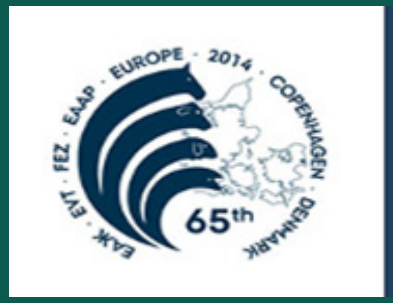

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In vitro incubation of dairy cow diets: 1. Degradability, total gas and methane yield

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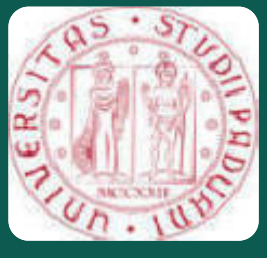


Methane emissions

- ✓ CH_4 is one of fermentation gases (CO_2, CH_4 and VFA) → loss of gross energy intake to the animal, quantified around 2-12% (Johnson and Johnson, 1995)
- ✓ CH_4 is also considered an atmospheric greenhouse gas (GHG: CO_2, CH_4, N_2O, and O_3) → greenhouse effect & climate changes
- ✓ Assessments of CH_4 emissions vary considerably depending on the references and countries.

AIM

Objectives

- ✓ To evaluate *in vitro*
  - ~ Degradability
  - ~ Total gas production
  - ~ Methane yield

of diets for dairy cows actually used in the Veneto region, in order to estimate their range of variation on methane emission

MATERIAL & METHOD

Diets

- ✓ A Reference Diet (RD) → representative of dairy cow diets commonly used in the Veneto region

- ✓ Other 7 diets were formulated changing the proportions of CP, NDF and lipids, within the limits of viable:
  - ~ Low Protein (LP)
  - ~ High Protein (HP)
  - ~ Low Fibre (LF)
  - ~ High Fibre (HF)
  - ~ Low Lipid (LL)
  - ~ High Lipid, fat supplement (HLF) (calcium soaps of palm)
  - ~ High Lipid, extruded oilseeds (HLO)

MATERIAL & METHOD

Chemical composition (g/kg DM) of 8 diets

	RD	LP	HP	LF	HF	LL	HLF	HLO
CP	152	117	187	152	152	152	152	152
NDF	370	370	370	331	448	370	370	370
ADF	186	177	200	149	255	186	189	192
ADL	28	26	33	20	43	28	28	28
Lipids	33	33	33	33	33	22	55	55
Starch	271	333	203	329	151	282	246	231
NFC	393	434	350	438	307	403	372	371
Ash	52	46	60	46	60	52	52	52
GE, MJ/Kg DM	18.6	18.5	18.7	18.7	18.7	18.4	19.1	19.1
$ME_{TDN,}$ MJ/kg DM	12.1	12.2	11.8	12.7	11.1	11.8	12.7	12.7

- ✓ Low Protein (LP) and High Protein (HP)
- ✓ Low Fibre (LF) and High Fibre (HF)
- ✓ Low Lipid (LL) and High Lipid: fat supplement: calcium soaps of palm (HLF) and High Lipid: extruded oilseeds (HLO)

