EAAP ANNUAL MEETING 2016 BELFAST

Dry period plane of energy: Effects on glucose tolerance in peripartum dairy cows

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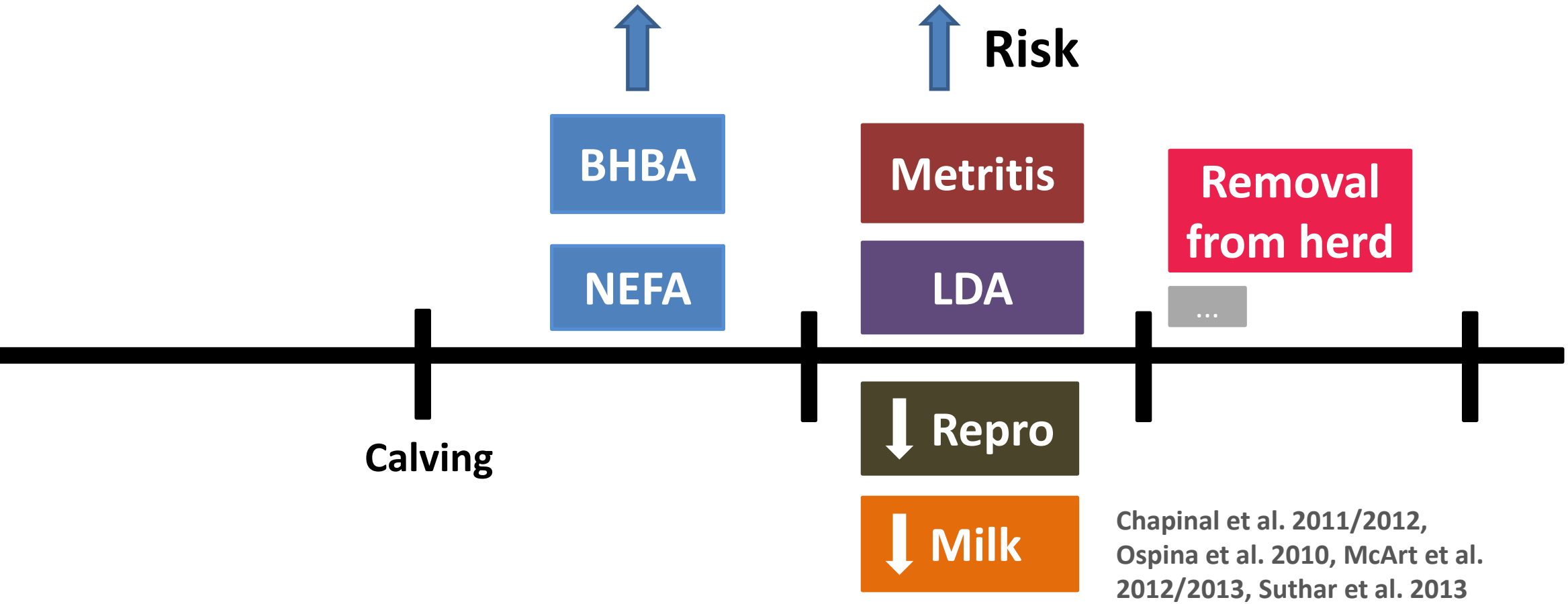
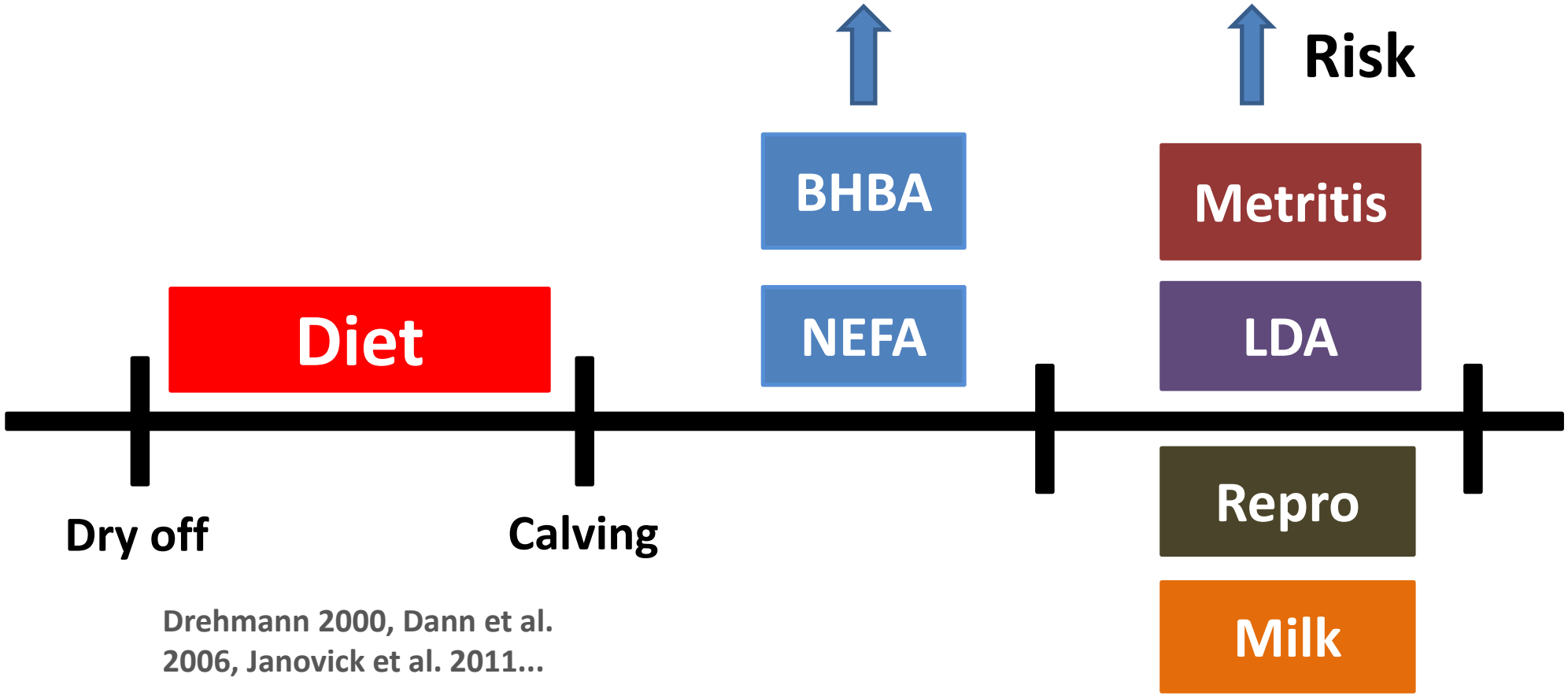
INTRODUCTION



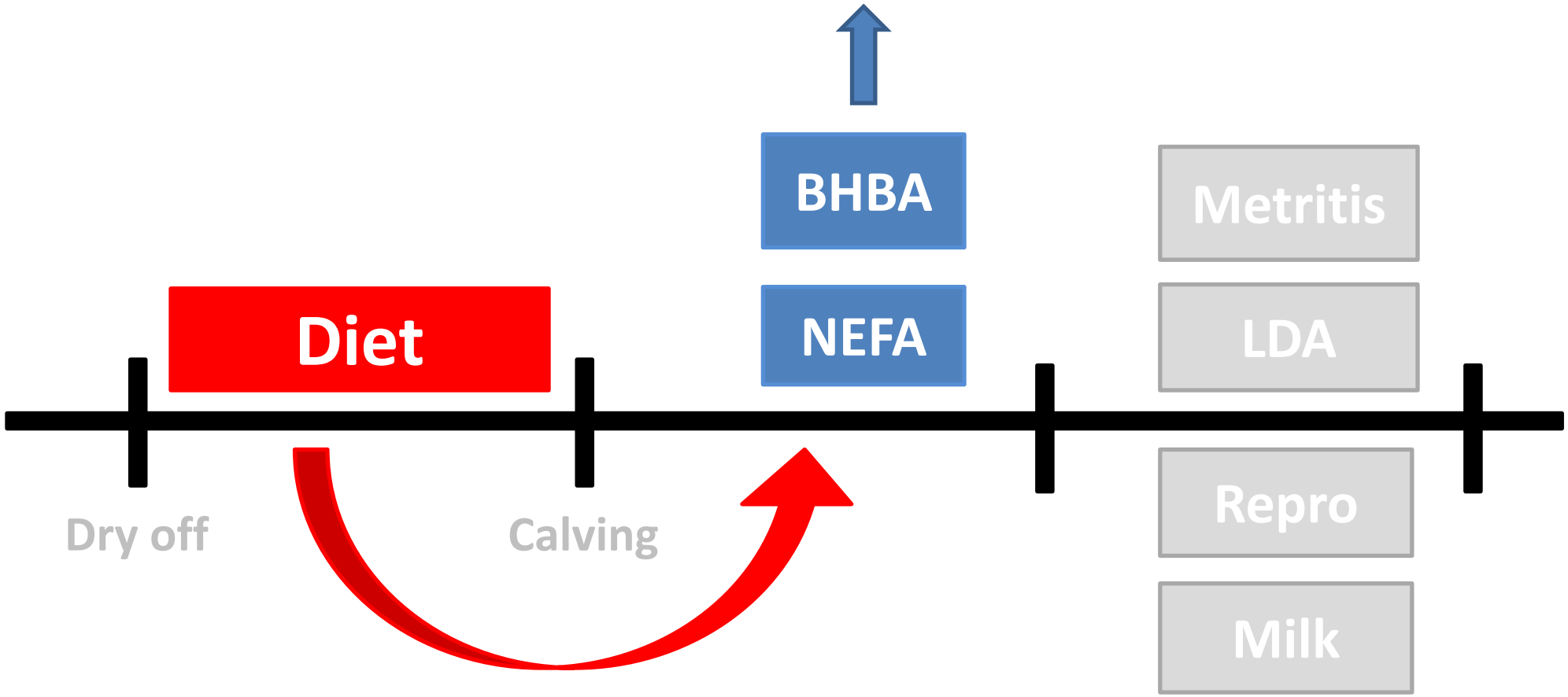
Chapinal et al. 2011/2012, Ospina et al. 2010, McArt et al. 2012/2013, Suthar et al. 2013

INTRODUCTION



Drehmann 2000, Dann et al. 2006, Janovick et al. 2011...

INTRODUCTION



[Glucose] [Insulin]

Glucose tolerance ?

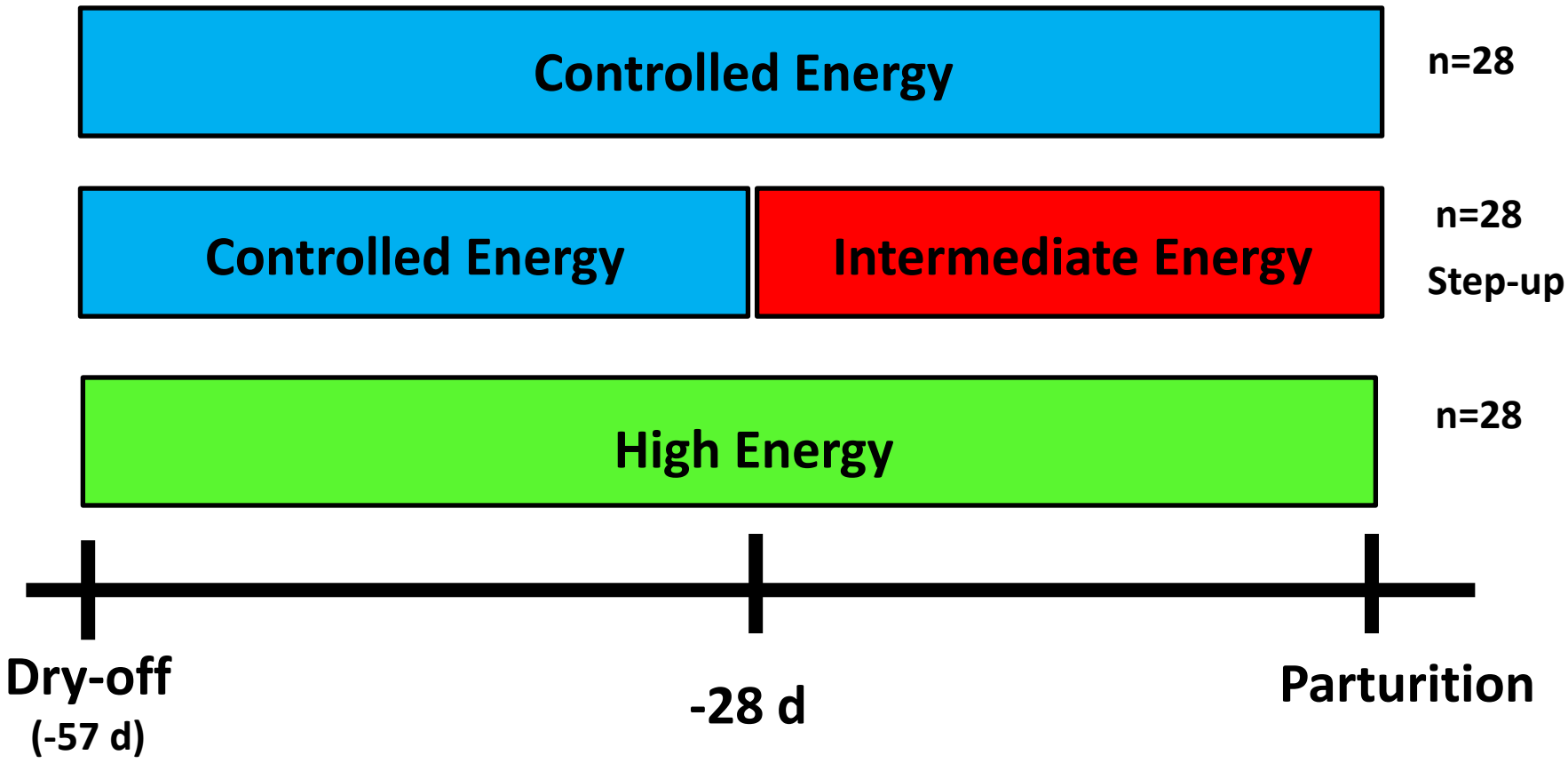
HYPOTHESIS

Overfeeding energy during the dry period

- affects regulation of blood glucose concentration, and
- affects peripartal glucose tolerance

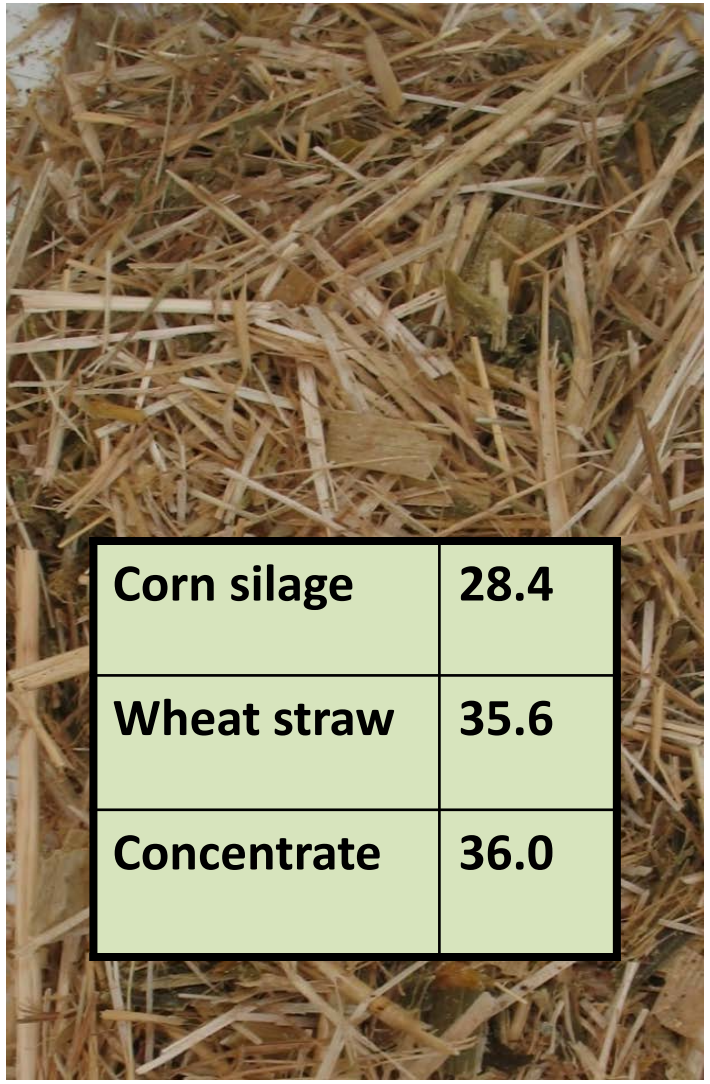
predisposing cows to hyperketonemia and increased lipolysis postpartum

