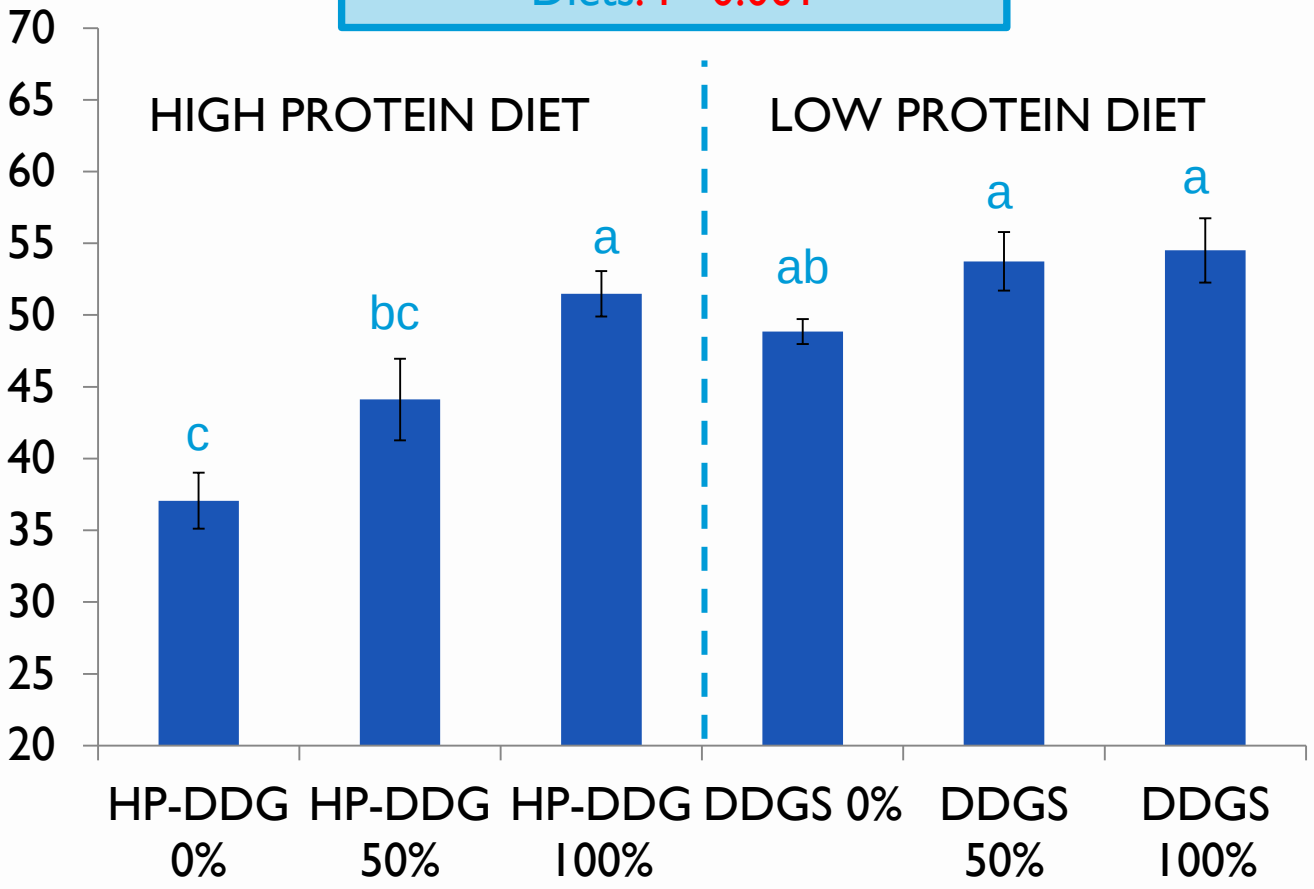
Energy digestibility, %

HiPro vs LoPro: P<0.001
