Effects of phosphorus and energy intakes on markers of P deficiency in pregnant heifers

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Laboratory for Animal Endocrinology
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The University of Queensland Australia

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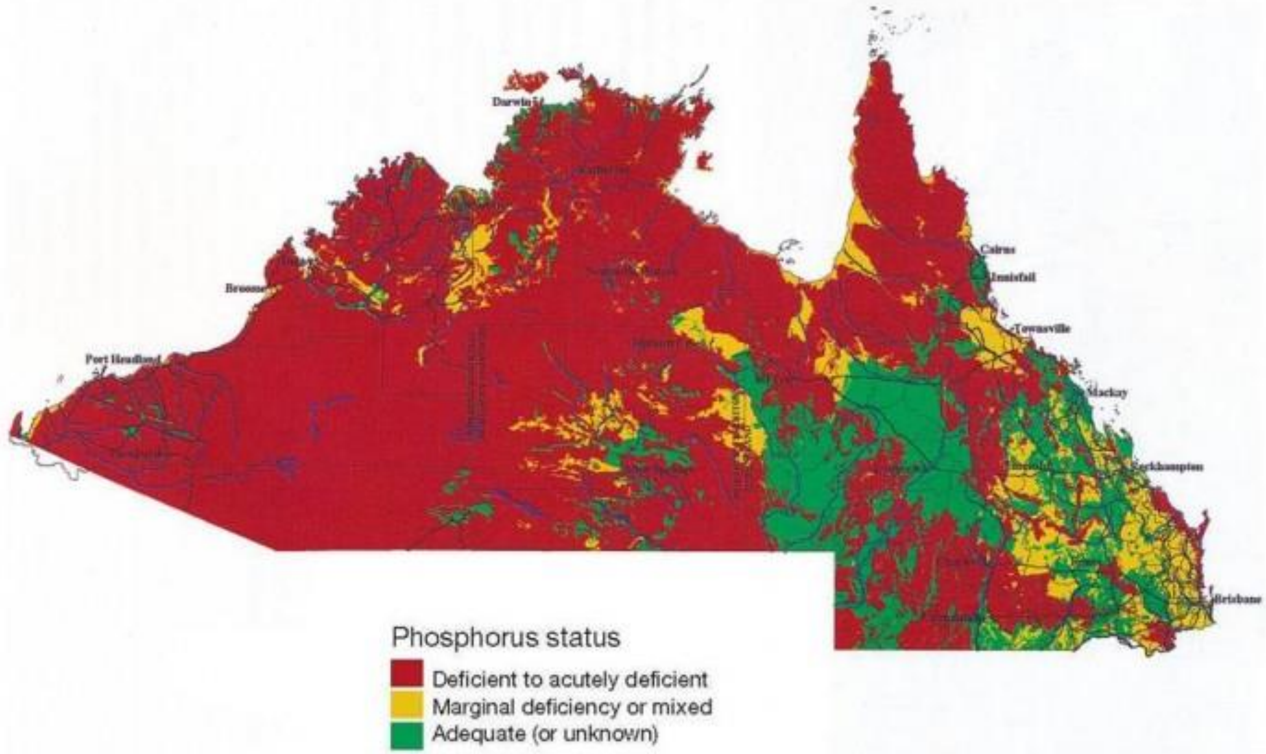
Phosphorus is a key limiting nutrient



Nutritional phosphorus deficiency is important in cattle grazing rangelands in Northern Australia & elsewhere

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Large responses to P supplementation

Herd P supplemented

Herd no supplement

Photos of the 2 herds plus / minus P supplements from weaning.
Victoria River Downs, Northern Territory
Tim Schatz & Keiren McCosker, unpub.

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Concurrent P and E deficits

In late dry season, there is also a lack of ME intake

Breeders mobilise substantial body tissue reserves during late pregnancy

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Our challenge

Better understand the physiological control of body phosphorus reserves in beef breeder cows

Improve diagnostic tests for P deficiency

Currently plasma Pi concentrations are used for P status, but PiP vary acutely with P intake.

Other circulating biomarkers?