TREATMENT GROUPS



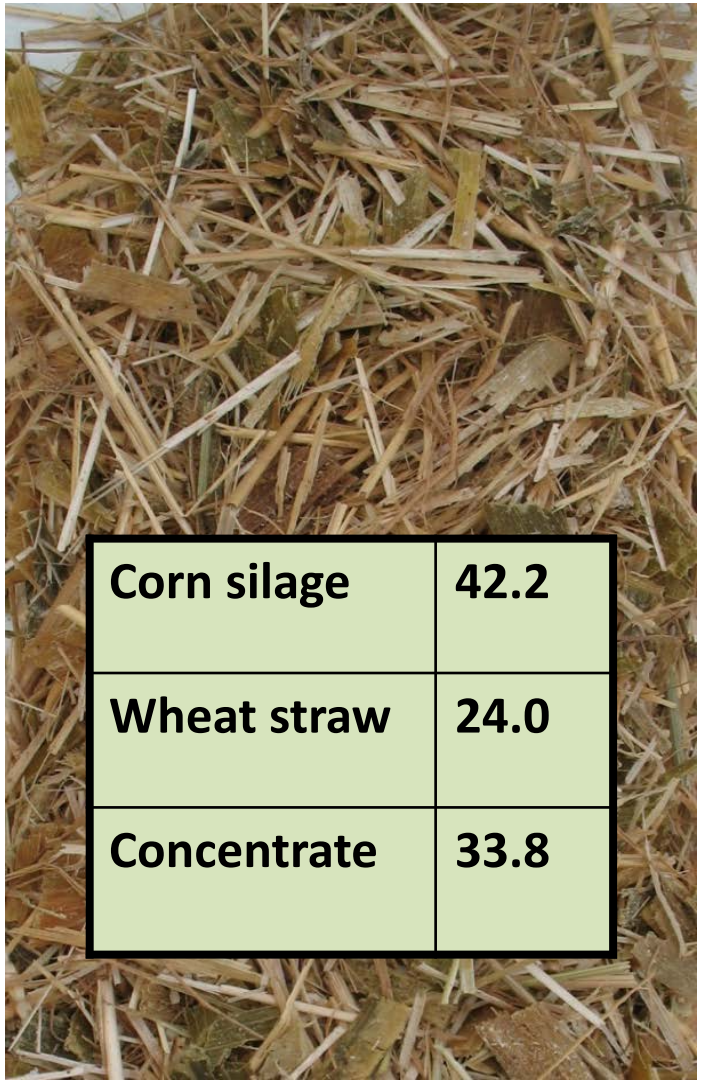
Lactation ≥ 2, housed in individual tie-stalls with feed buckets, all diets fed ad libitum, all animals fed same fresh cow TMR, enrollment randomized block design

DIET COMPOSITION (%DM)



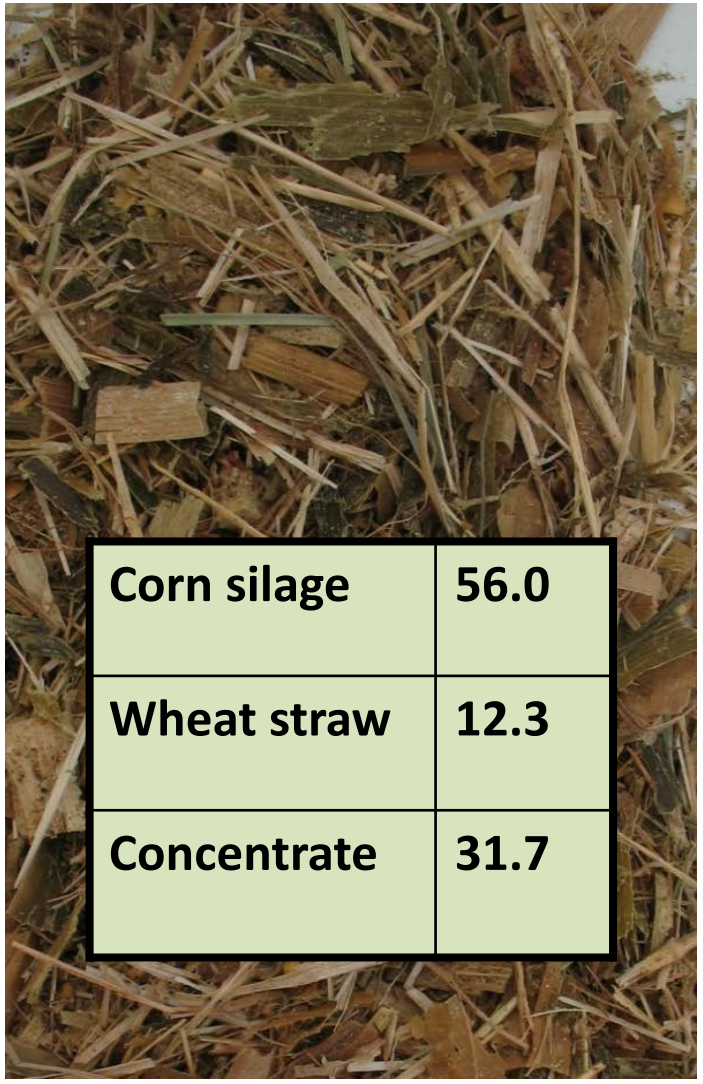
Corn silage	28.4
Wheat straw	35.6
Concentrate	36.0

Controlled



Corn silage	42.2
Wheat straw	24.0
Concentrate	33.8

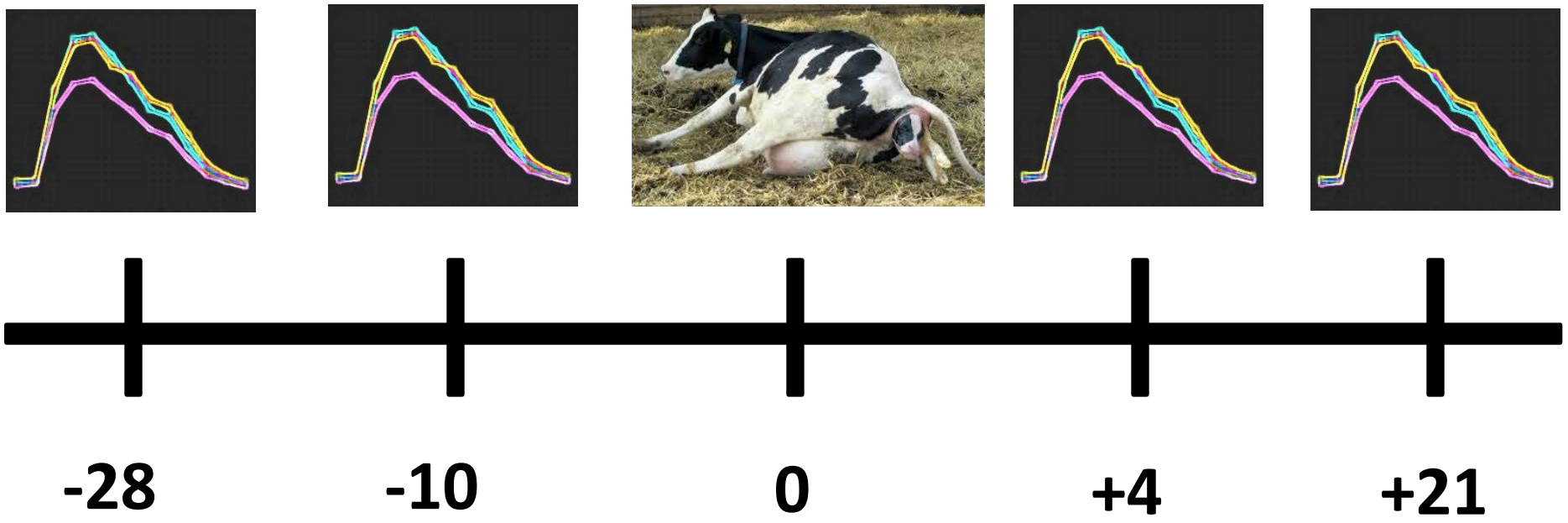
Intermediate

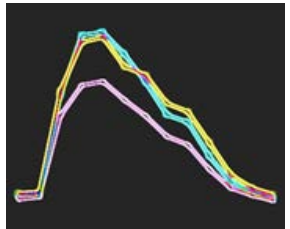


Corn silage	56.0
Wheat straw	12.3
Concentrate	31.7

High

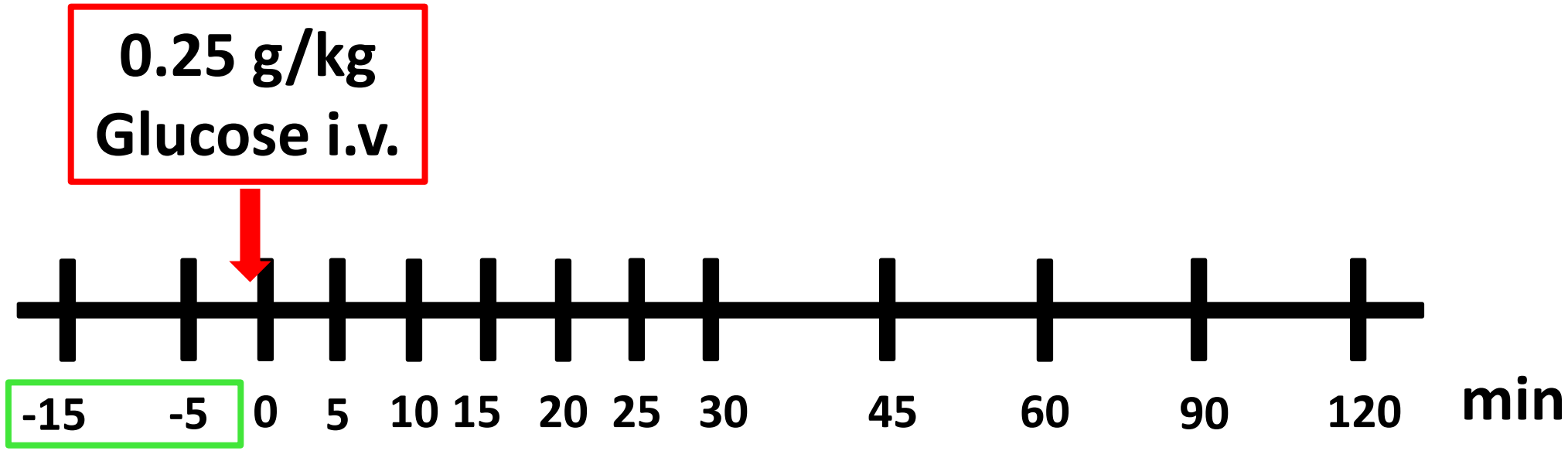
SAMPLING TIME POINTS





= **I**ntra**v**enous **G**lucose **T**olerance **T**est **(IVGTT)**
0.25 g/kg glucose i.v. as 50% solution

IVGTT + BASELINE SAMPLES



Baseline values: Glucose, Insulin, NEFA, BHBA, glucagon

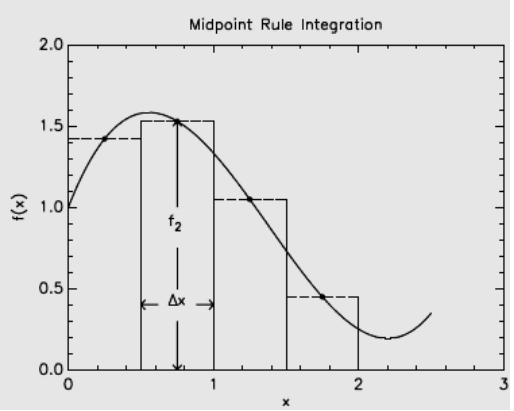
All timepoints: Glucose, Insulin, NEFA

ANALYSIS

- Laboratory analysis
  - Heparinized plasma within 30 min after collection, snap frozen and stored at -20°C
  - Glucose and NEFA by enzymatic colorimetric method (Sigma, Wako)
  - Insulin and glucagon by radioimmunoassay (Millipore)
  - BHBA cow-side (Precision Xtra, Abbott)

- Statistical analysis (SAS 9.3)
  - For IVGTT: Area under the curve (AUC) (Cardoso et al. 2011)

    positive incremental area from baseline
  - Mixed-effects ANOVA (fixed effect of treatment group, random effect of enrollment block)
  - Tukey´s posthoc test for differences among the groups

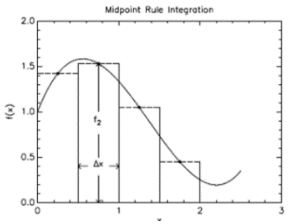


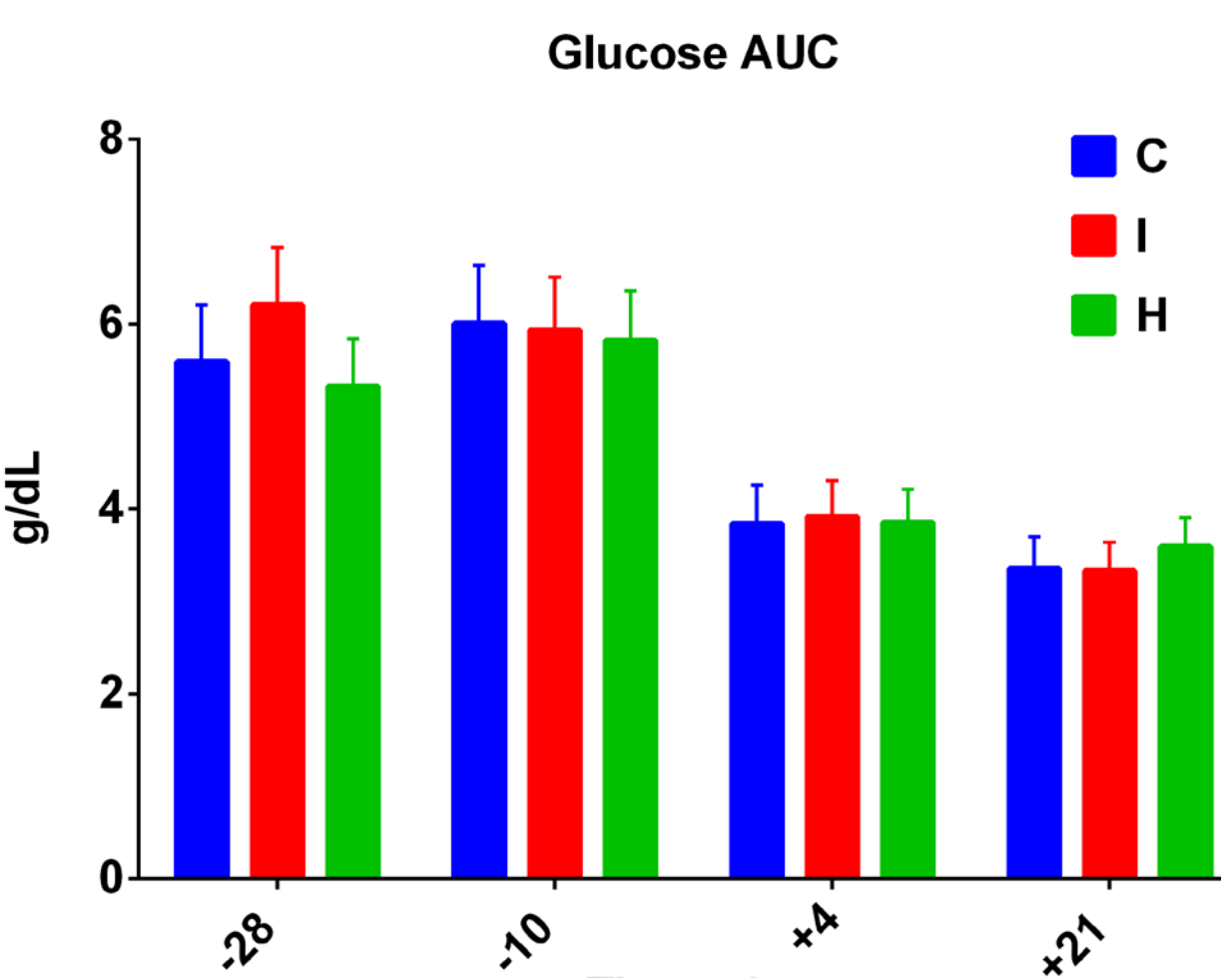
RESULTS: RATION ANALYSIS

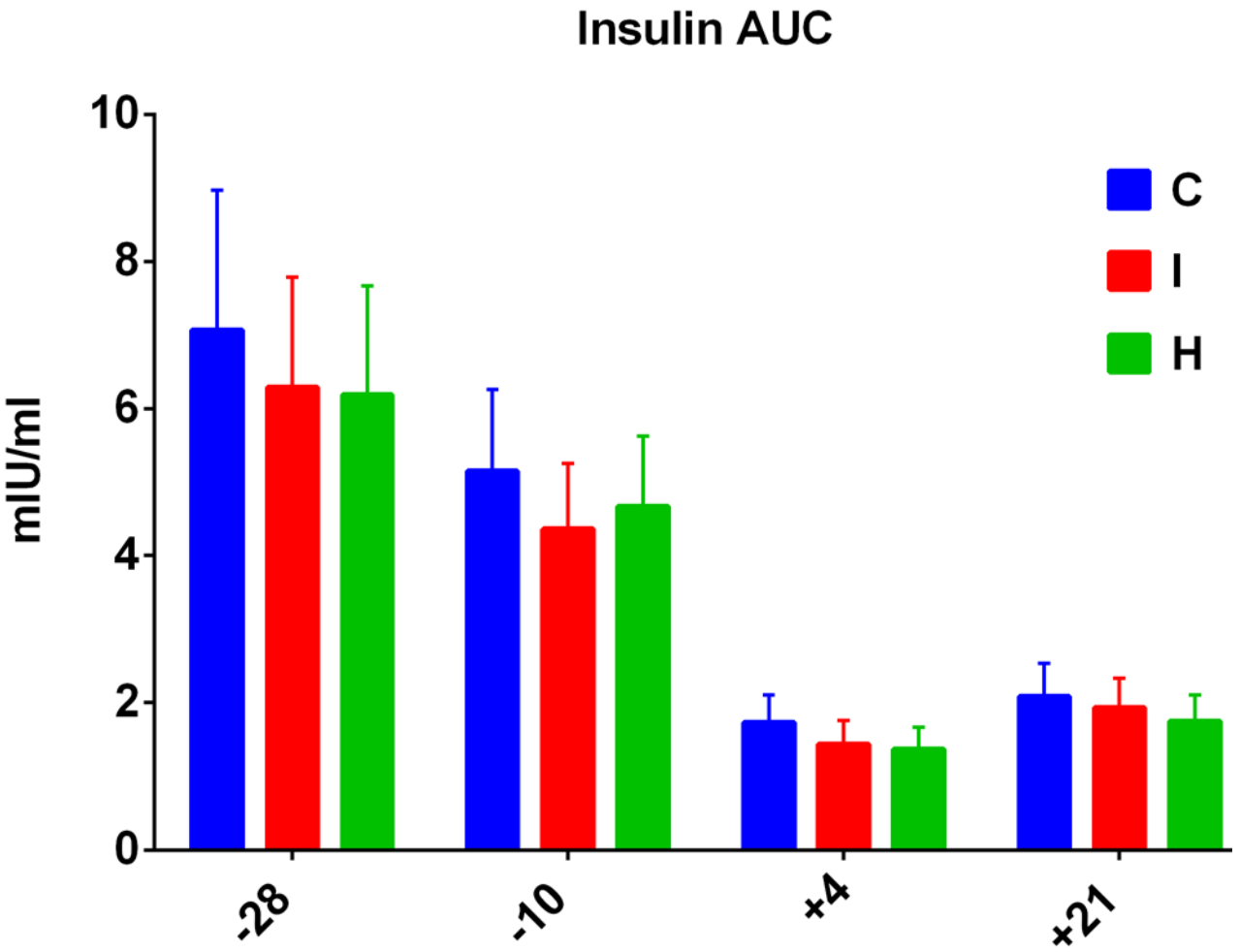
Variable	Controlled	I-med	High
ME (Mcal/kg)[a]	1.98	2.12	2.23
Energy balance (% of req.)[a]	112	126	153
Total MP Available[a] (g/day)	1492	1523	1518
MP (% of req.)[a]	124	123	118
NDF (% DM)[b]	48.4	42.2	41.0
Starch (% DM)[b]	15.0	20.1	23.7