Replacement level: P=0.005
Diets: P<0.001

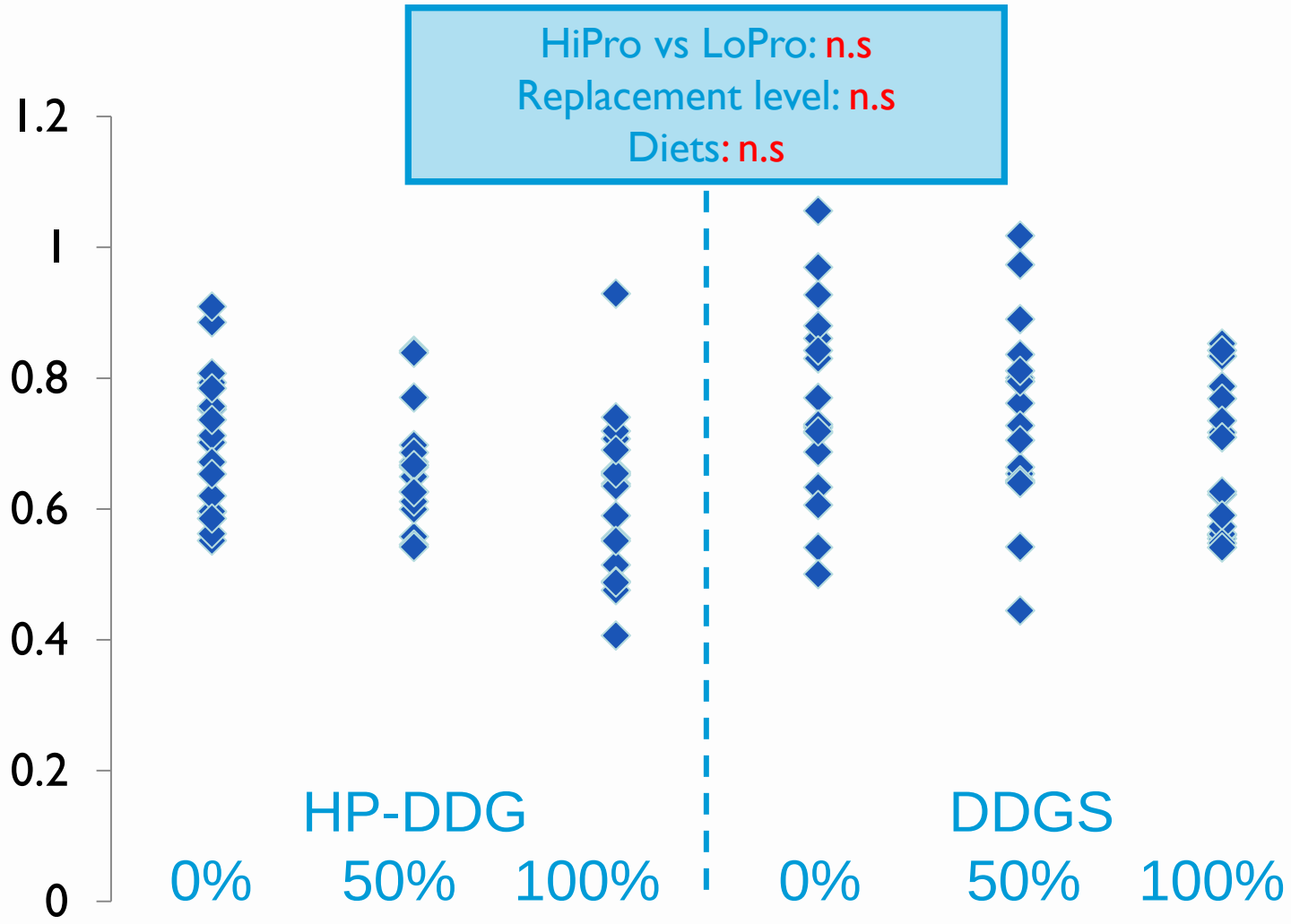


P digestibility, %