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Our approach

Bone metabolism markers

bone formation versus bone resorption

Osteoblasts

Bone alkaline phosphatase & Osteocalcin

Osteoclasts

Breakdown peptides type I collagen (CTX-1)

+ Plasma minerals: Pi, total Ca

Design & Methods

Pregnant Bos indicus cross heifers n = 42
Initial LW 419 ± 5 kg, BCS 3.9 ± 0.1
Housed in pens during the last 14-18 weeks of pregnancy

Fed restricted amounts of wheat straw and molasses-urea
3x2 factorial design
Either **low (nil) or high P (supplement)**
and **low, medium or high ME diets**

Energy diets designed to provide substantial CF-LW loss

Low ME -0.4 kg/day
Med ME -0.2 kg/day
High ME nil loss

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Results

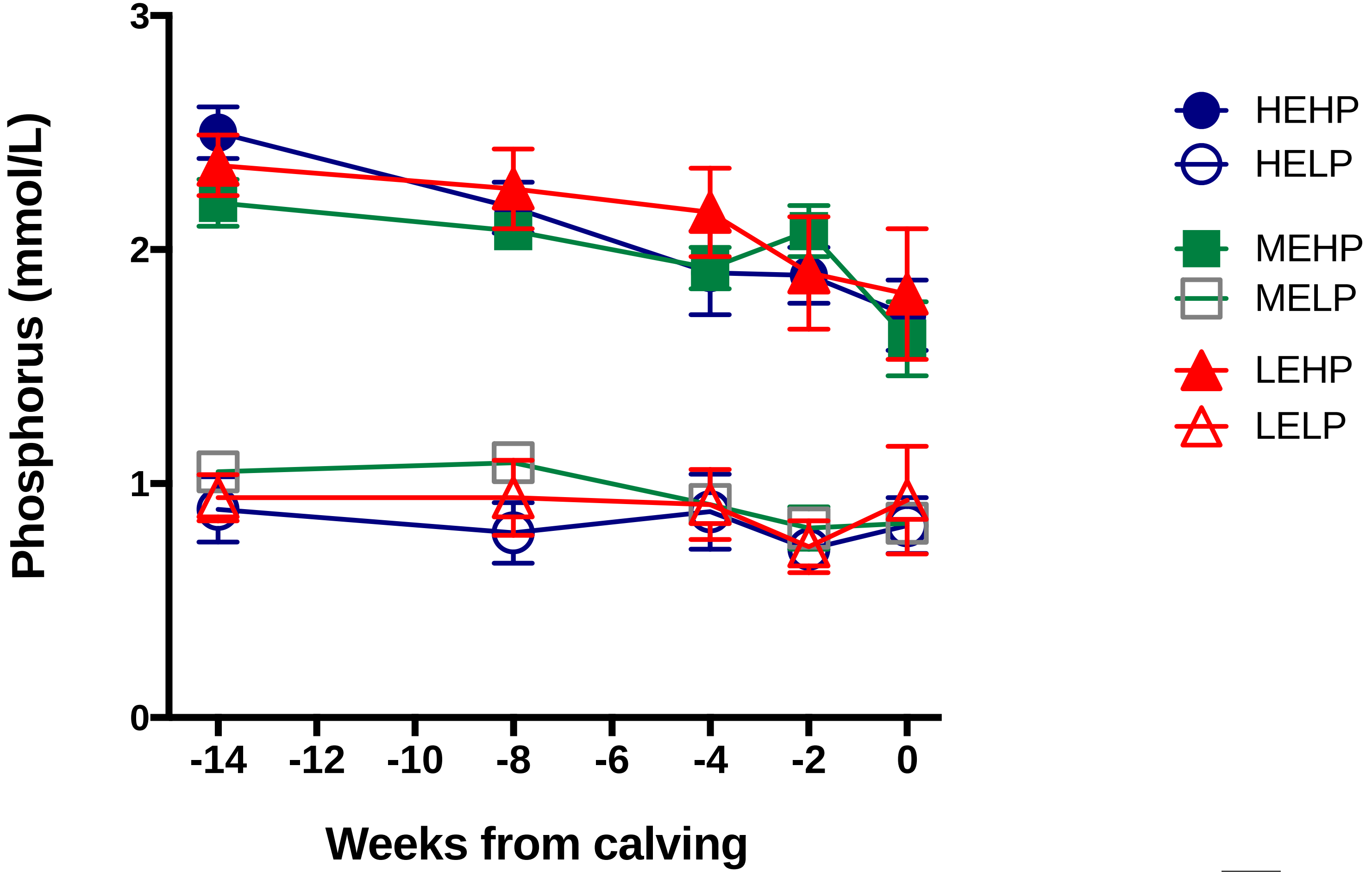
Measurement	Low-ME		Med-ME		High-ME		Signif.		
	LP	HP	LP	HP	LP	HP	E	P	Int
P required (g P/day)	--	3-5	--	6-9	--	9-12			
P intake (g P/day)	3	17	4	18	5	19	**	***	ns