Wet chemistry analysis Dairy One Coop. Ithaca; [a] CNCPS v.6.1 estimation ; [b]average of 10 monthly composites

RESULTS: AREA UNDER CURVE

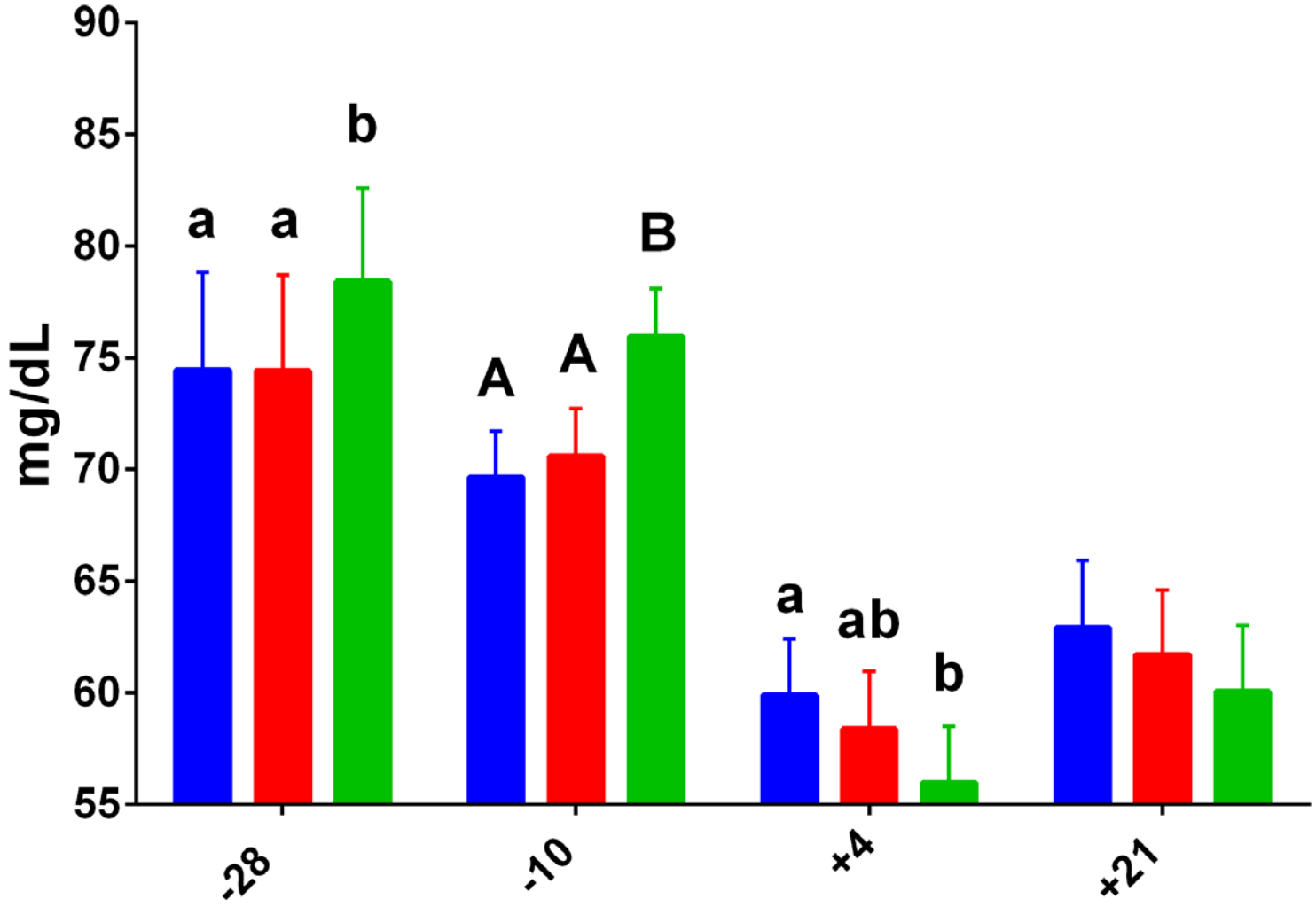






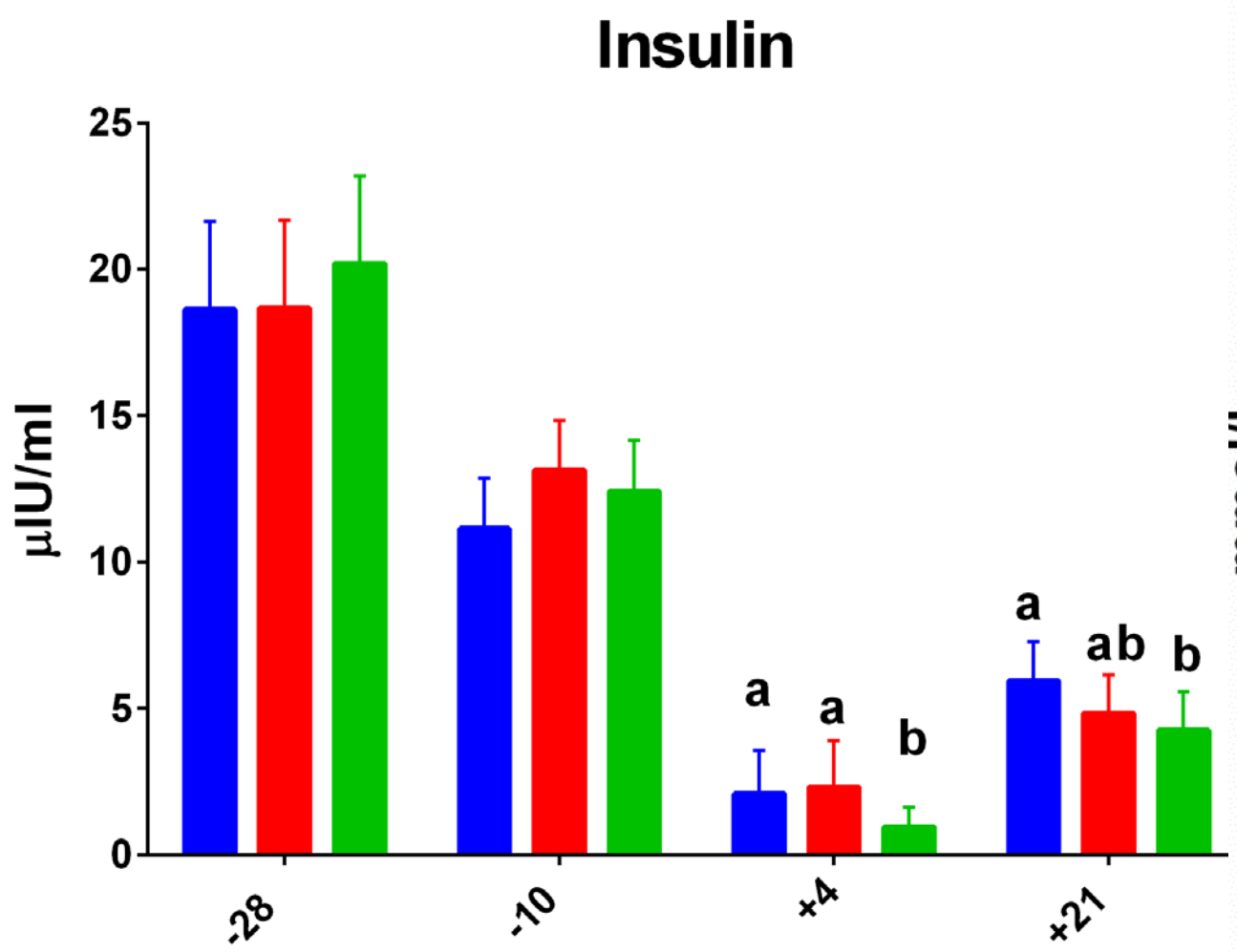
Group means at each time-point marked with different letters are different at a level of
^{A,B} ***P* < 0.05**, ^{a,b} ***P* < 0.10** in Tukey's HSD test; mixed-effects ANOVA. Error bars represent 95% CI.

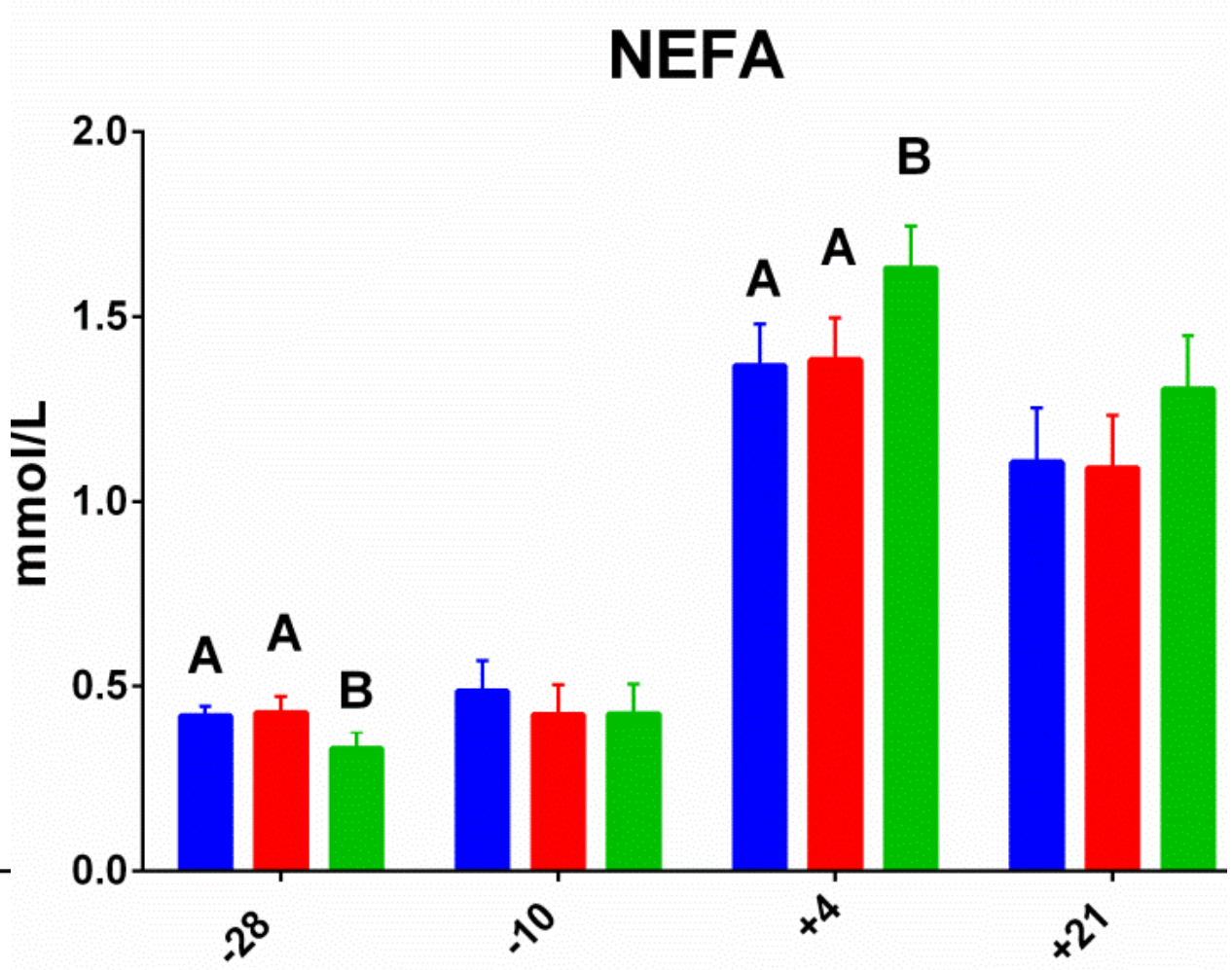
RESULTS: BASELINE GLUCOSE



Group means at each time-point marked with different letters are different at a level of ^{A,B} $P < 0.05$, ^{a,b} $P < 0.10$ in Tukey's HSD test; mixed-effects ANOVA. Error bars represent 95% CI.

RESULTS





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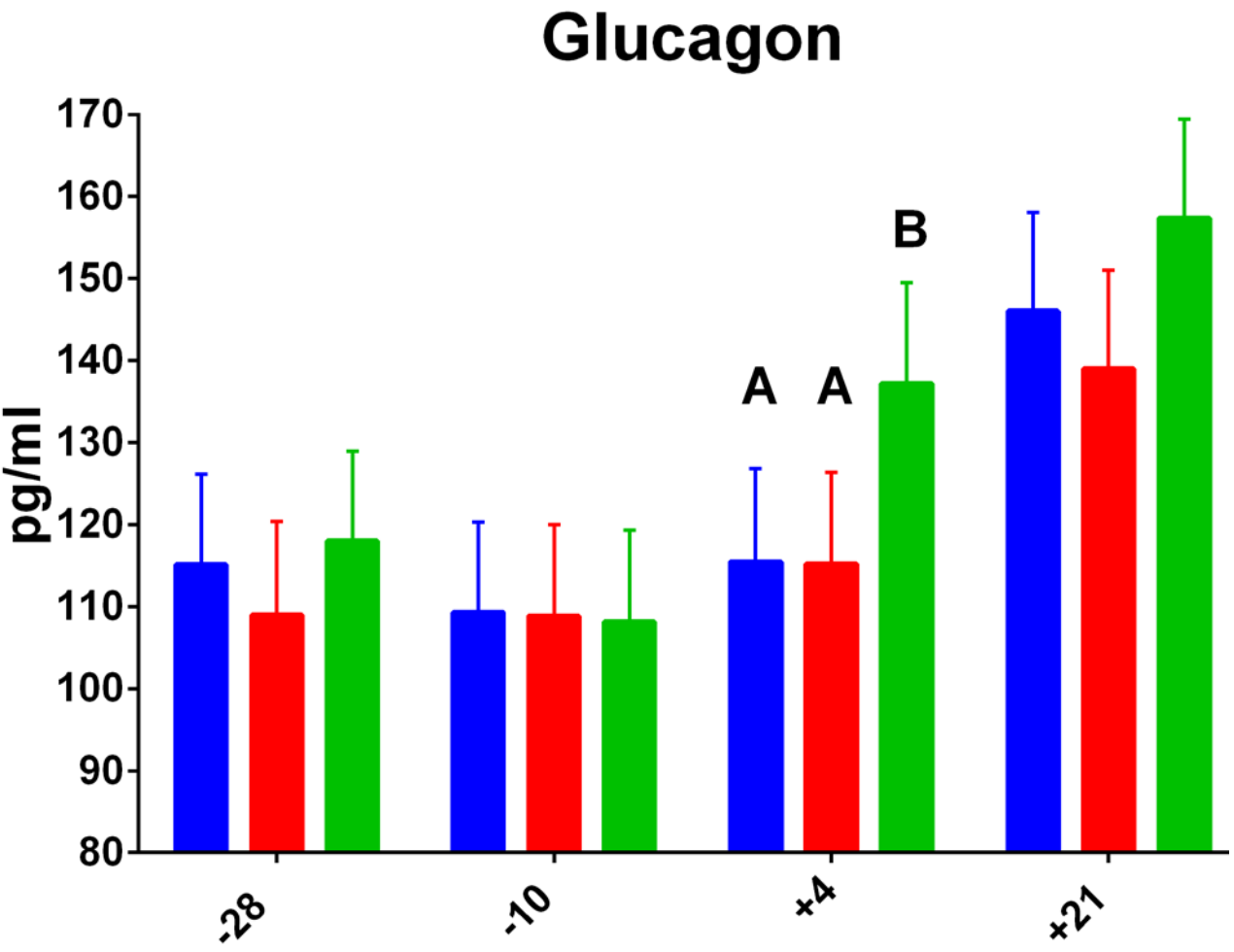
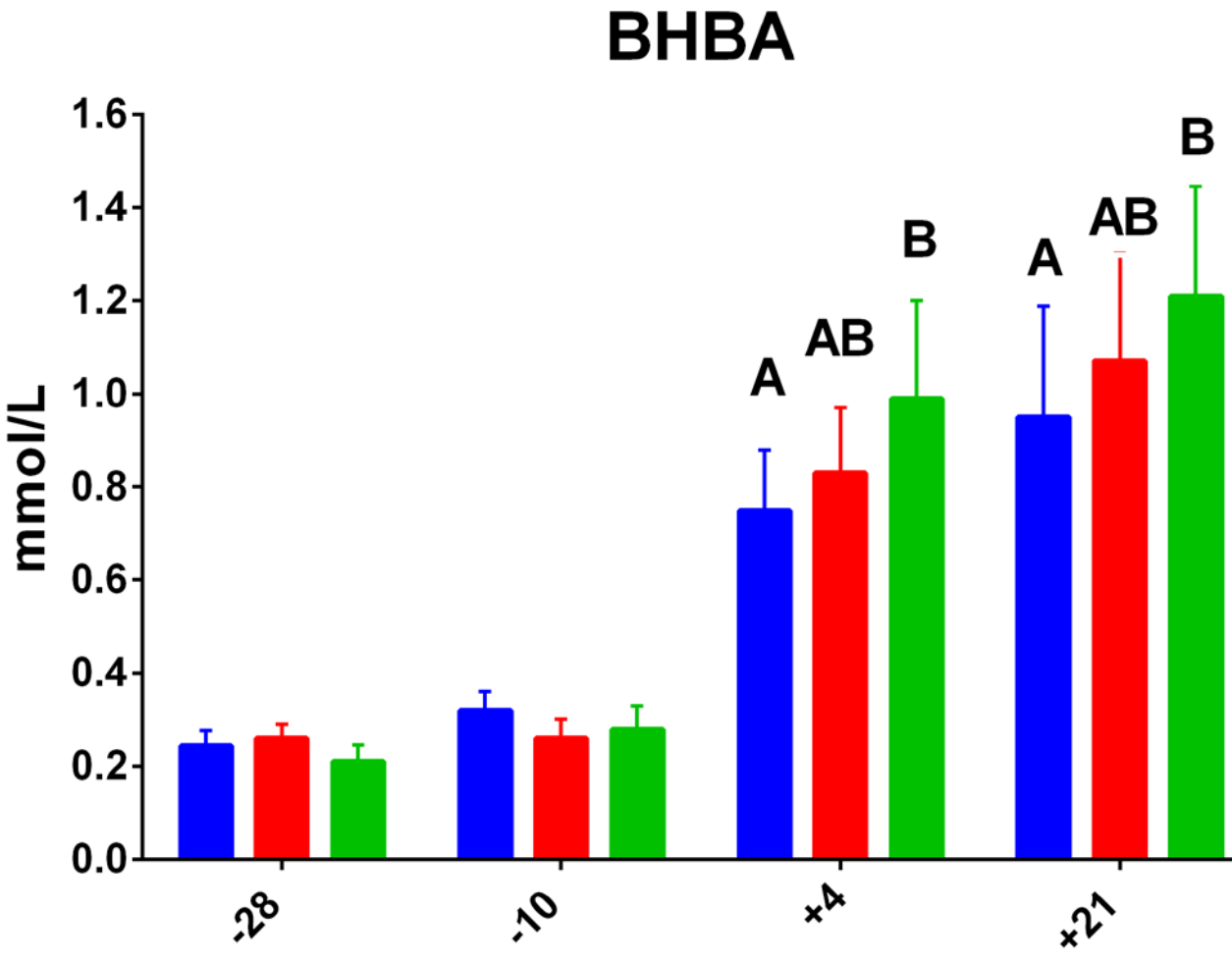