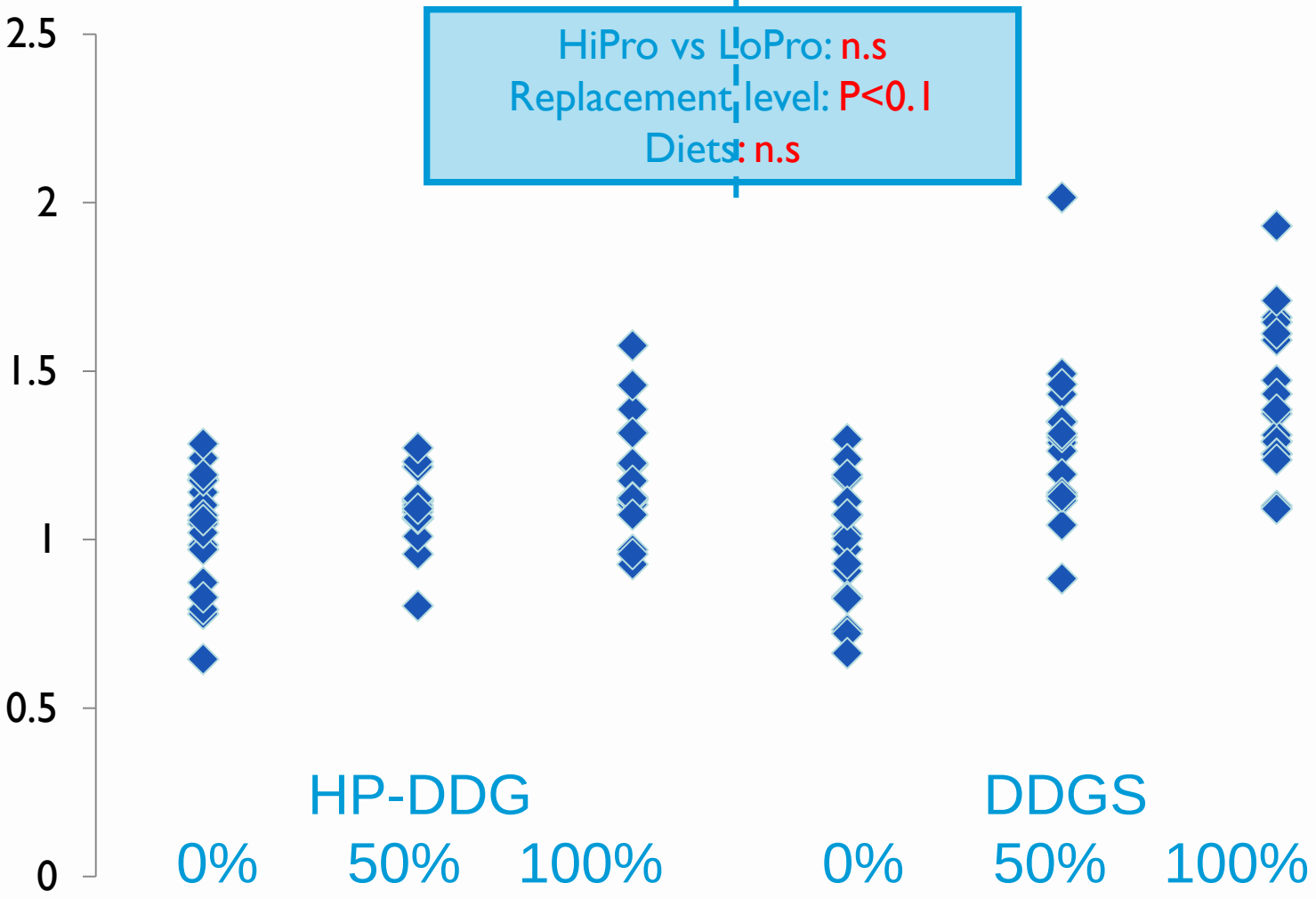
HiPro vs LoPro: P<0.001
Replacement level: P<0.001
Diets: P<0.001



