Supplementary crude protein and phosphorus levels: effect on spring milk production in dairy cows

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Introduction

- Irish dairy industry is grass-based system
- Effectively grazed grass is cheapest feed available for Irish farms (Dillon *et al*., 1995)
- Maximum profitability for dairy farms achieved through optimum utilisation of grass (O'Donovan *et al*., 2007)
- Dietary crude protein can affect milk composition (Broderick 2003)
  - Protein composition of milk is central to milk processability (O'Brien *et al*., 1996)

Introduction

- Phosphorus has more known functions in animal body than other minerals
  - Vital for energy metabolism in the formation of phosphates and ATP/ADP (McDonald *et al*., 2001)
- Reduced dietary phosphorus can have negative impact on milk protein (Wu and Satter, 2000)
  - Anecdotal evidence of cows exhibiting signs of phosphorus deficiency (e.g. eating stones)

Background

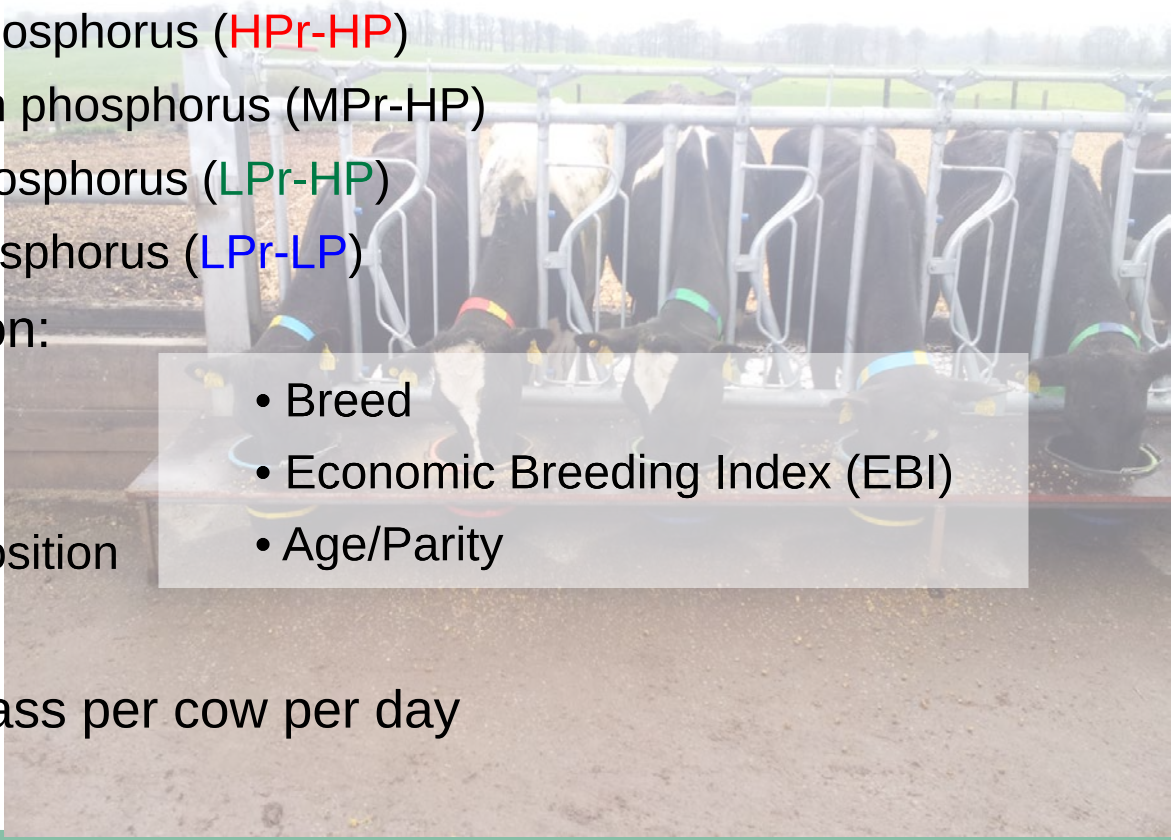
- In 2012, 58% whole milk was processed as butter and 31% as cheese (IDB, 2012)
  - Necessary to include measurements related to milk processability in experimental studies
- Milk urea nitrogen (MUN) is an indicator of non-protein nitrogen (NPN) in milk. The concentration of NPN is an important factor in terms of milk processability
  - high NPN → poor processability
- ~ half of phosphorus in milk protein is complexed with casein
  - → a reduction in dietary phosphorus may have negative implications for casein concentration
  - → and processability (Satter 2003)