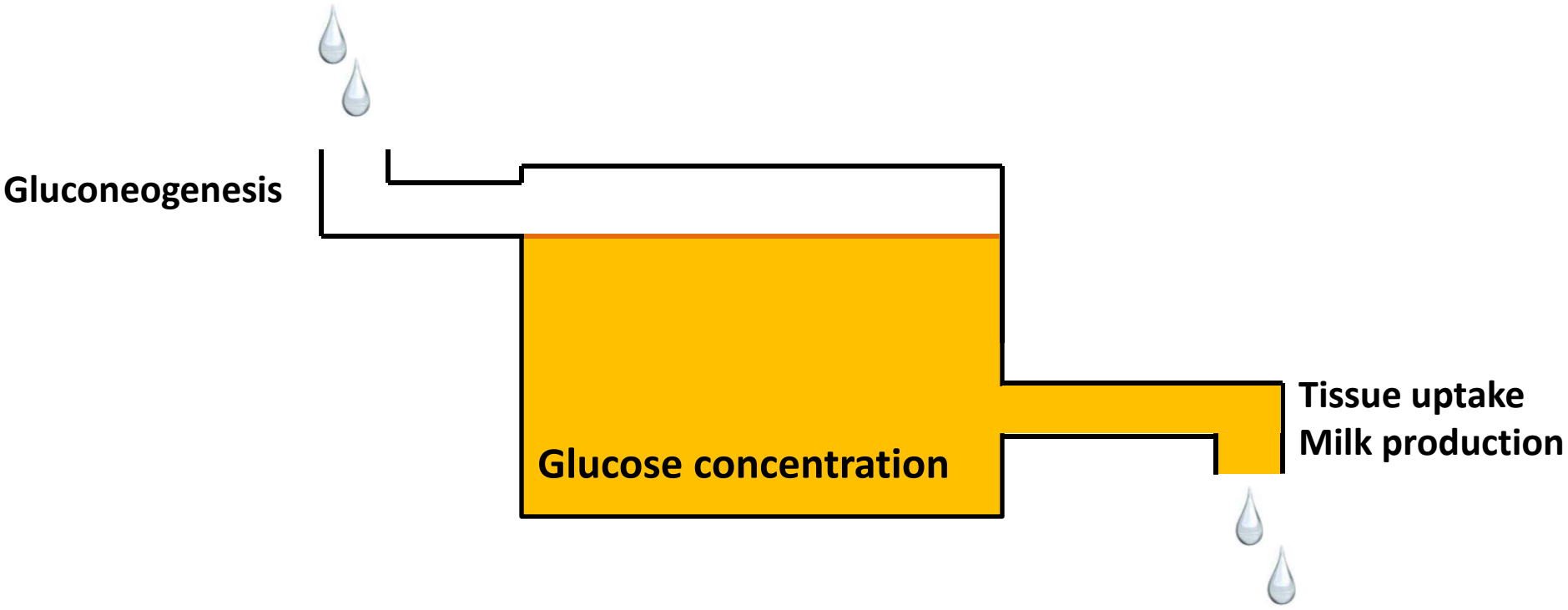
Group means at each time-point marked with different letters are different at a level of ^{A,B} $P < 0.05$, ^{a,b} $P < 0.10$ in Tukey's HSD test; mixed-effects ANOVA. Error bars represent 95% CI.

SUMMARY

- **Feeding a high compared with a controlled energy dry diet was associated with:**
  - **Effect on blood glucose and pancreatic hormone concentrations, especially early postpartum**
  - **No effect on glucose clearance or insulin response as assessed by IVGTT**
  - **Increased NEFA concentrations ⟹ increased lipolysis**
  - **Increased concentrations of BHBA postpartum**

FUTURE DIRECTION

Cause(s) of change in resting glucose concentration postpartum ?



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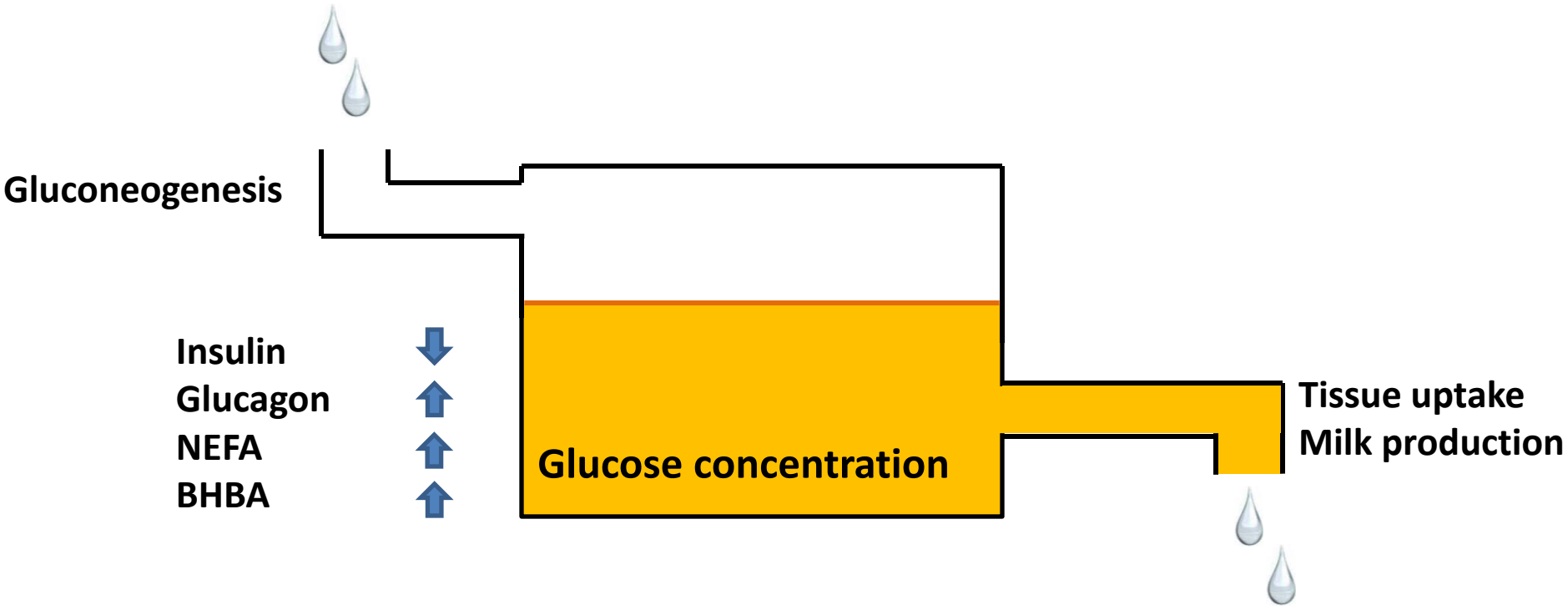

FUTURE DIRECTION

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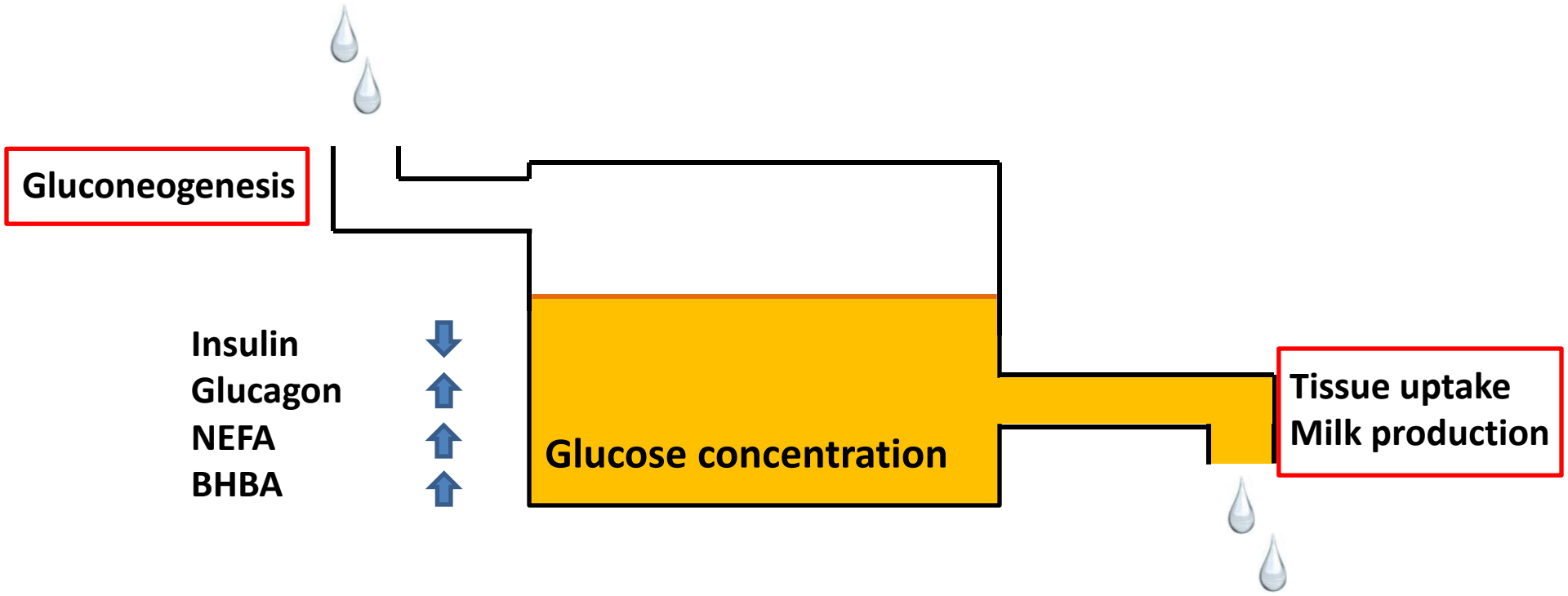

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Endocrinology lab at AHDC

Cummings lab

and

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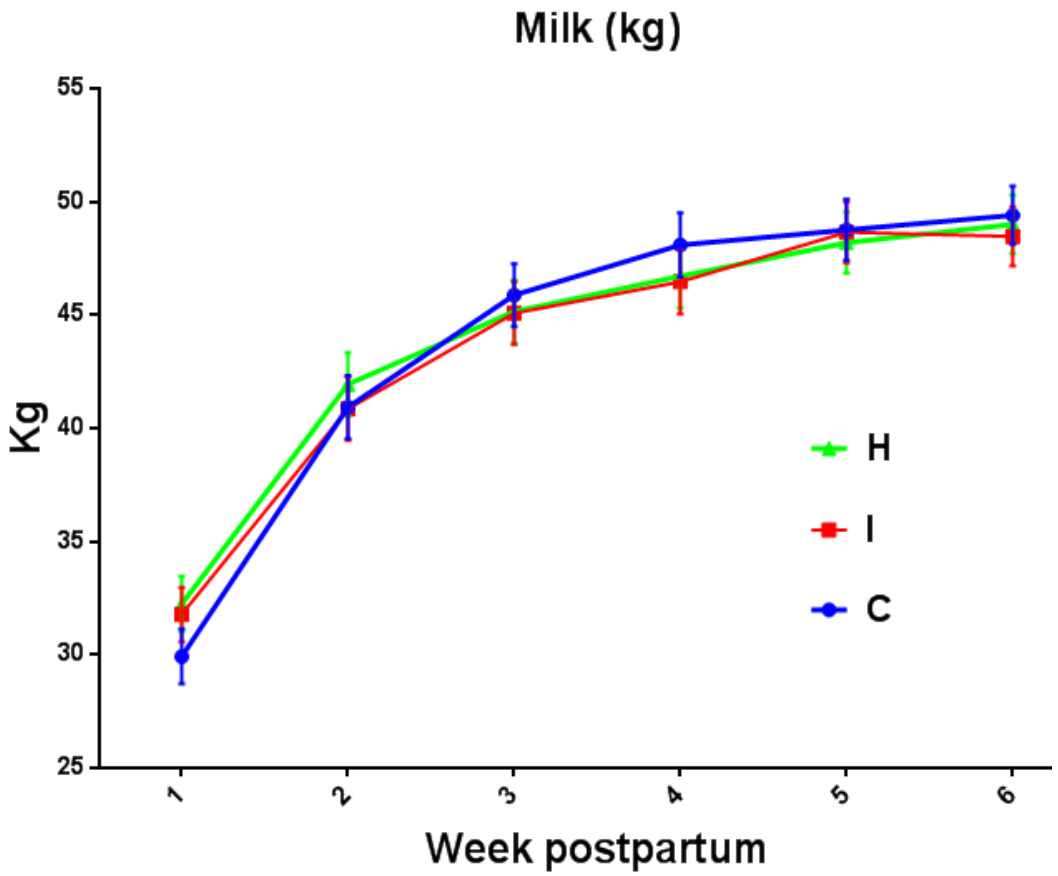
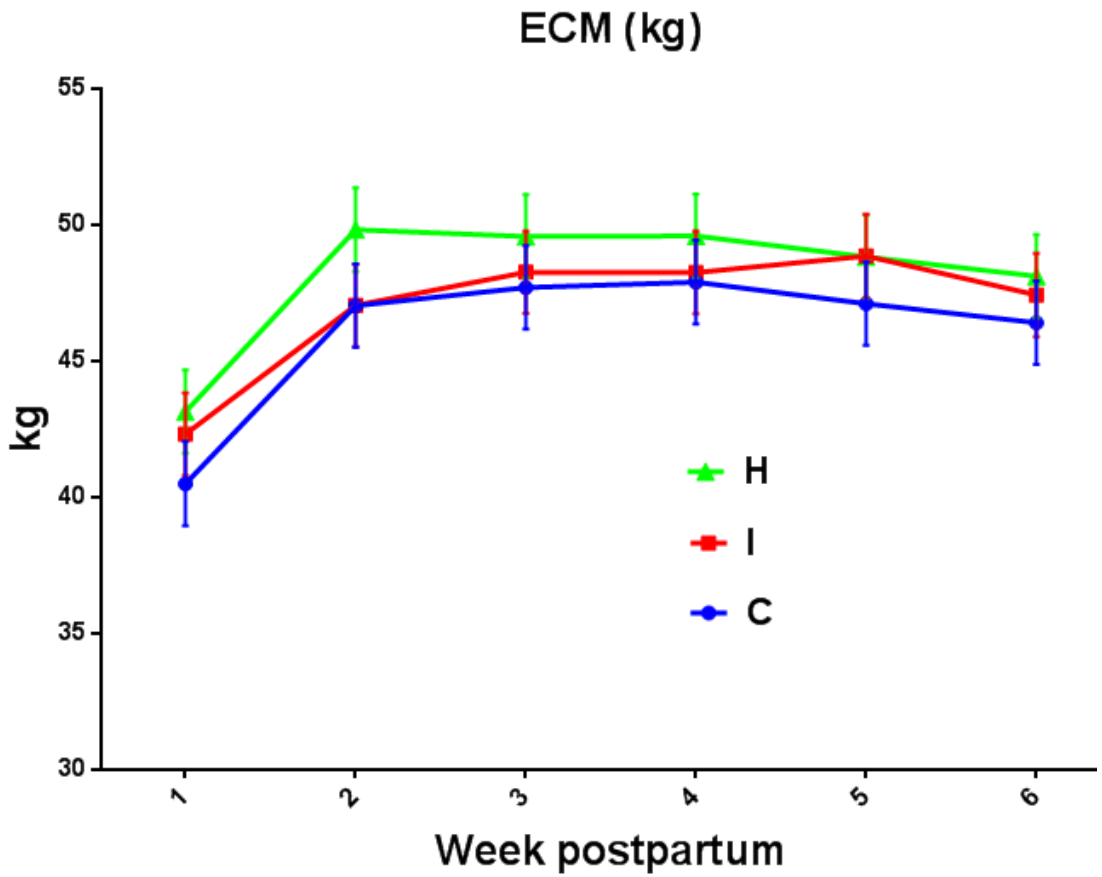
  "Any opinions, findings, conclusions, or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the view of NIFA or the USDA"