Relative DI weights, %

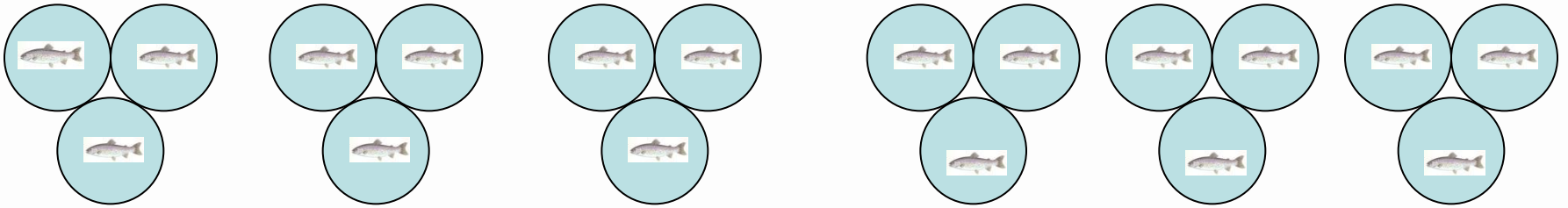


Relative Liver weights, %



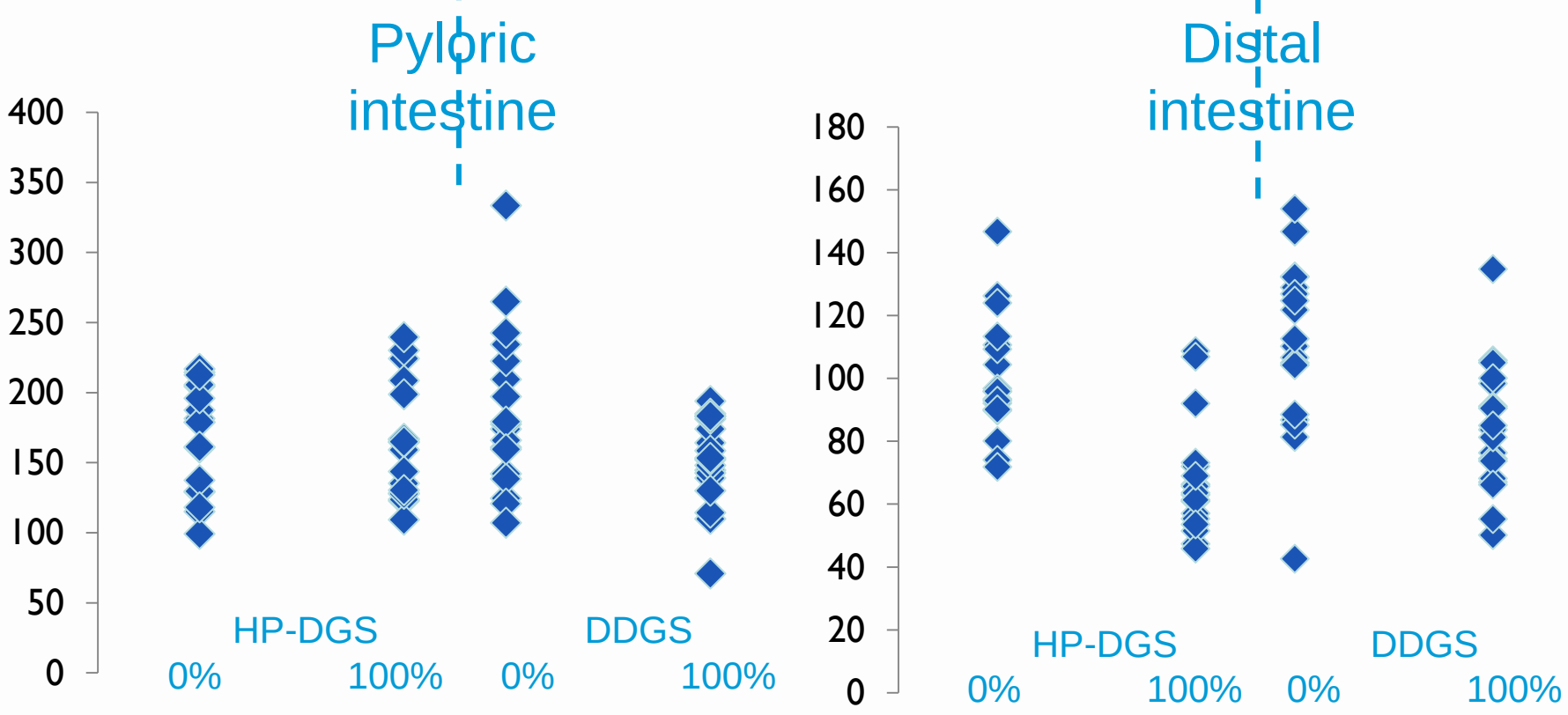