Objectives

- Assess effects of differing dietary nitrogen and phosphorus concentrations on:
  - » Milk yield
  - » Milk composition
  - » Dry matter intake
  - » Body weight (BW) and body condition score (BCS)
  - » Animal N and P status
    - Faecal and urine N and P concentration
    - Blood N and P concentration
- Duration: 8 weeks (March – May 2012)

Materials and Methods (1)

- 48 spring-calving dairy cows
- In early lactation (Mar – May)
- Randomly allocated to one of four supplementary concentrate treatments (4 kg DM per cow per day) (randomised complete block design)
  - High protein, high phosphorus (HPr-HP)
  - Medium protein, high phosphorus (MPr-HP)
  - Low protein, high phosphorus (LPr-HP)
  - Low protein, low phosphorus (LPr-LP)
- Randomised based on:
  - Calving date
  - BW and BCS
  - Milk yield and composition
  - Breed
  - Economic Breeding Index (EBI)
  - Age/Parity
- Offered 13 kg DM grass per cow per day



Materials and Methods (2)

- Diet summary

	Crude Protein (g/kg DM)	Phosphorus (g/kg DM)
HPr-HP	266	3.5
MPr-HP	239	3.0
LPr-HP	224	3.1
LPr-LP	224	2.2

- Mean grass CP: 268 ± 30.8 g/kg DM (higher than expected)
- Mean grass P: 2.7 ± 0.31 g/kg DM (lower than expected)

Materials and Methods (3)

- Milk yield
  - » Monitored and recorded daily
- Milk composition:
  - » Assessed using four concurrent milkings per week (by cow)
  - » Analysed by mid infra-red spectroscopy (MIR)
- Milk nitrogen fractions
  - » Assessed on three occasions with bulked treatment samples
  - » Analysed using the Kjeldahl method
- Grass dry matter intake (DMI):
  - » Assessed on one occasion using the n-alkane technique (Dillon and Stakelum, 1989)
- BW and BCS:
  - » Assessed and recorded weekly

Materials and Methods (4)

- Animal N and P status
  - » Faecal and urine N and P concentration assessed on one occasion
  - » Blood N and P concentration:
    - Three occasions – Pre experiment, mid-experiment and post-experiment

Statistical Analysis

- Data analysed using PROC MIXED (SAS, 2001)
  - Terms for treatment, week and treatment x week interaction included in model
  - Cow included as random effect
  - Appropriate covariate used in model

Results (1)

The effects on animal performance of offering concentrates differing in crude protein and phosphorus concentration to grazing dairy cows in early lactation

	HPr-HP	MPr-HP	LPr-HP	LPr-LP	S.E.	Significance
Milk Yield (Kg)	27.6	27.0	26.2	27.0	0.73	ns
Milk Fat (g/kg)	44.5	45.4	46.2	42.7	1.43	ns
Milk Protein (g/kg)	34.0	33.6	33.7	33.9	0.37	ns
Milk Solids Yield (Kg)	2.1	2.1	2.0	2.1	0.05	ns
Casein (%)	2.66	2.60	2.60	2.61	0.031	ns
Conc Intake (kg DM)	4.0^{a}	4.0^{a}	3.8^{ab}	3.7^{b}	0.08	**
BW Change (Kg)	39	23	12	22	6.6	ns
BCS Change	-0.05	-0.10	-0.13	-0.05	0.071	ns

a-b Means within a row not sharing a common superscript differ significantly (P<0.05)

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BW Change (Kg)	39	23	12	22	6.6	ns
BCS Change	-0.05	-0.10	-0.13	-0.05	0.071	ns
GDMI (kg DM)	11.9	12.4	13.6	13.2	0.48	0.06