MATERIAL & METHOD

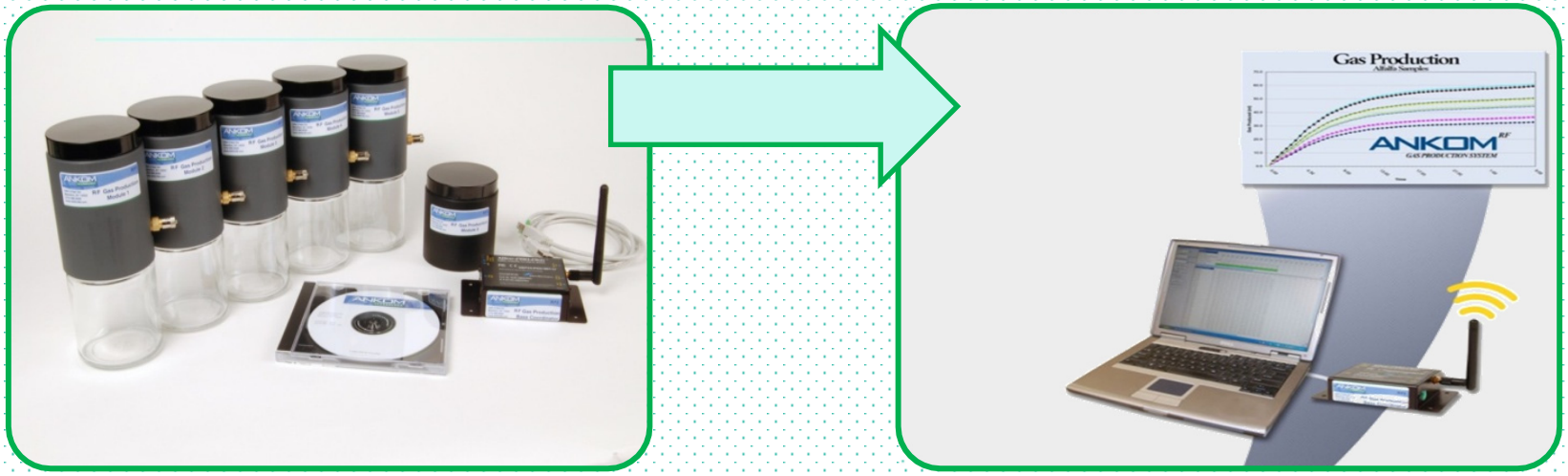
Experimental design

Diets	8
Incubation times	2
Runs for each incubation time	2
Replications of diets for run	5
Total bottles	160
Blanks	20
Temperature, °C	39.0
Feed sample, g	1.0 ± 0.010
Buffer, mL	100
Rumen fluid, mL	50

MATERIAL & METHOD

Automated GP system: Ankom® RF

- ✓ Kit of 50 bottles (317 ml), with spout and screw cap with septum puncture-proof, equipped with:
  - ~ a pressure detector
  - ~ an open-closed valve for gas venting at 6.8 KPa
- ✓ All bottles are wireless connected to a PC
- ✓ Pressure values inside the bottles are recorded by PC every minute



MATERIAL & METHOD

Gas samples collection

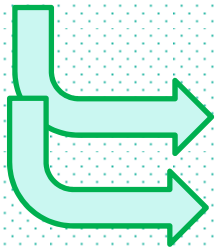
- ✓ 9 mL of fermentation gas were collected with a gas-tight syringe and injected into a Vacuette®
- ✓ An aliquot of 10 µL was analyzed for CH_4 by GC

MATERIAL & METHOD

Computations

- ✓ NDF (NDFd, %) and true dry matter (TDMd, %) degradability (Goering and Van Soest, 1970)
- ✓ Gas production (GP, mL/g DM) was calculated by a conversion of psi into mL (Lopez *et al.*, 2007)
- ✓ Total CH_4 production = CH_4 measured in bottle headspace × [(bottle headspace (257 mL) + GP mL)]

  CH_4 loss was calculated according to Ramin and Huhtanen (2012)