GI enzymes and histology

High CP			Low CP		
HPDDG 0%	HPDDG 50%	HPDDG 100%	DDGS 0%	DDGS 50%	DDGS 100%



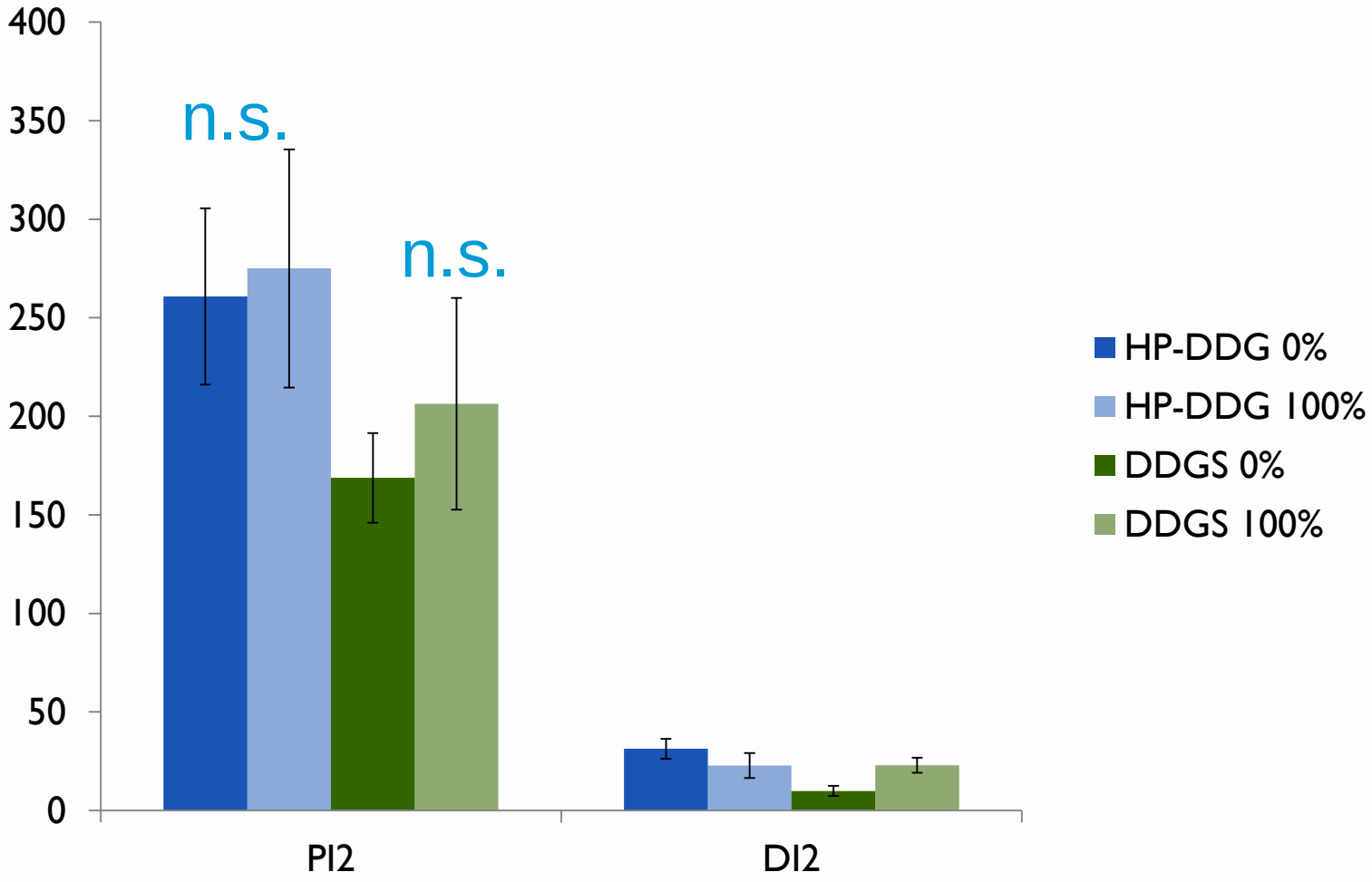