- Cornell University College of Veterinary Medicine Graduate Research Assistantship

MILK AND ECM YIELD

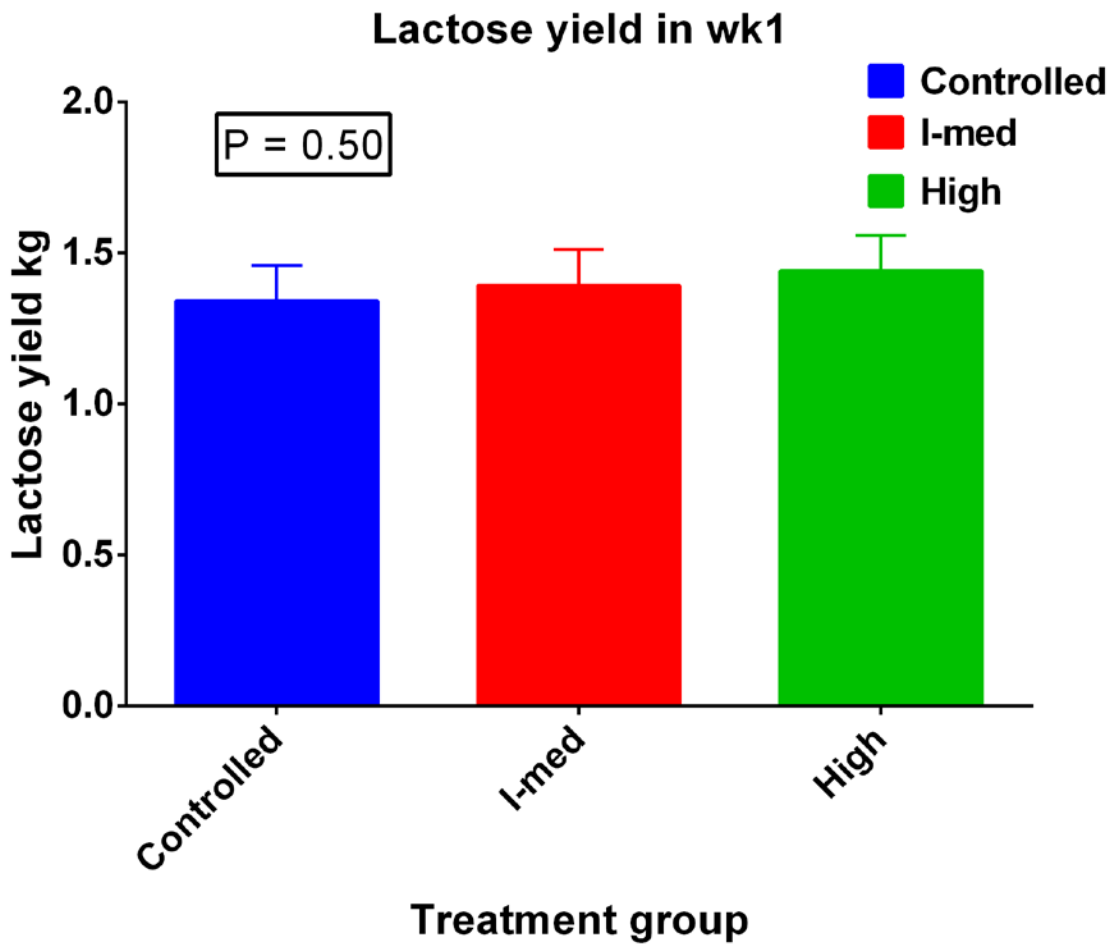


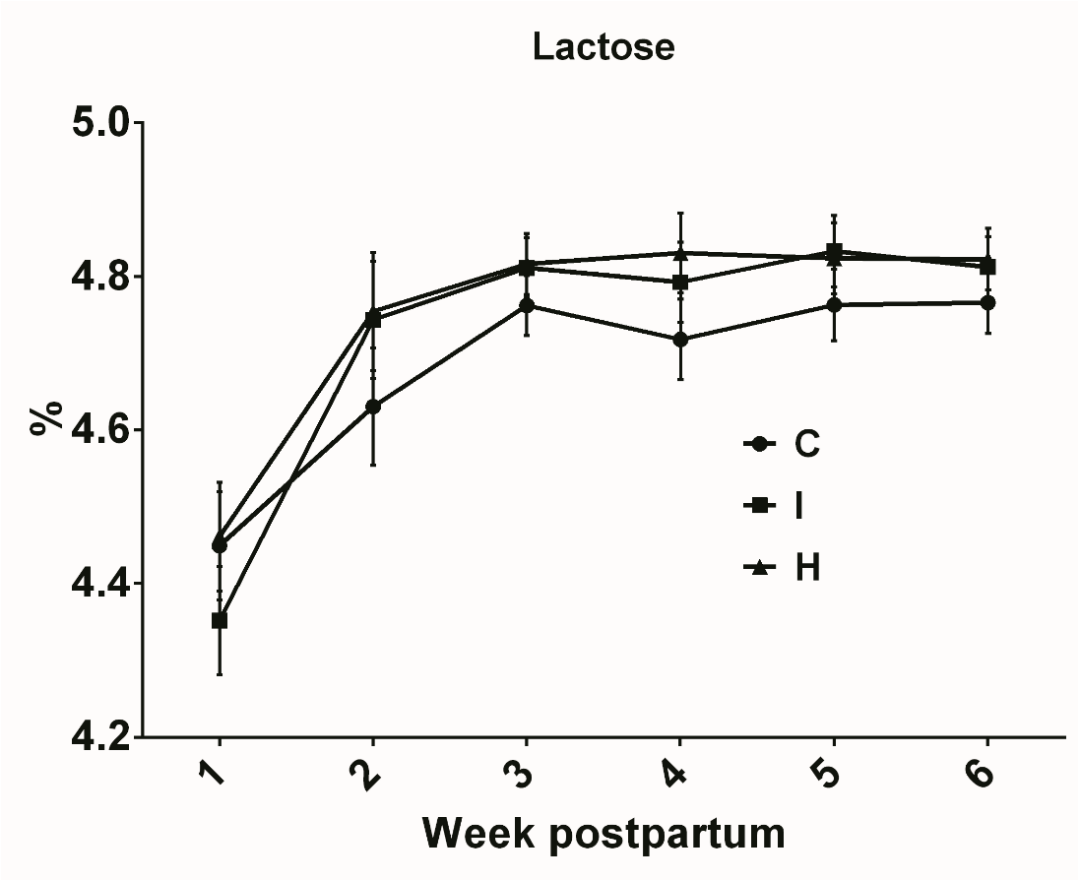


Tx*Time *P*=0.31, Tx *P*=0.98, Time P < 0.001

Tx*Time *P*=0.92, Tx *P*=0.48, Time P < 0.001

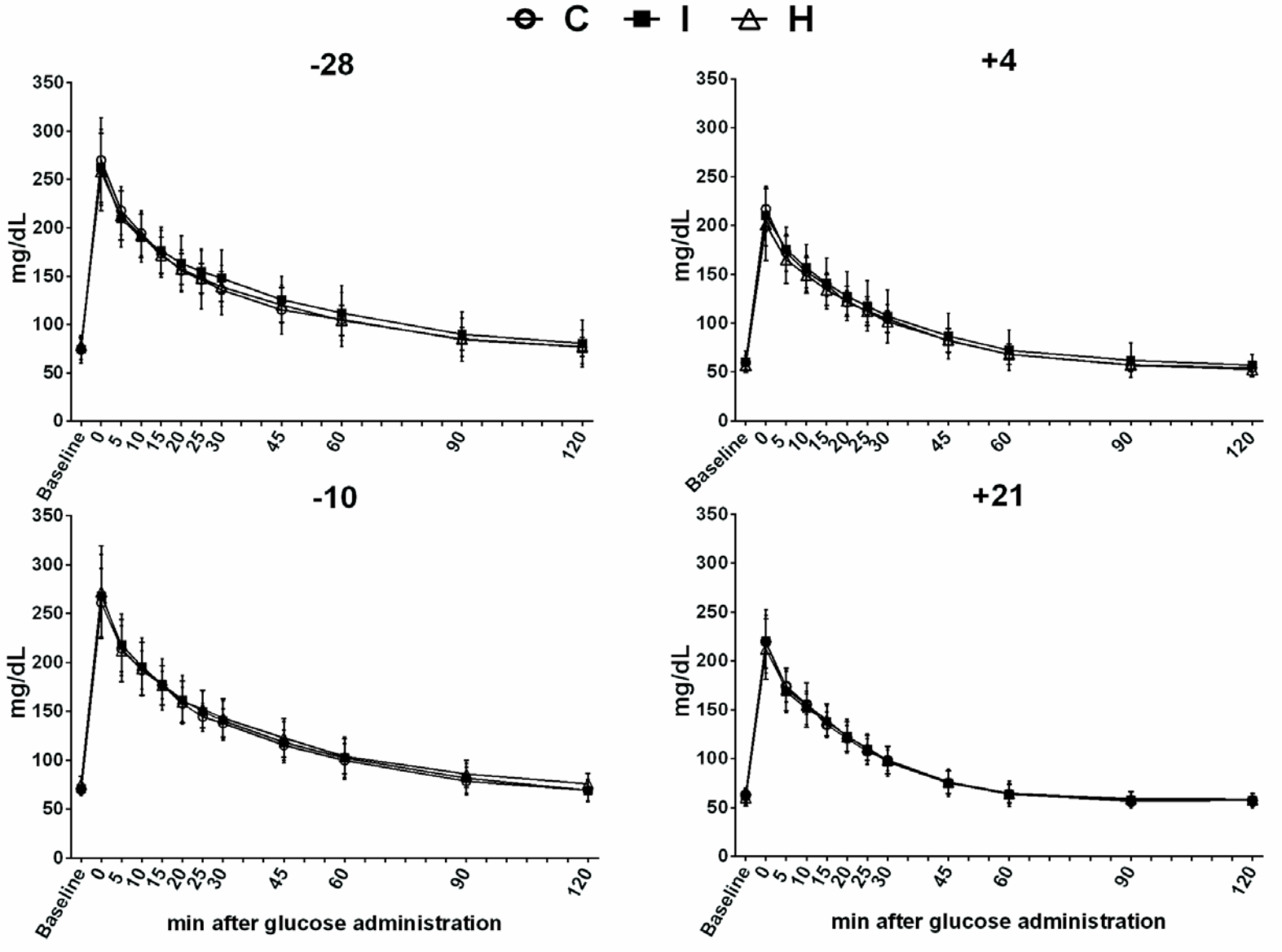
LACTOSE YIELD AND CONCENTRATION



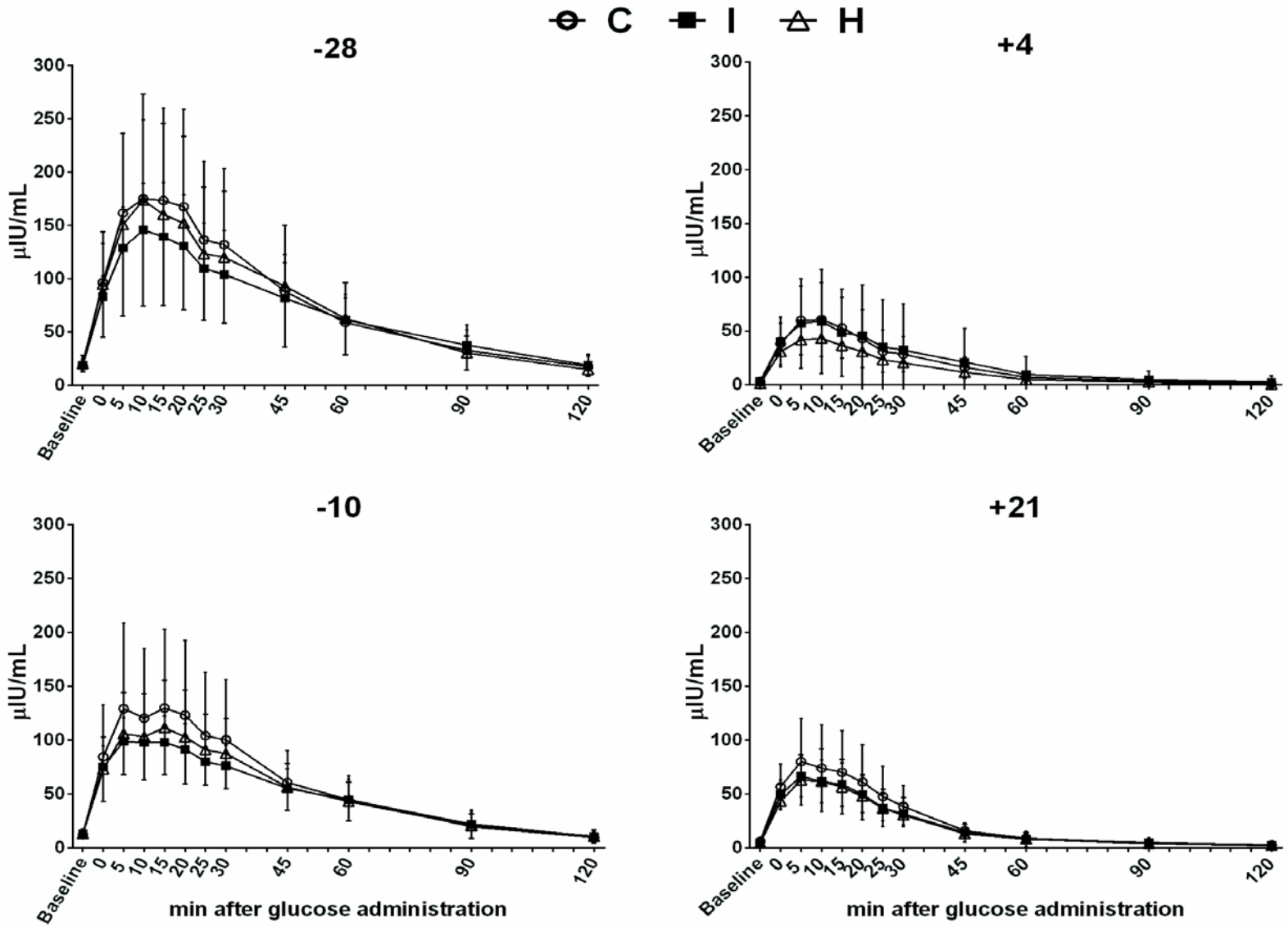


Tx*Time *P*=0.88, Tx *P*=0.53, Time P < 0.001

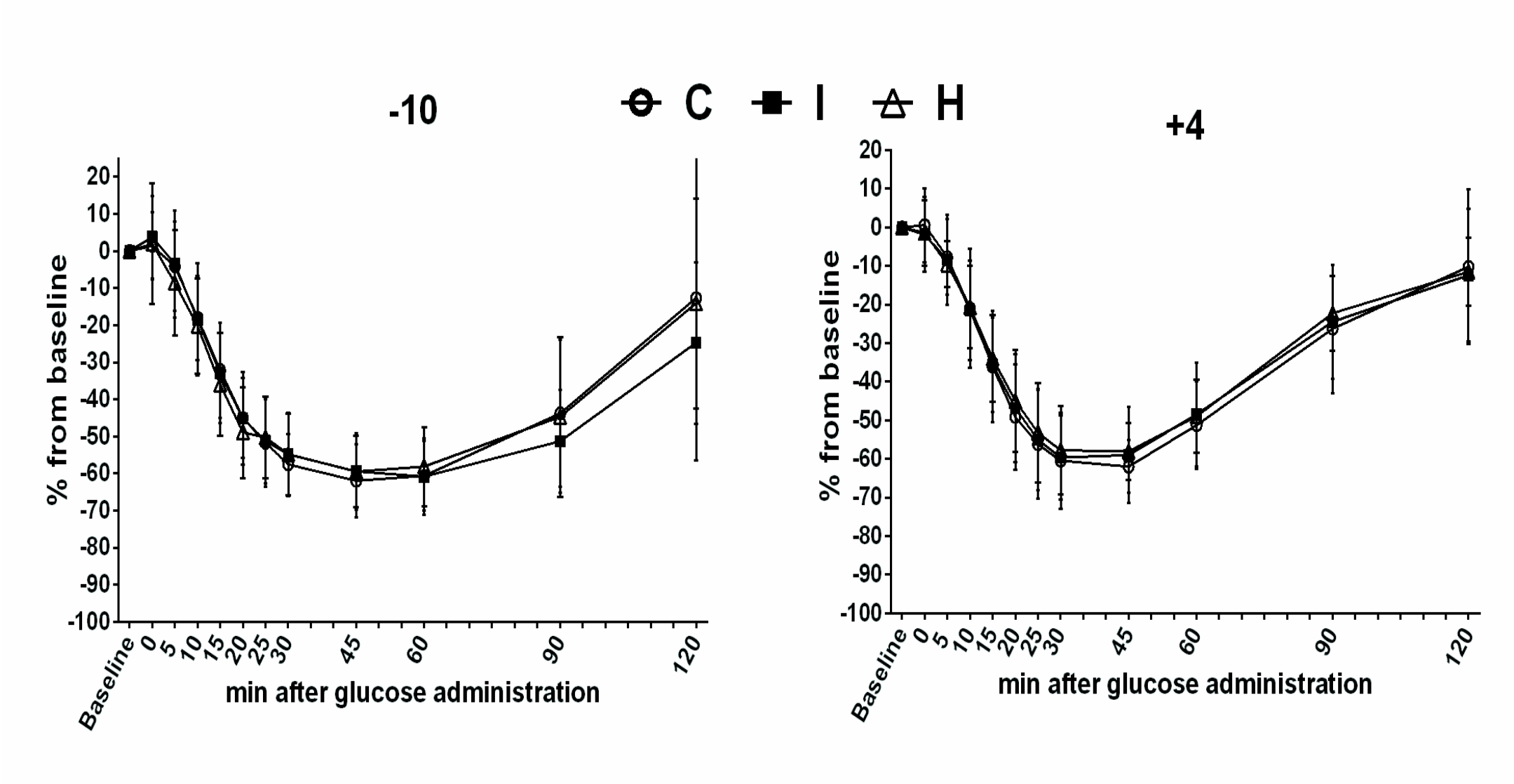
GLUCOSE CURVES IVGTT