mL/g DM incubated

mL/g TDM degraded

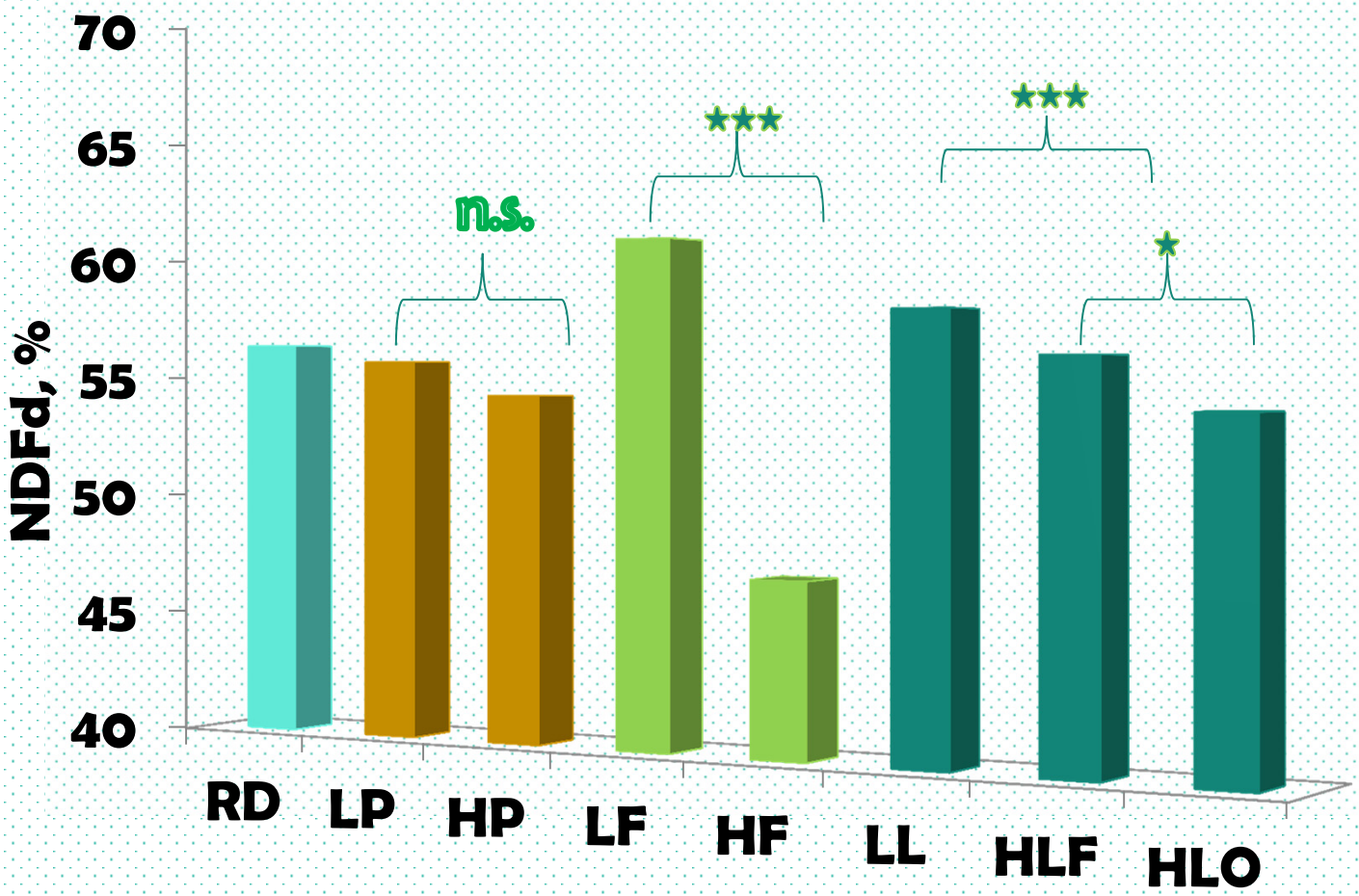
Statistical analysis

- ✓ ANOVA (PROC GLM, SAS):
  - ~ Diet (1-8)
  - ~ Incubation time (24 and 48 h)
  - ~ Run within incubation time (1-2)

- ✓ Contrasts:
  - ~ LP *vs* HP diet → effect of CP level
  - ~ LF *vs* HF diet → effect of NDF level
  - ~ LL *vs* (HFL + HOL)/2 → effect of lipid level
  - ~ HLF *vs* HLO → effect of lipid source

Effect of diet on NDFd (% NDF)