Leucine Amino Peptidase

mmol/h/kg fish



Trypsin activity

U/mg DM



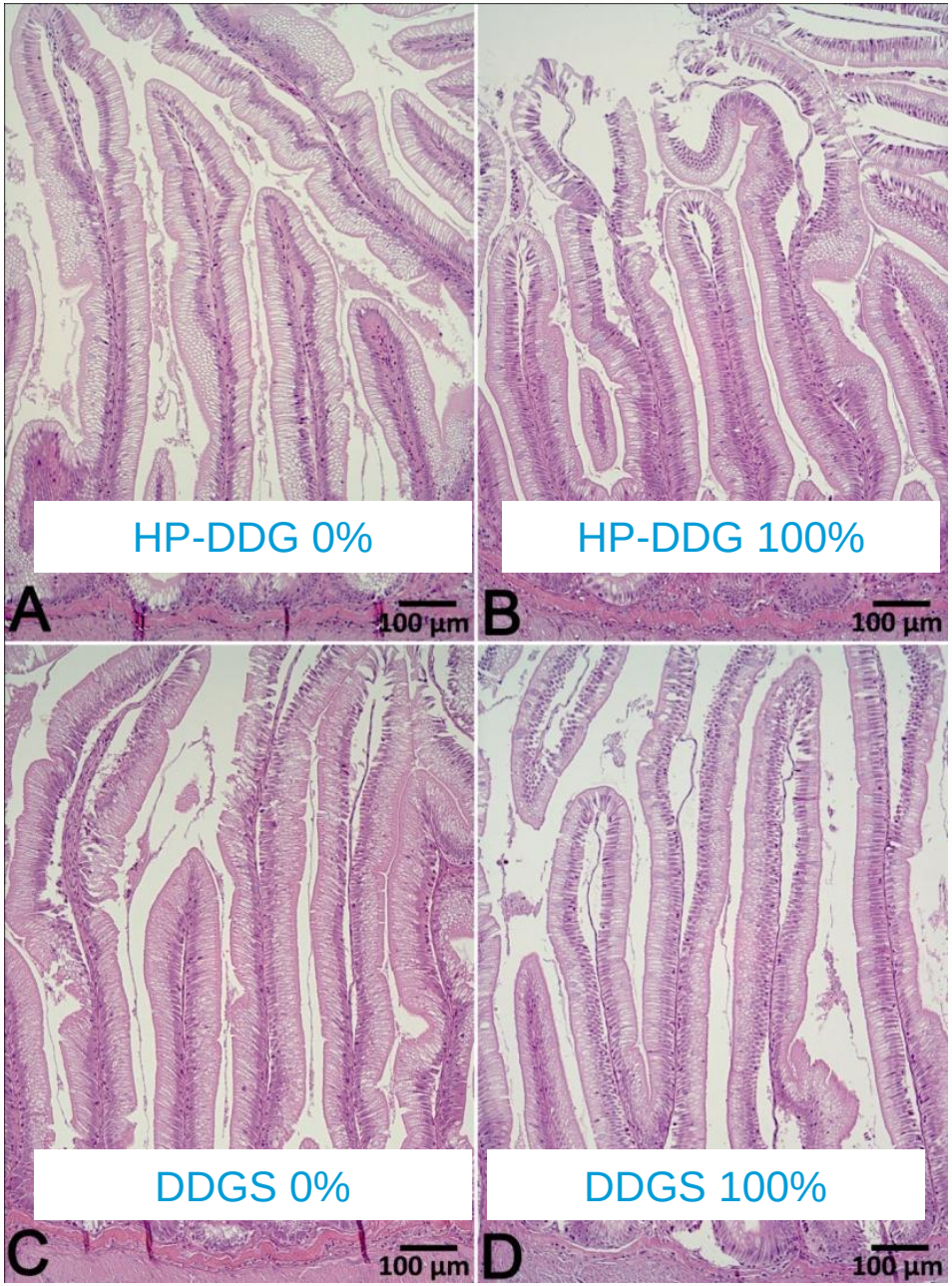
Histology of the distal intestine