PiP decreased by low P diet

Low ME intakes resulted in CF liveweight loss

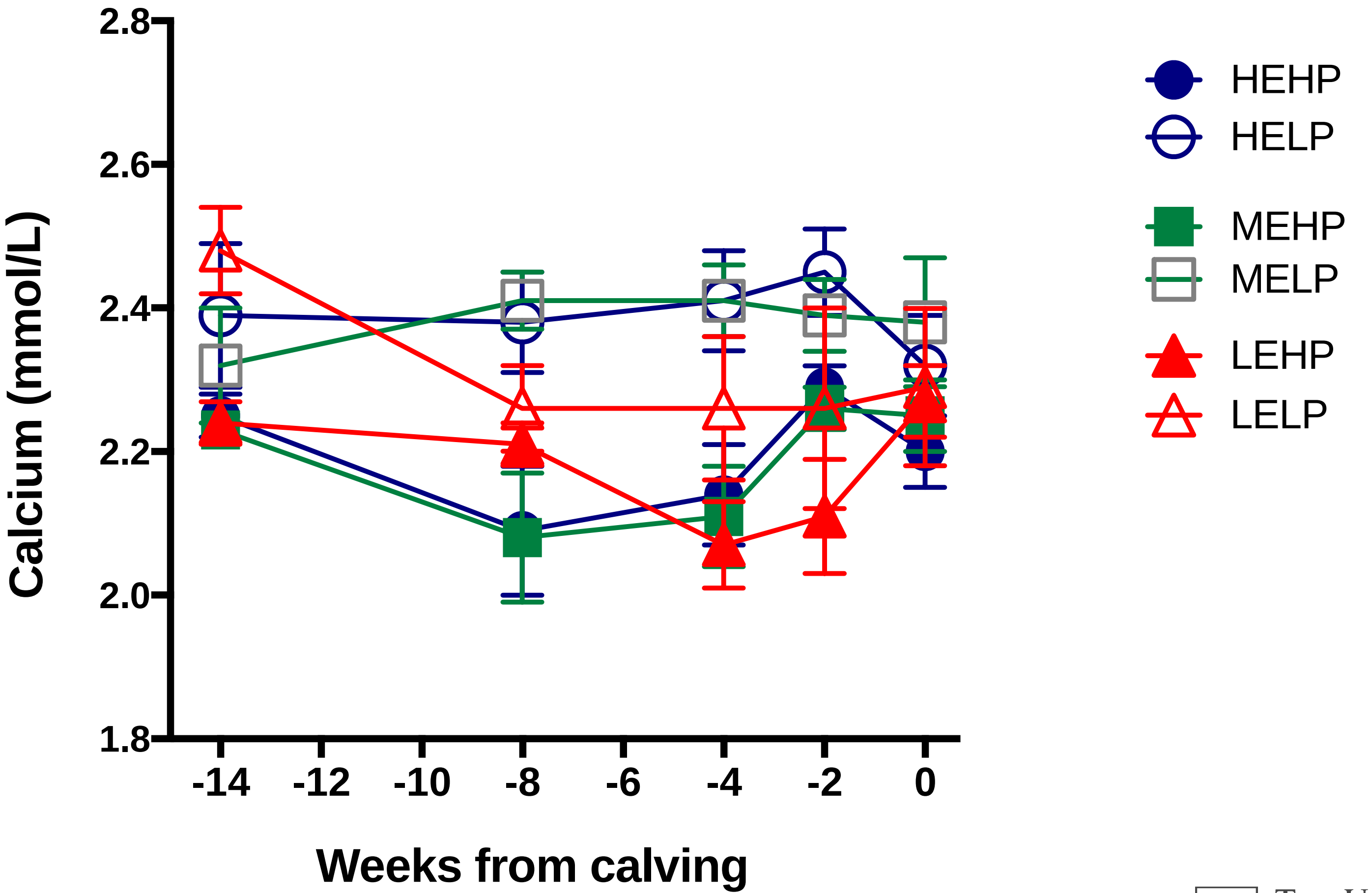
Feeding high P diet in late pregnancy increased P balance from about zero to 7-8 g P/day