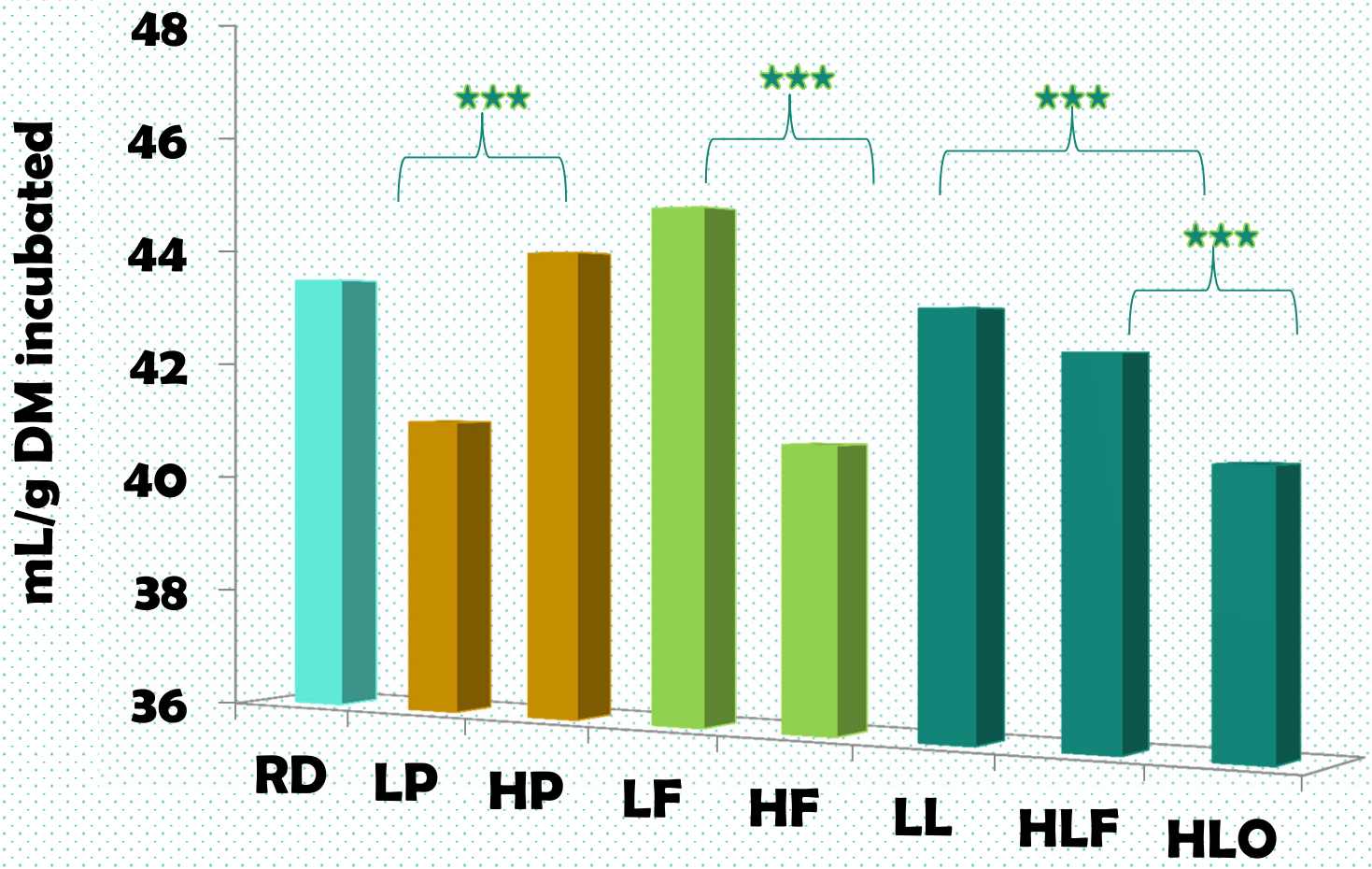
***P<0.001
* P<0.05



RESULTS & DISCUSSION

Effect of diet on CH_4 (mL/g DM incubated)