Normal intestine (Fish meal fed)

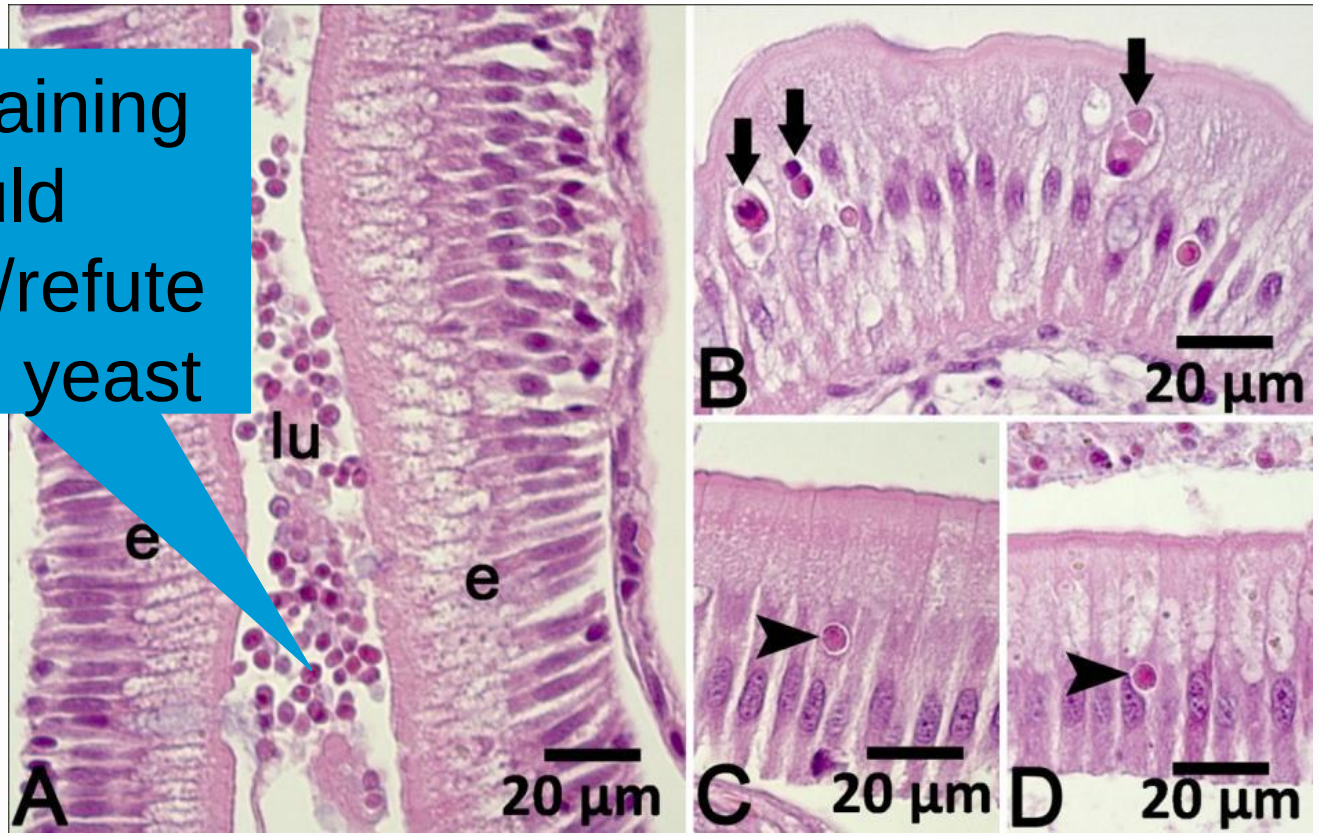
SBM-induced enteritis
(20% extracted SBM in the diet)