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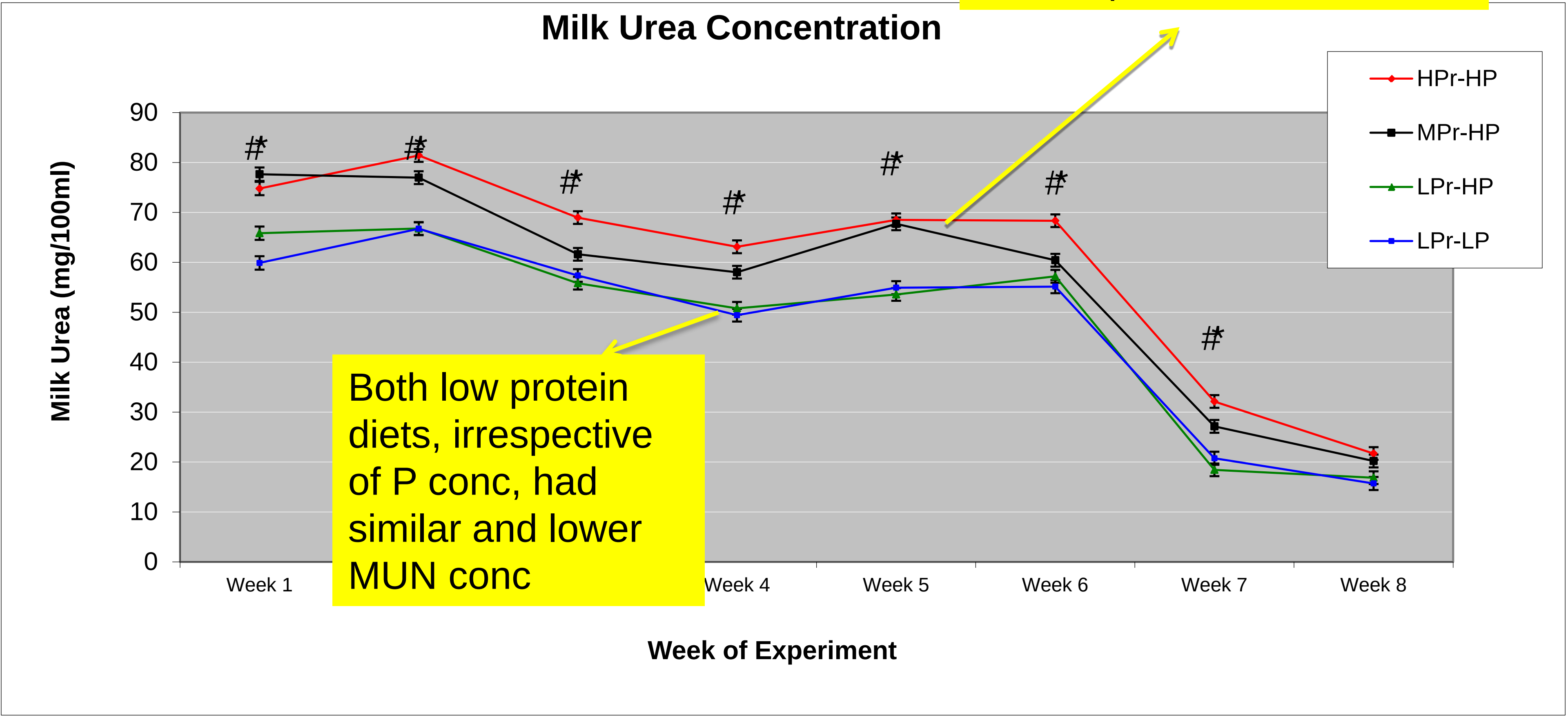
Results (2)

High MUN is an indicator of excess protein in the diet



Both low protein diets, irrespective of P conc, had similar and lower MUN conc

- Significant time by treatment interaction
- During weeks 1 – 7 there were differences between treatments

Results (3)

The effects on milk N fractions of offering concentrates differing in crude protein and phosphorus concentration to grazing dairy cows in early lactation

	HPr-HP	MPr-HP	LPr-HP	LPr-LP	S.E.	Sig.
Total Protein						
True Protein	0.941	0.946	0.948	0.950	0.0056	ns
NPN	0.059	0.054	0.052	0.050	0.0056	ns

Results (4)

The effects on milk N fractions of offering concentrates differing in crude protein and phosphorus concentration to grazing dairy cows in early lactation