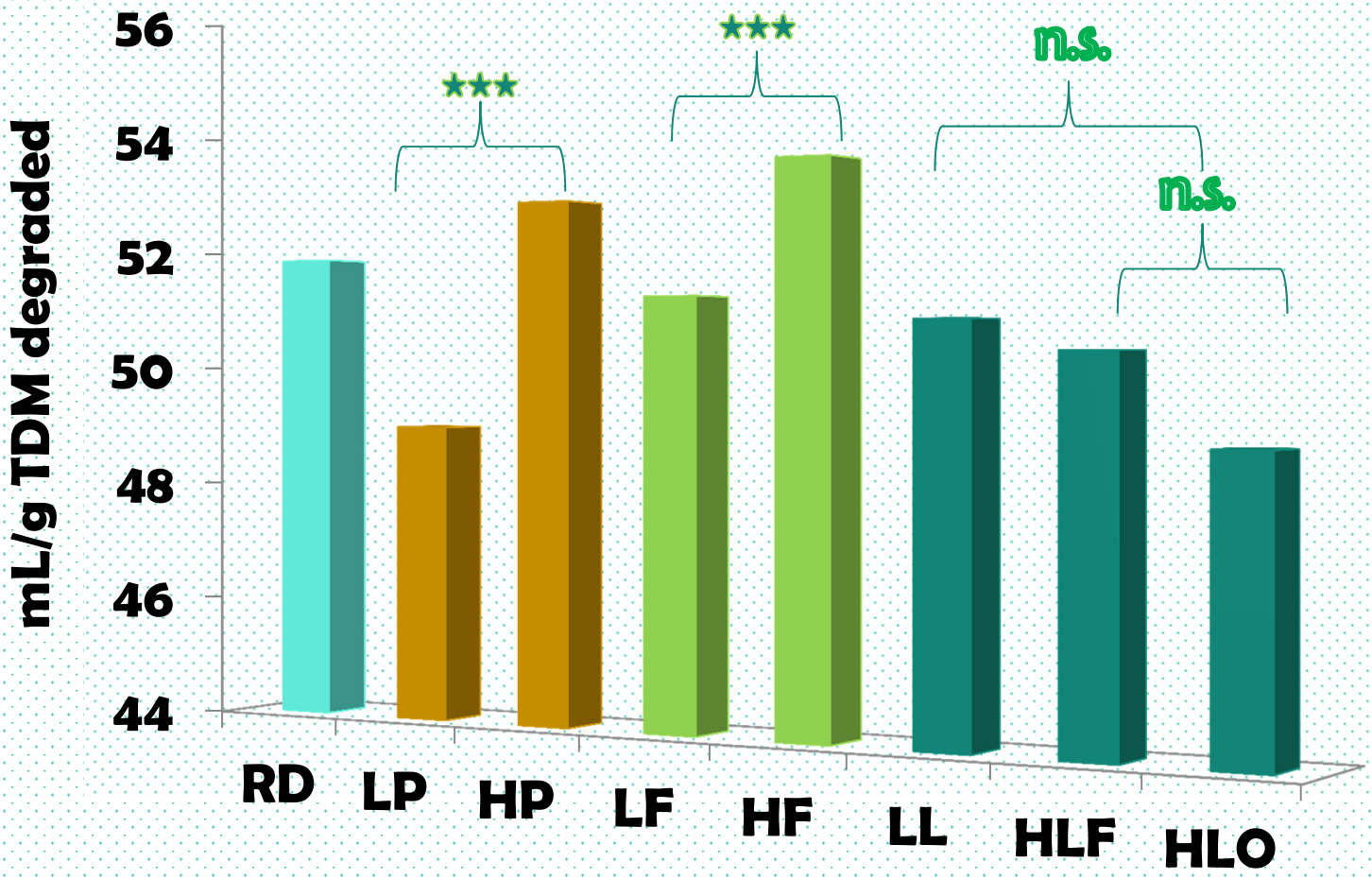
***P<0.001



RESULTS & DISCUSSION

Effect of diet on CH_4 (mL/g TDM degraded)

***P<0.001



RESULTS & DISCUSSION

CONCLUSIONS

Take home messages

- ✓ The amount of *in vitro* CH_4 produced was comparable to that reported by the literature
- ✓ The effects due to the CP, NDF and lipids were significant and comparable to other studies
- ✓ The magnitude of these effects is small in actual diets for lactating dairy cows
- ✓ In addition to N excretion, low-protein diets should also reduce CH_4 emission without negative effects on degradability of diet
  This effect should be more carefully considered *in vivo*

Acknowledgements

- ✓ The present study was financed by "ARCHAEA" Project: "Feeding strategies to reduce methane emissions from dairy cows", Veneto Region Rural Development Programme (RDP) 2007-2013

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REGIONE DEL VENETO

THANKS FOR YOUR ATTENTION

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65th annual meeting of European Federation of Animal Science

Ingredients (g/kg DM) of 8 diets

	RF	LP	HP	LF	HF	LL	HLF	HLO
Corn silage	351	375	281	430	-	351	351	351
Alfalfa hay	89	66	156	23	134	89	89	89
Ryegrass hay	47	43	52	-	231	47	52	56
Meadow hay	47	47	52	-	227	47	52	60
Corn meal	205	258	147	228	152	218	182	160
Barley meal	119	160	90	171	92	122	100	100
Soybean meal	113	27	188	119	126	126	121	18
Whole soybean	-	-	-	-	-	-	-	68
Extruded soybean	-	-	-	-	-	-	-	68
Extruded flaxseed	29	24	34	29	38	-	29	29
Fat supplement	-	-	-	-	-	-	24	-

MATERIAL & METHOD

Incubation procedures

- ✓ Rumen fluid was collected by an esophageal probe
- ✓ Buffer solution was prepared according to Menke and Steingass (1988)