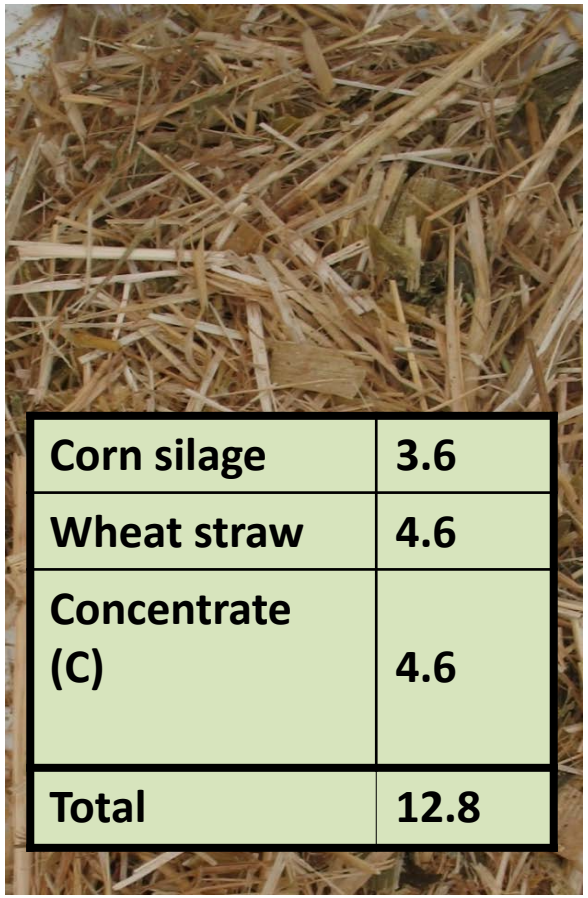
INSULIN CURVES IVGTT



NEFA REDUCTION IVGTT

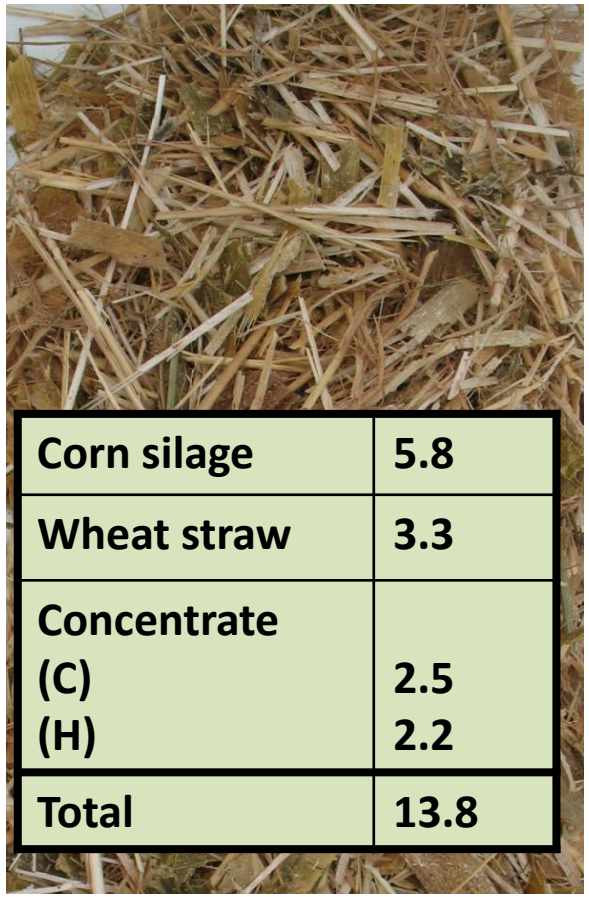


DIET COMPOSITION AND PREDICTED INTAKE (KG DM)



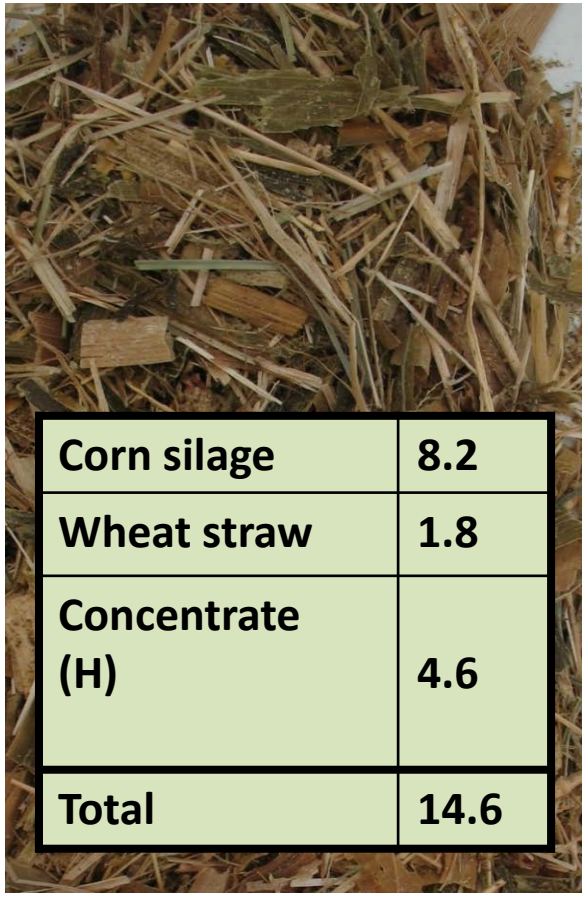
Corn silage	3.6
Wheat straw	4.6
Concentrate (C)	4.6
Total	12.8

Controlled



Corn silage	5.8
Wheat straw	3.3
Concentrate (C) (H)	2.5 2.2
Total	13.8

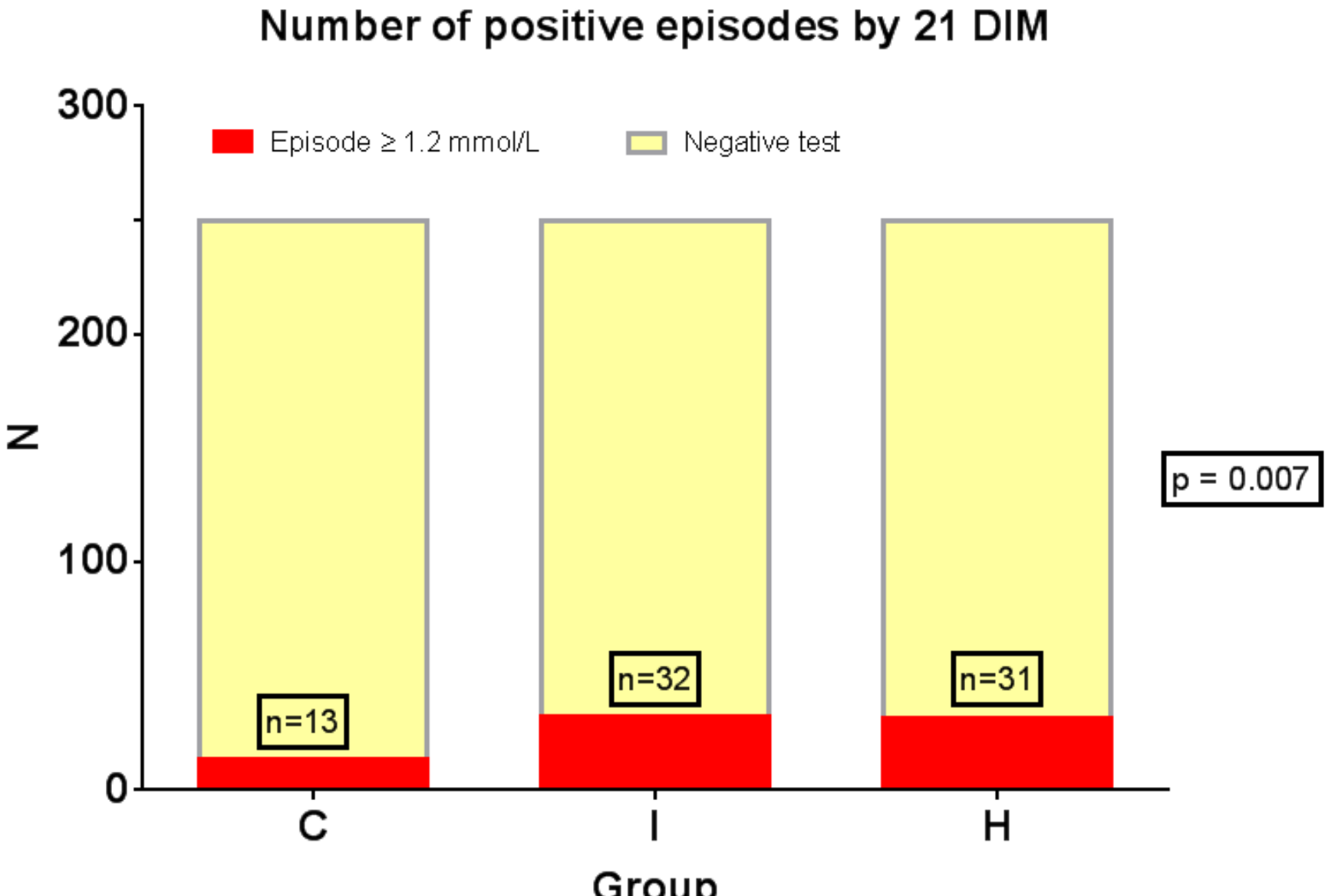
Intermediate



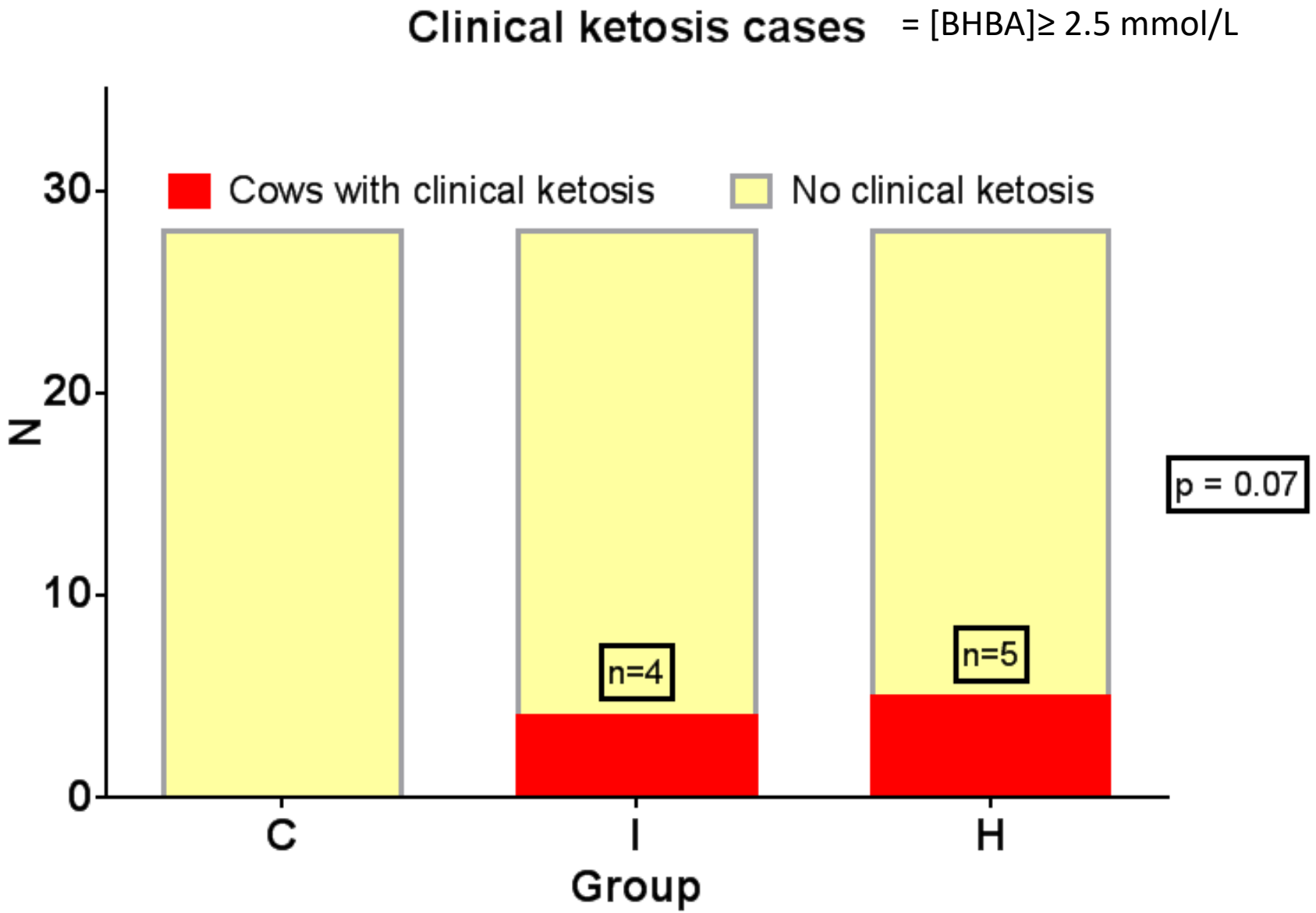
Corn silage	8.2
Wheat straw	1.8
Concentrate (H)	4.6
Total	14.6