No significant differences in tissue architecture.

All groups appeared within normal limits.

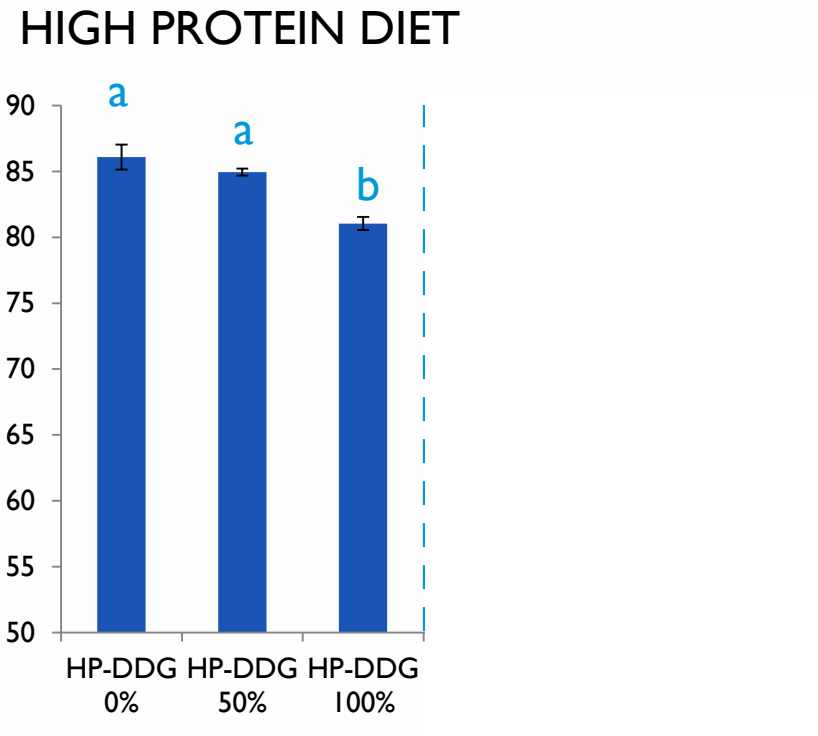


PAS-staining could confirm/refute if this is yeast



DDGS and HP-DDG fed fish: High numbers of large cellular material within the intestinal lumen. The material does not appear to be tissue origin as little epithelial sloughing was observed. The epithelium appeared otherwise normal. Yeast remnants?

Effect of yeast on N digestibility



- Reduced digestibility of N
- Partly caused by intact undigested yeast?

Conclusions

- CP level has a major impact on feed utilization
- Increased co-product inclusion supports increased feed utilization
- Inclusion of dephytinized co-products improves P digestibility ⟶reduced MCP supplementation
- No detrimental effects of HP-DDG or DDGS on DI histology
- Does *Saccharomyces cerevisiae* resist degradation, which in turn may reduce N digestibility?
- Not adressed in this study, but: ”wrong” **pigment** for **salmonids**

Acknowledgements

- CHS: providing co-products
- Personell at the UMB fish laboratory, Aas Norway

Thank you!