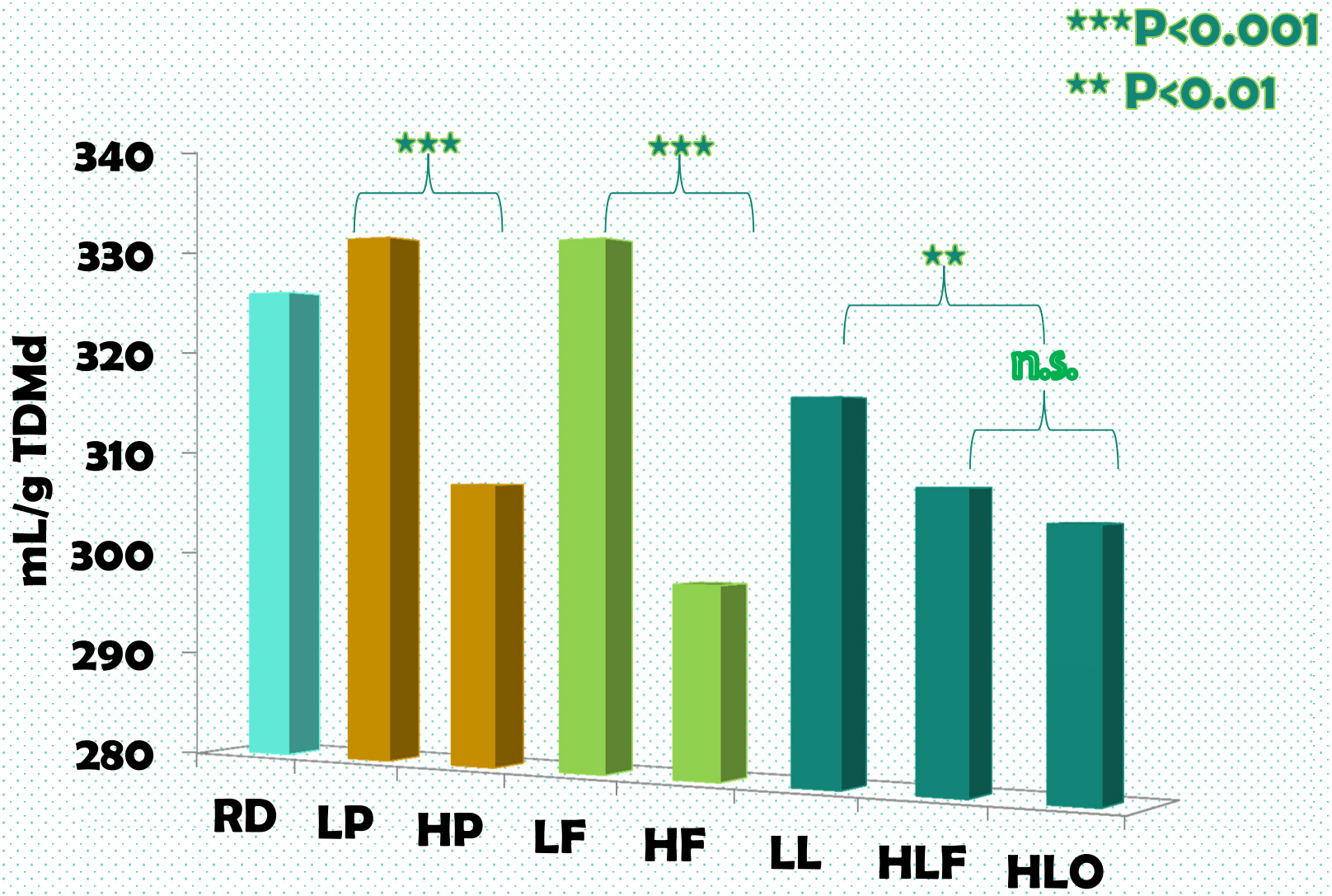
MATERIAL & METHOD

Gas chromatograph

- ✓ Model 7820A GC system, Agilent Technologies
- ✓ Flame ionization detector
- ✓ 30 m stainless steel column, GS-CarbonPLOT, Agilent Technologies
- ✓ Gas carrier: Hydrogen, flow rate: 1.6 ml/min
- ✓ Isothermal oven temperature: 40°C