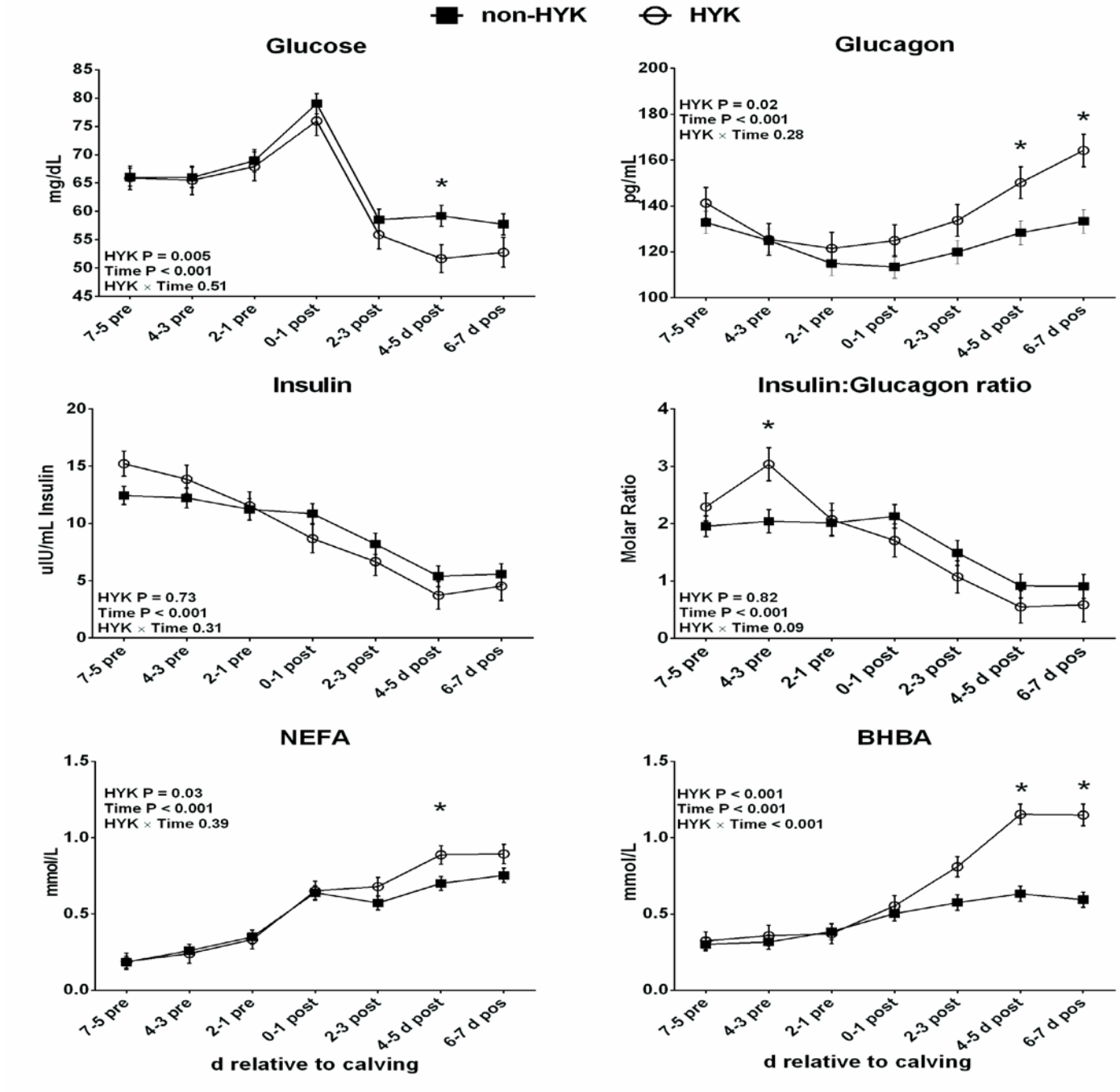
High

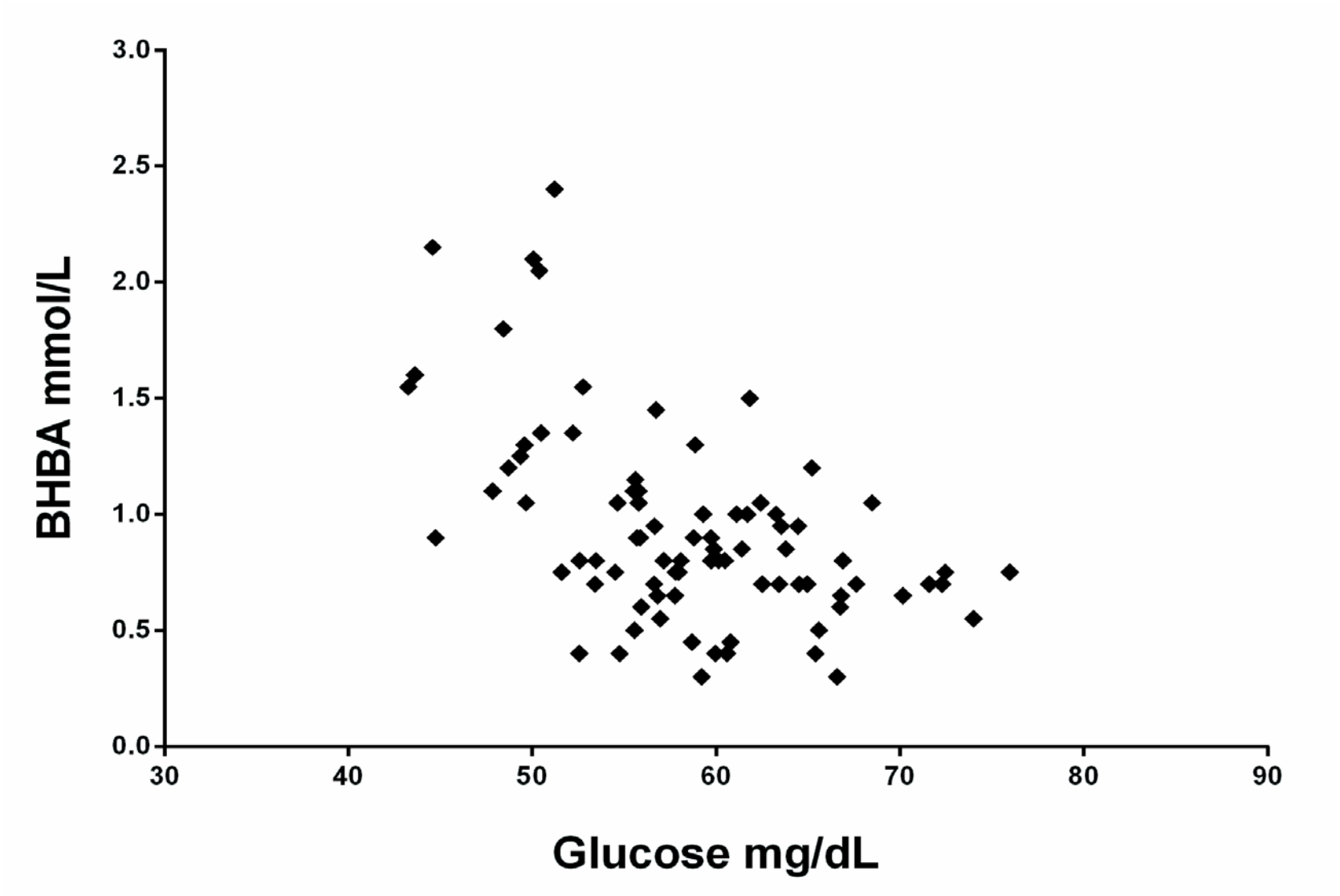
HYPERKETONEMIA



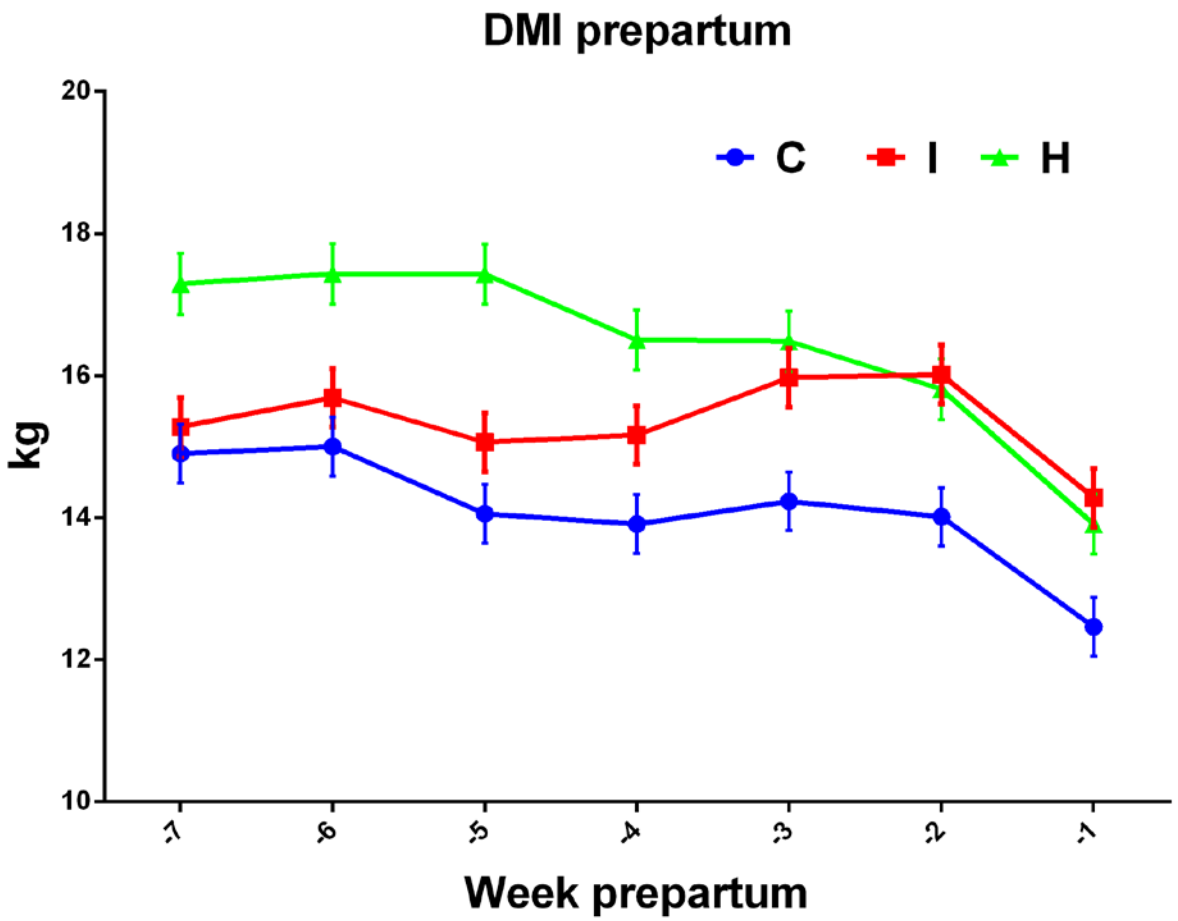
CLINICAL KETOSIS

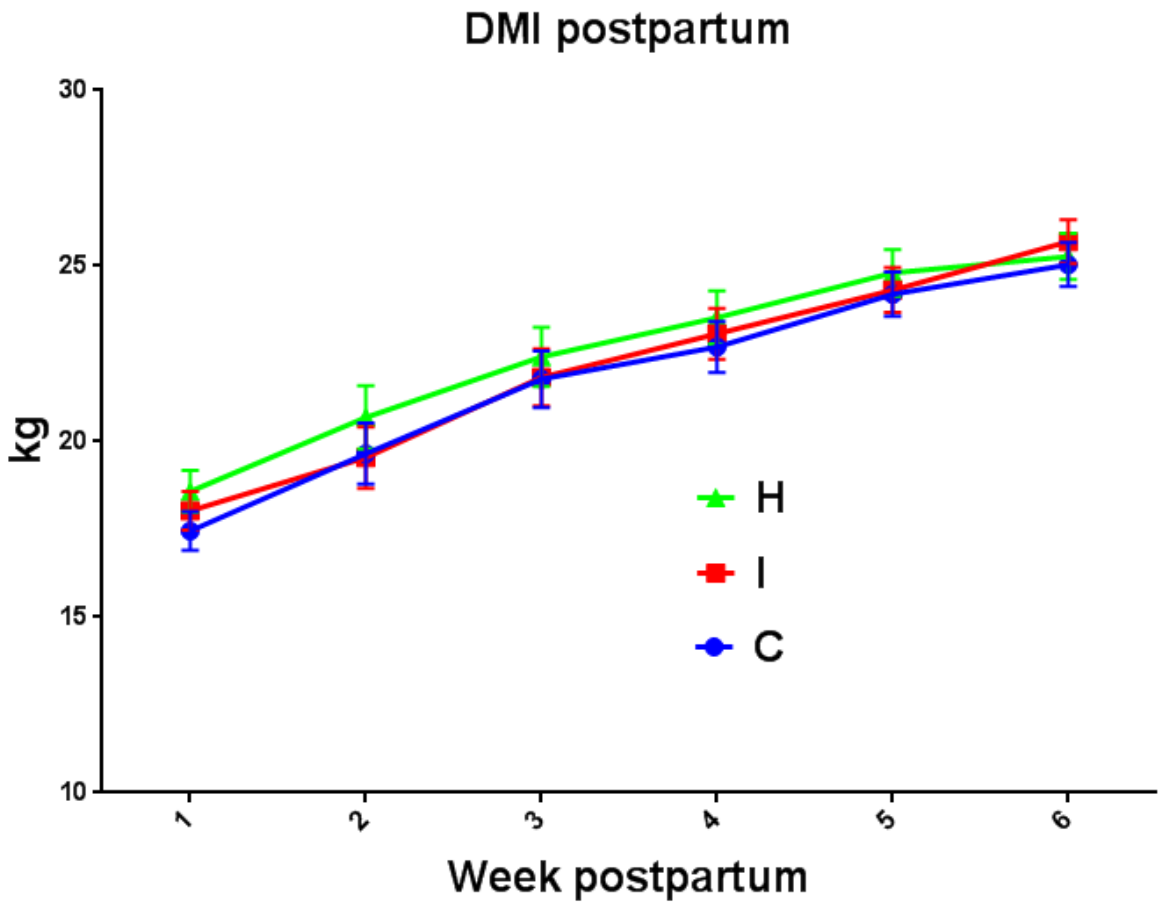



non-HYK
HYK
Glucose
mg/dL
HYK P = 0.005
Time P < 0.001
HYK × Time 0.51
Glucagon
pg/mL
HYK P = 0.02
Time P < 0.001
HYK × Time 0.28
Insulin
uIU/mL Insulin
HYK P = 0.73
Time P < 0.001
HYK × Time 0.31
Insulin:Glucagon ratio
Molar Ratio
HYK P = 0.82
Time P < 0.001
HYK × Time 0.09
NEFA
mmol/L
HYK P = 0.03
Time P < 0.001
HYK × Time 0.39
BHBA
mmol/L
HYK P < 0.001
Time P < 0.001
HYK × Time < 0.001
7-5 pre
4-3 pre
2-1 pre
0-1 post
2-3 post
4-5 d post
6-7 d pos
d relative to calving


BHBA mmol/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
30
40
50
60
70
80
90
Glucose mg/dL

DRY MATTER INTAKE





Tx*Time p=0.03, Tx p<0.0001

Tx*Time p=0.75, Tx p=0.99

MOLAR INSULIN:GLUCAGON RATIO

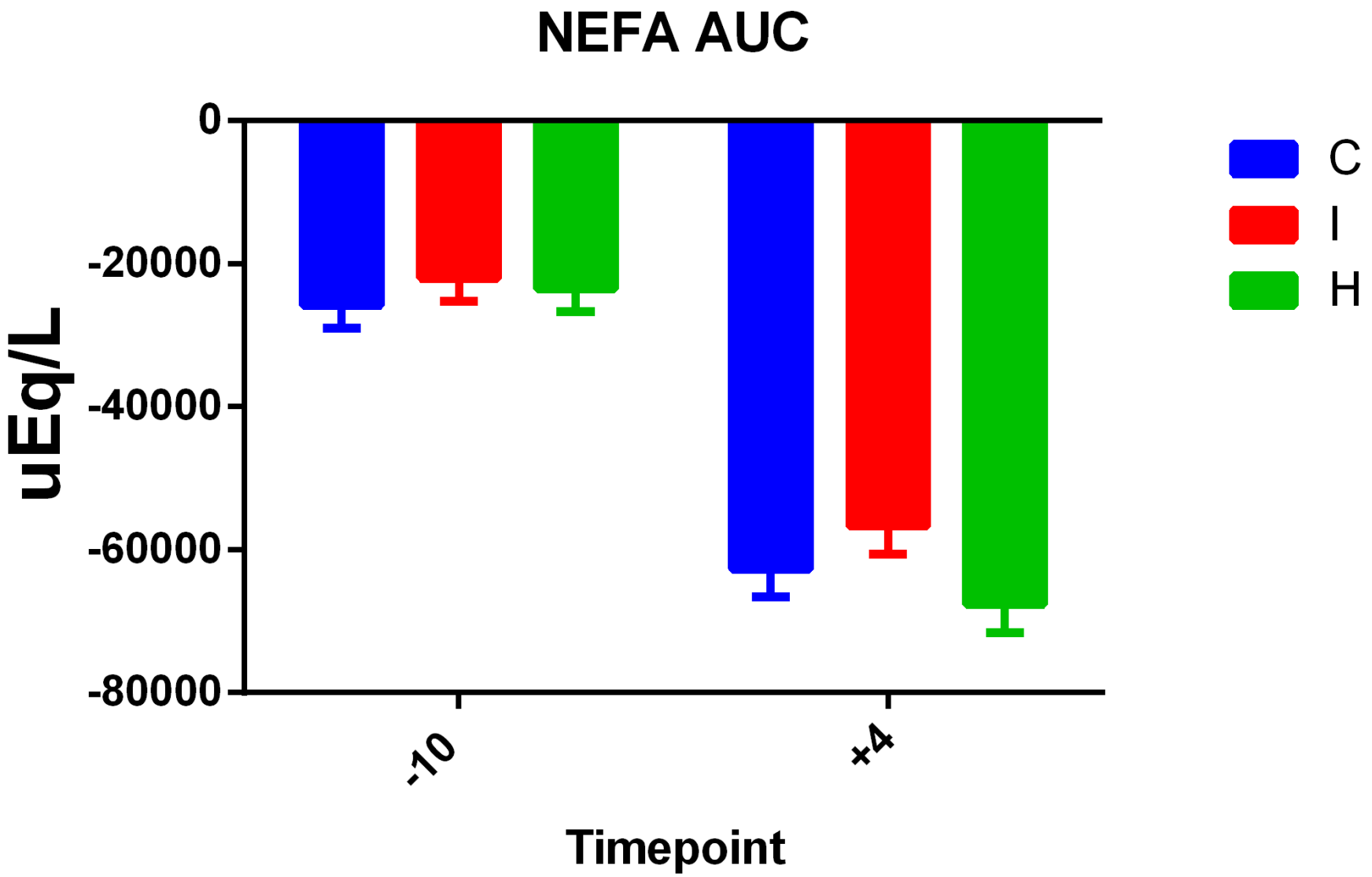
Day 4 postpartum:

	C (n=19)	I (n=19)	H (n=19)	*P*
I:G ratio (95% CI)	**0.30[a]** (0.20-0.50)	**0.40[a]** (0.20-0.70)	**0.13[b]** (0.10-0.20)	**0.02**

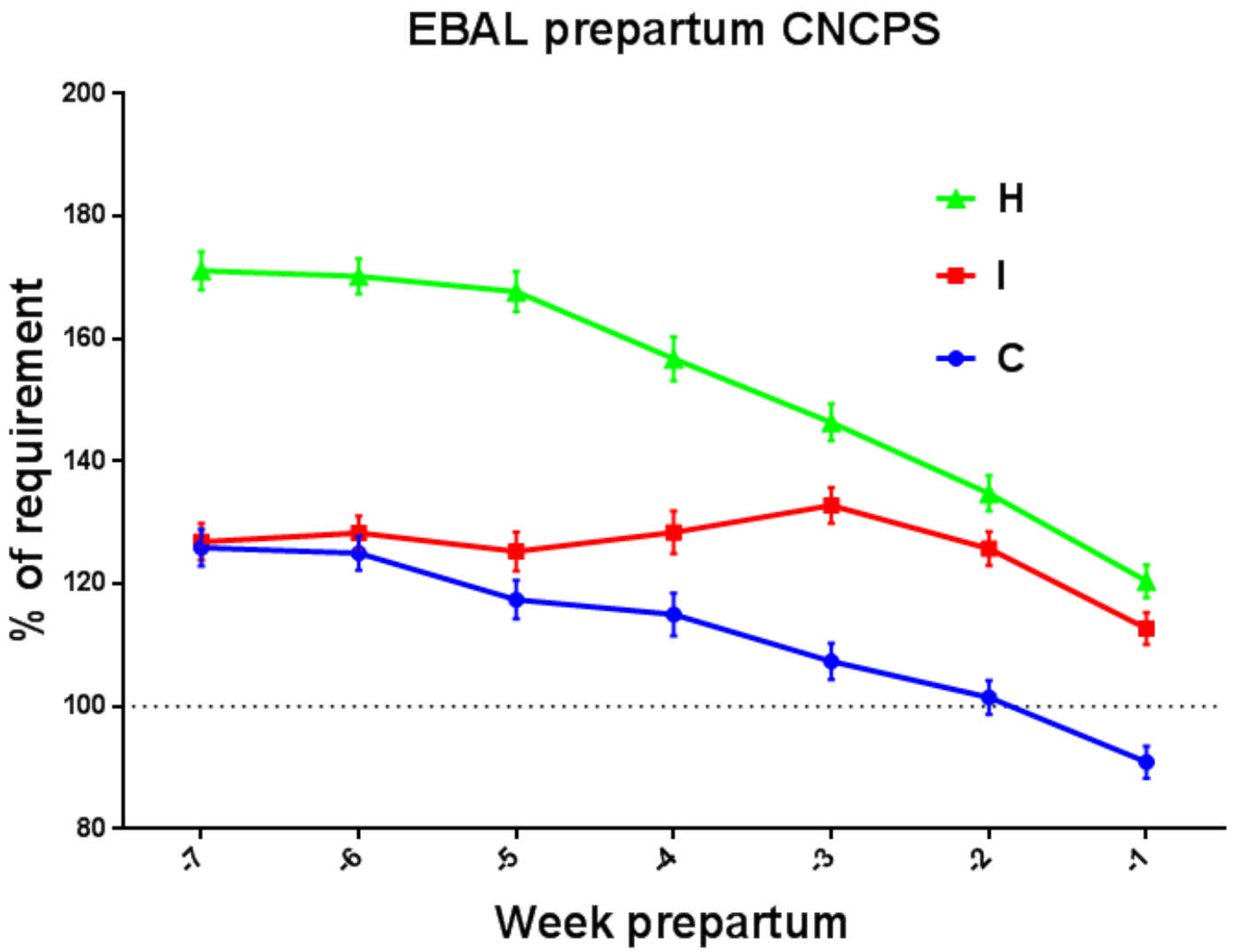
Row means with different letters showed $P<0.10$ in one-way ANOVA and post-hoc Tukey´s HSD