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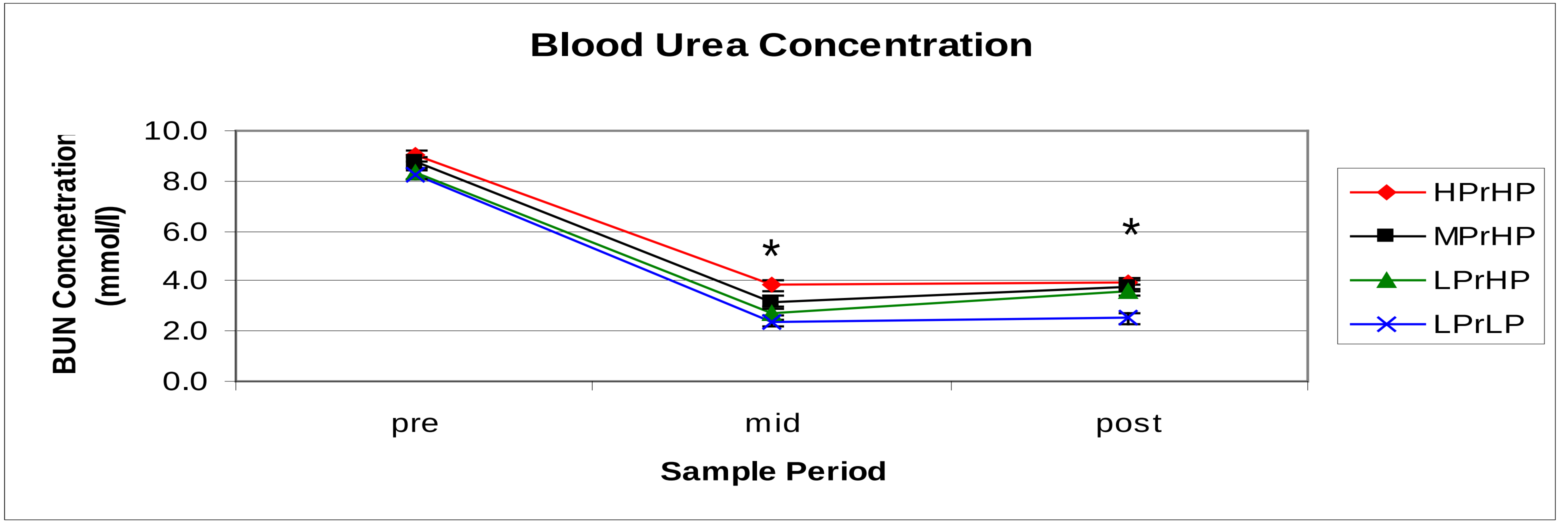
NPN	0.059	0.054	0.052	0.050	0.0056	ns
True Protein						
Casein	0.829	0.814	0.822	0.828	0.0049	ns
Whey	0.171	0.186	0.178	0.172	0.0049	ns

Results (5)

The effects on animal N status of offering concentrates differing in crude protein and phosphorus concentration to grazing dairy cows in early lactation

	HPr-HP	MPr-HP	LPr-HP	LPr-LP	S.E.	Sig.
Faecal N (g/kg DM)	32.8[a]	31.5[b]	33.4[ac]	34.1[c]	0.29	*
Urine N (mmol/l)	13.9[a]	11.8[ab]	9.6[b]	10.3[b]	0.76	***

a-b Means within a row not sharing a common superscript differ significantly (P<0.05)



Results (6)

The effects on animal P status of offering concentrates differing in crude protein and phosphorus concentration to grazing dairy cows in early lactation

	HPr-HP	MPr-HP	LPr-HP	LPr-LP	S.E.	Sig.
Faecal P (g/kg dm)	6.48[a]	6.22[a]	6.29[a]	4.90[b]	0.678	***
Urine P (mmol/l)	0.21	0.24	0.17	0.19	0.009	ns
Blood P (mmol/l)	1.28[a]	1.23[a]	1.33[a]	0.95[b]	0.071	***

a-b Means within a row not sharing a common superscript differ significantly ($P<0.05$)

Blood P in LPrLP dropped below NRC (2001) recommended level of 1.1 mmol/l

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Effect of Dietary Protein

- No effect of dietary CP on
  - Milk yield
  - Milk solids

However……

- Reduction in dietary CP significantly reduced MUN concentration
  - Positive processability implications

Effect of Dietary Phosphorus

- Reduction in dietary P significantly reduced faecal P output
  - Positive environmental implications – as reduced excretion to the environment
  - But dietary P dropped below recommended levels when low P diet was offered

Take Home Message

- Low protein supplementary feeds have an important role in grass-based diets
- Knowledge of farm mineral status is essential in order to meet dietary mineral recommendations

<u>Thank you</u>

- Questions that were asked:
- Q: What was the herbage P conc?
  - » A: 2.7 g/kg
  - » Q: Were the treatment balanced for energy isometrically, and were the PDIN:PDIE levels adequate to support a lactating dairy cow at this stage of lactation?
  - » A: yes, all treatment were balanced for energy, with concentrate UFL's ranging from 1.12 – 1.14, and the PDIE:PDIN were above the recommended level.
- Q: Are there any full-lactation studies, why such a short study?
  - » A: Wanted to capture the early lactation period as this is the time that concentrates are routinely offered. It is the aim of Irish grass-based systems to include as much grass in the diet, so when there is enough grass, it becomes the sole constituent of the diet.
- Q: What was the herbage CP?
  - » A: 27%
- Q: Was I recommending that a high-protein conc should be offered, as they produced more milk, even though it wasn't significant?
  - » A: No, it wasn't significant and the reduction in MUN was significant, meaning better suited for processing. Provided there is adequate grass in the diet, there should be enough CP to allow a low CP conc to be given.
- Q: What is the optimum MUN concentration that processors want?
  - » A: Studies on high-input systems have recommendations of approx 15 – 25 mg/100ml, however, not much research on grass-based systems. In terms of processors, the lower the better. We had high levels due to there being high protein in the grass.