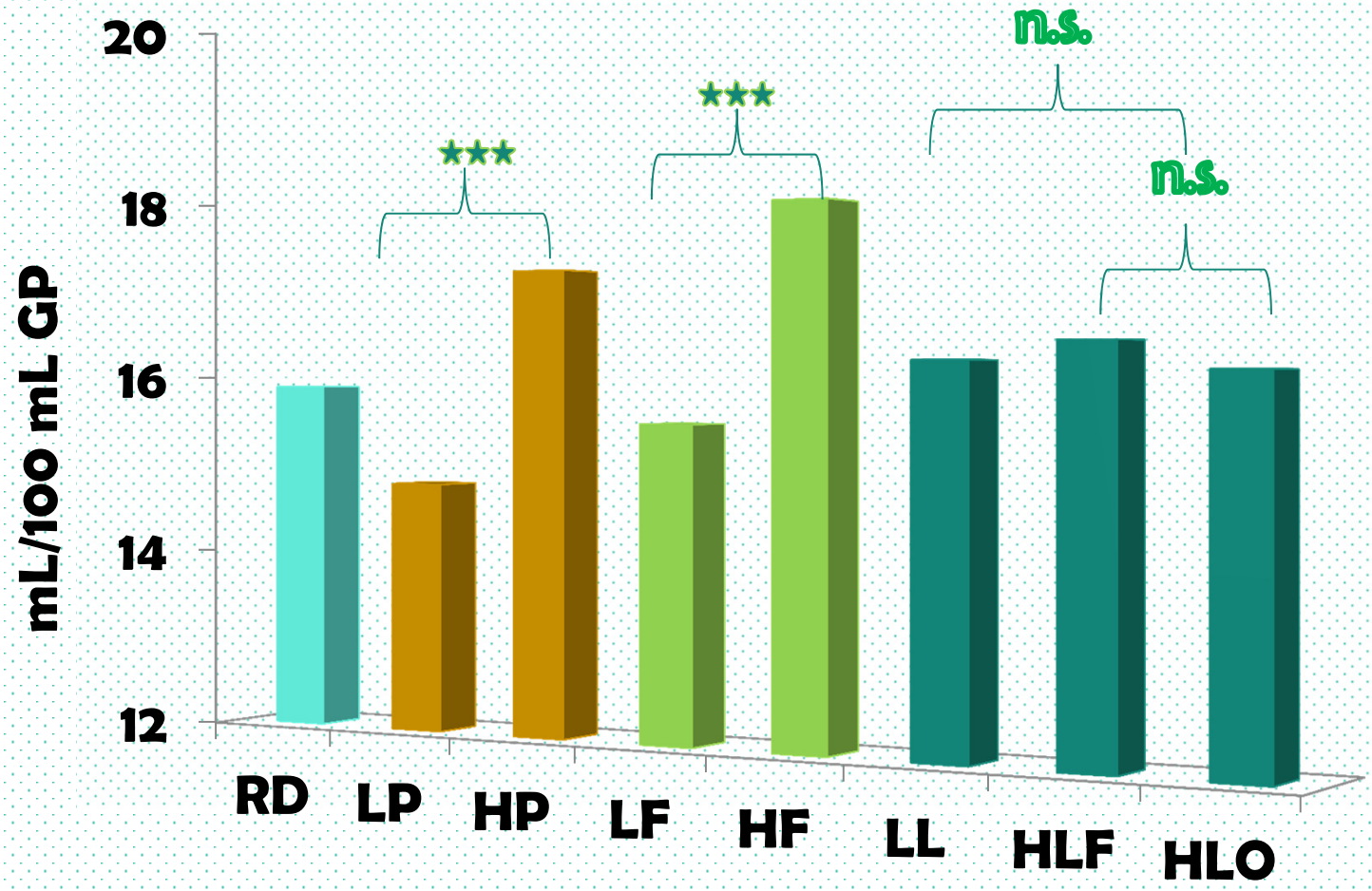
RESULTS & DISCUSSION

Effect of diet on GP (mL/g TDMd)



Effect of diet on CH_4 (mL/100 mL GP)

***P<0.001



RESULTS & DISCUSSION

RESULTS & DISCUSSION

Effect of variation in CP, NDF and lipid content on CH_4 reduction

✓ A decrease of 1% of chemical compound in the diet:

	mL CH_4 / g TDMd	mL CH_4 / g DM	*KJ CH_4 / MJ GE*	Ramin and Huhtanen (2013) In vivo KJ CH_4 / MJ GE
CP	-0.55	-0.41	-0.79	n.s.
NDF	-0.21	+0.33	+0.63	-0.46
Lipid	+0.55	+0.45	+0.86	+1.30