⇓ Insulin:Glucagon ratio = ⇑ Negative energy balance

NEFA AUC

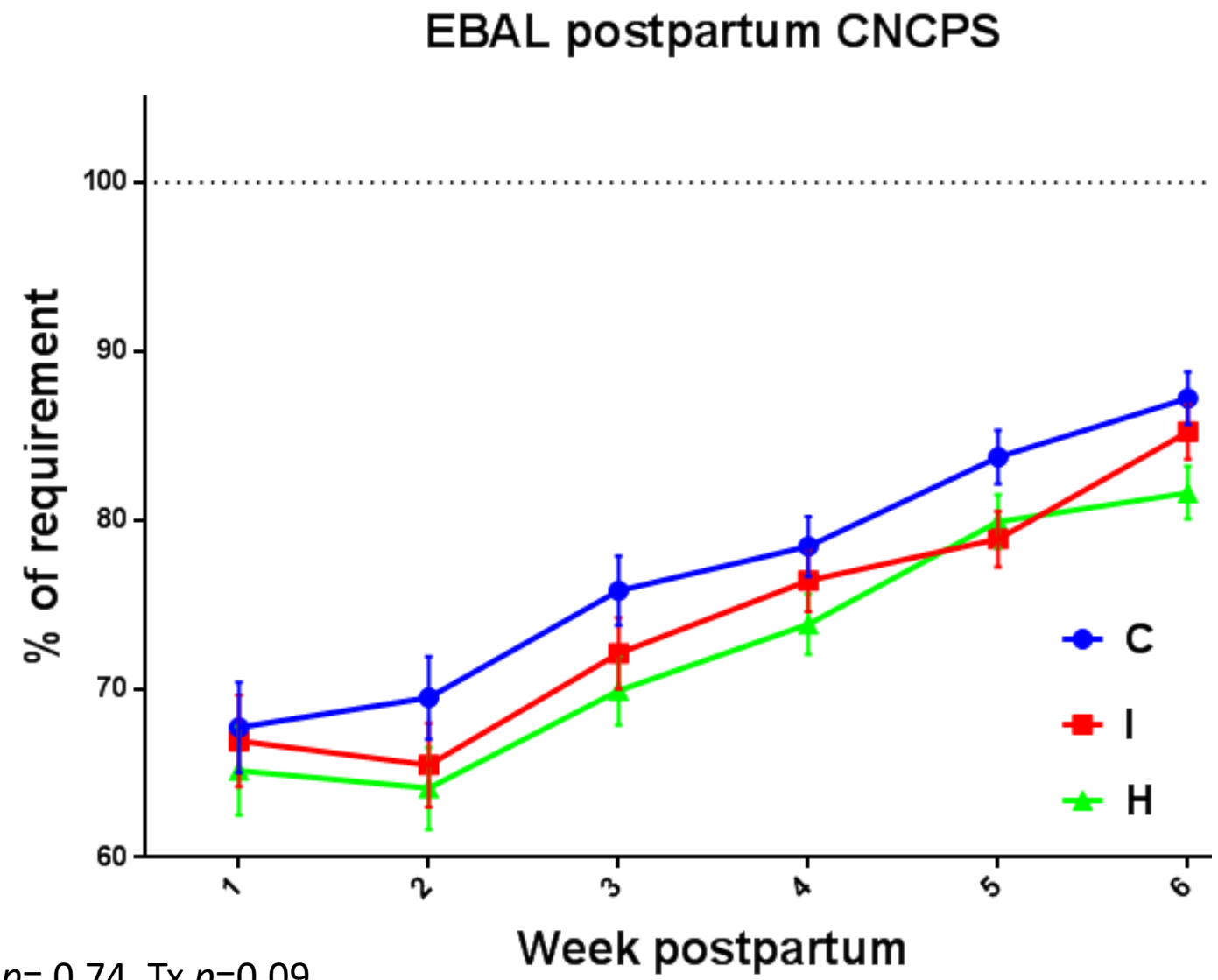


ENERGY BALANCE PREPARTUM



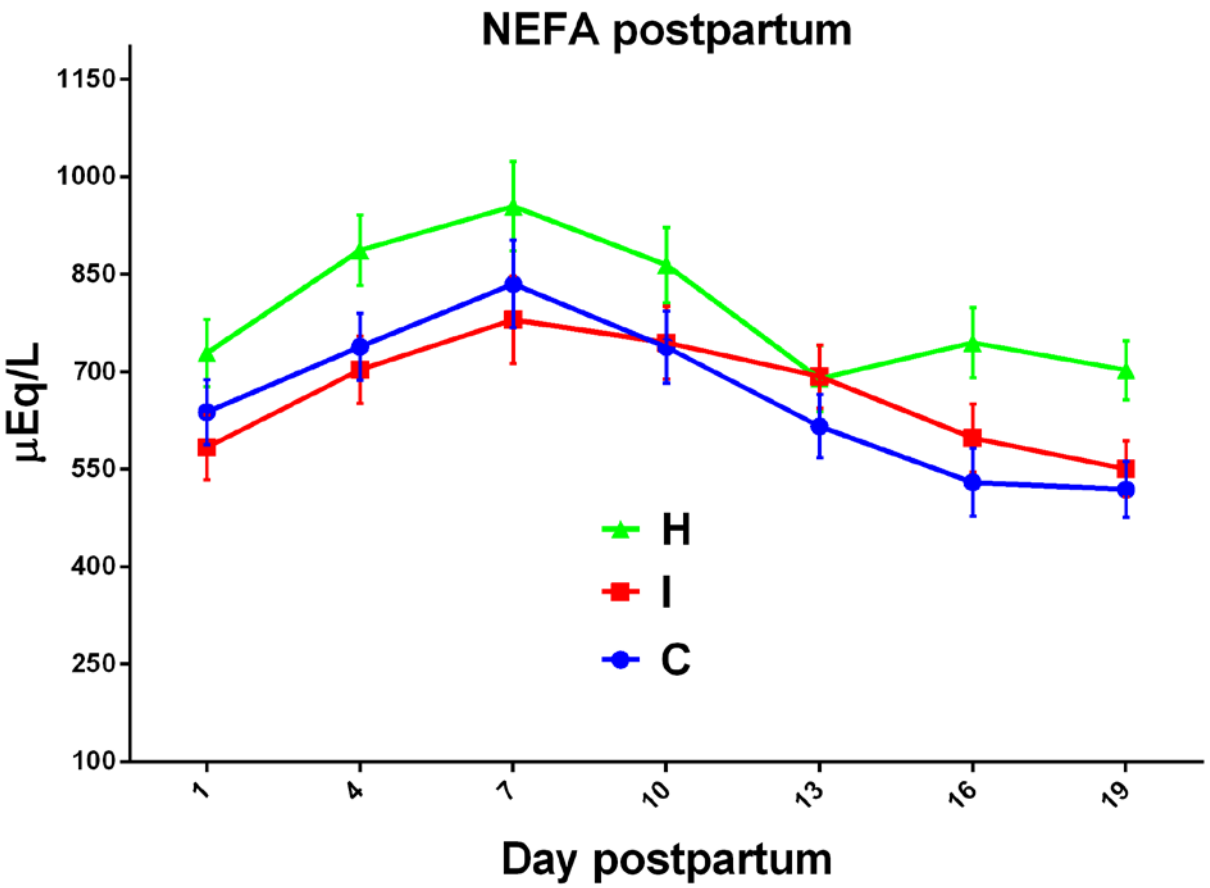
Tx*Time $p<0.0001$, Tx $p<0.0001$

ENERGY BALANCE POSTPARTUM

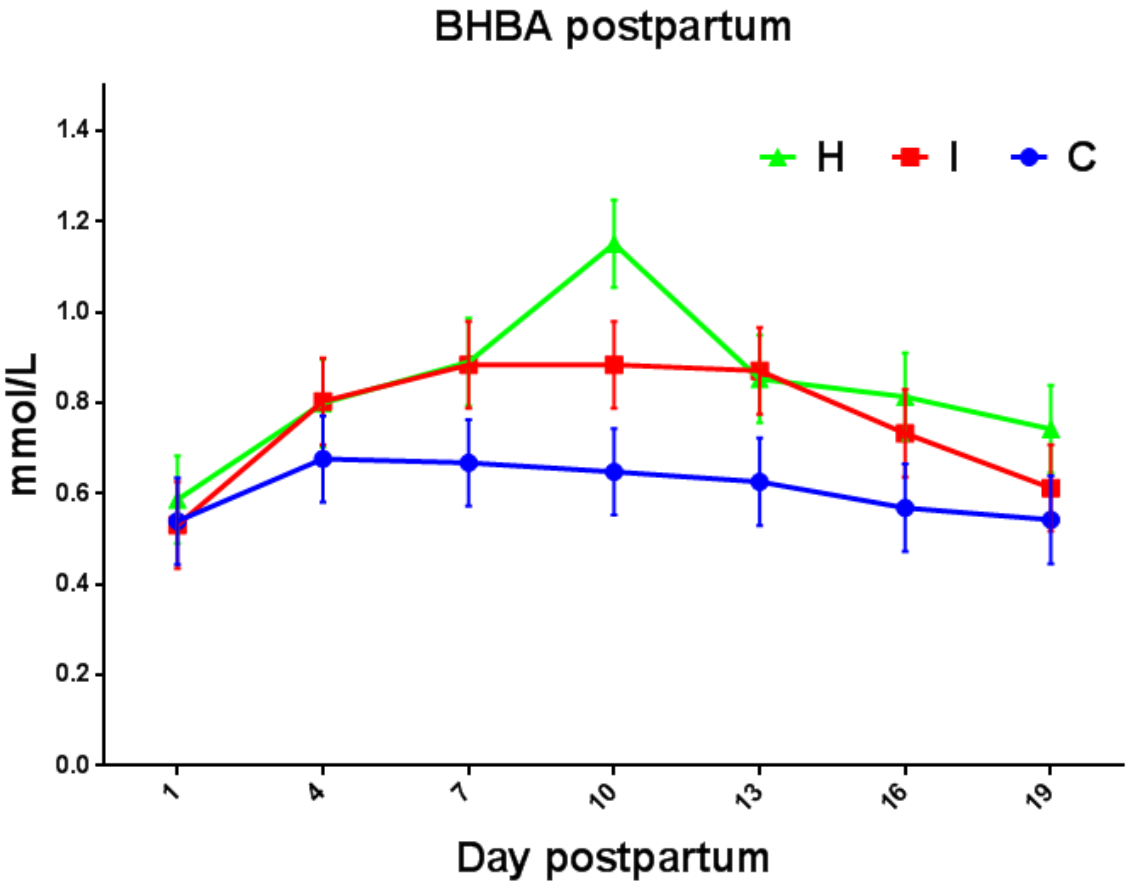


Tx*Time *p*= 0.74, Tx *p*=0.09

NEFA AND BHBA POSTPARTUM

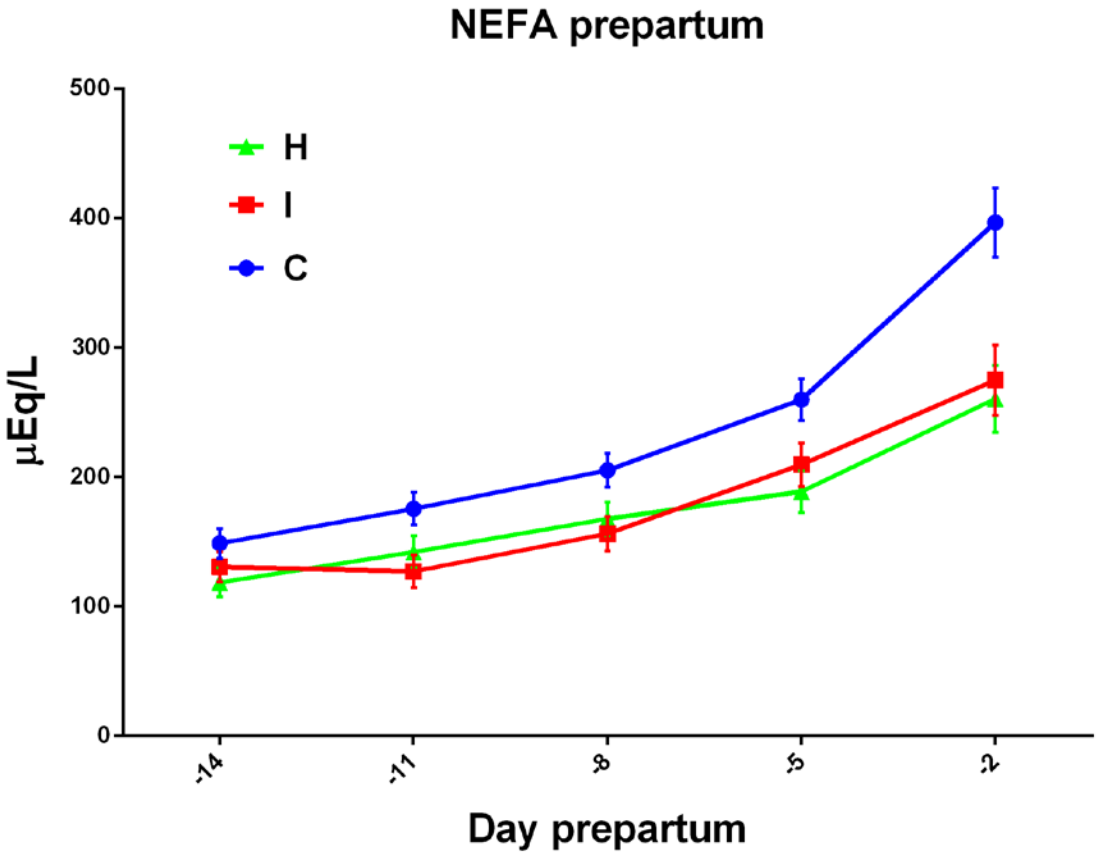


Tx*Time p=0.37, Tx p=0.02

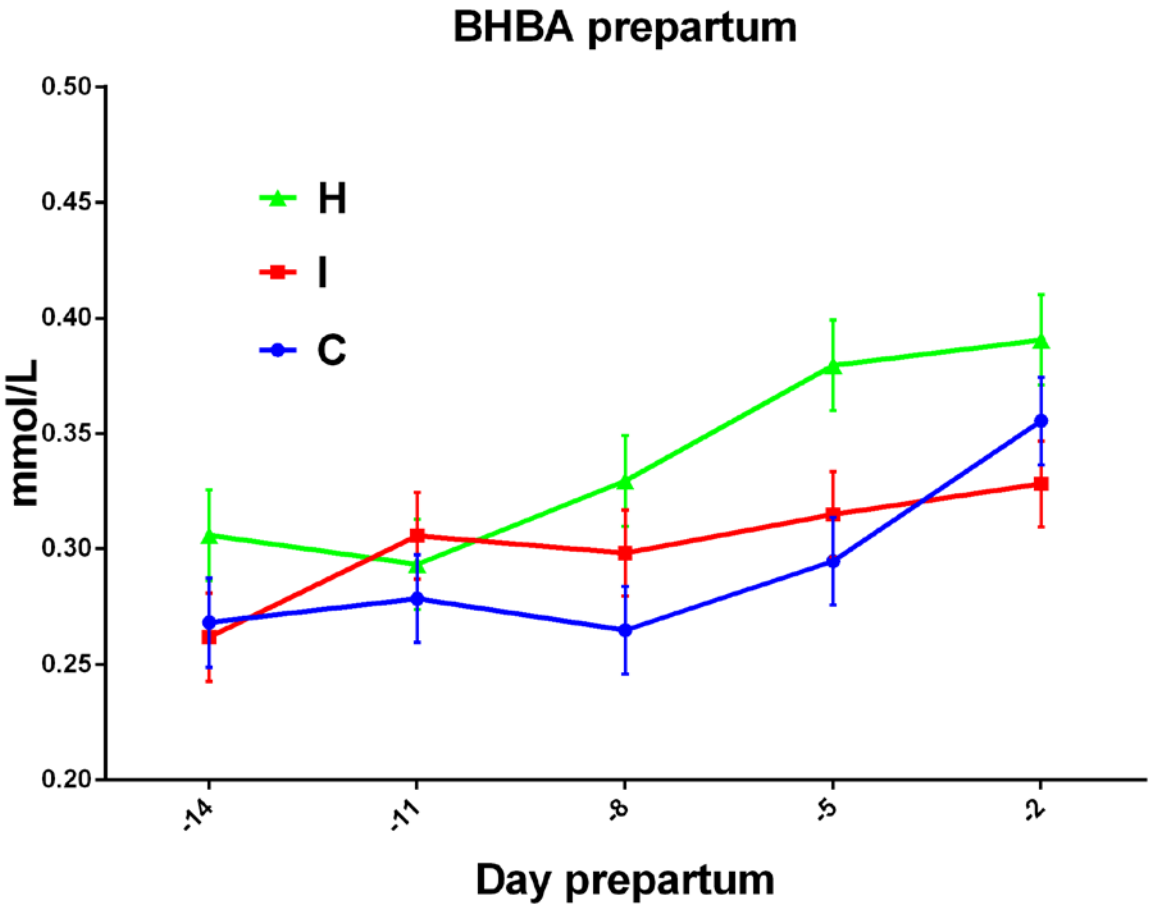


Tx*Time p=0.36, Tx p=0.04

NEFA AND BHBA PREPARTUM



Tx*Time p=0.03, Tx p=0.001



Tx*Time p=0.03, Tx p=0.04