Results: Phosphorus



Low P diets = lower plasma P

Results: total Ca



Low P diets = small increase Ca

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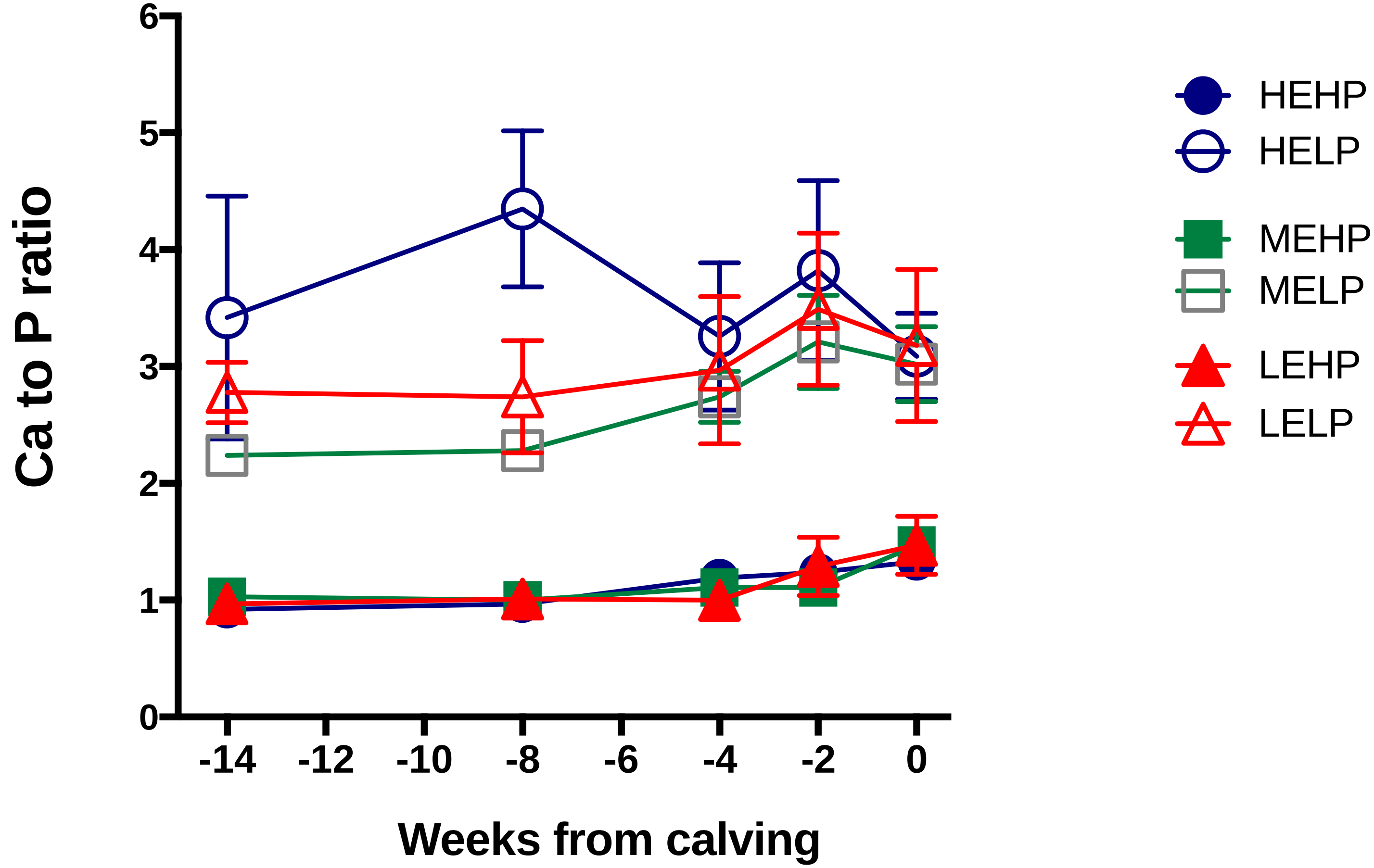
Results: plasma Ca to P ratio



Low P diets = higher plasma Ca to P ratio

Results

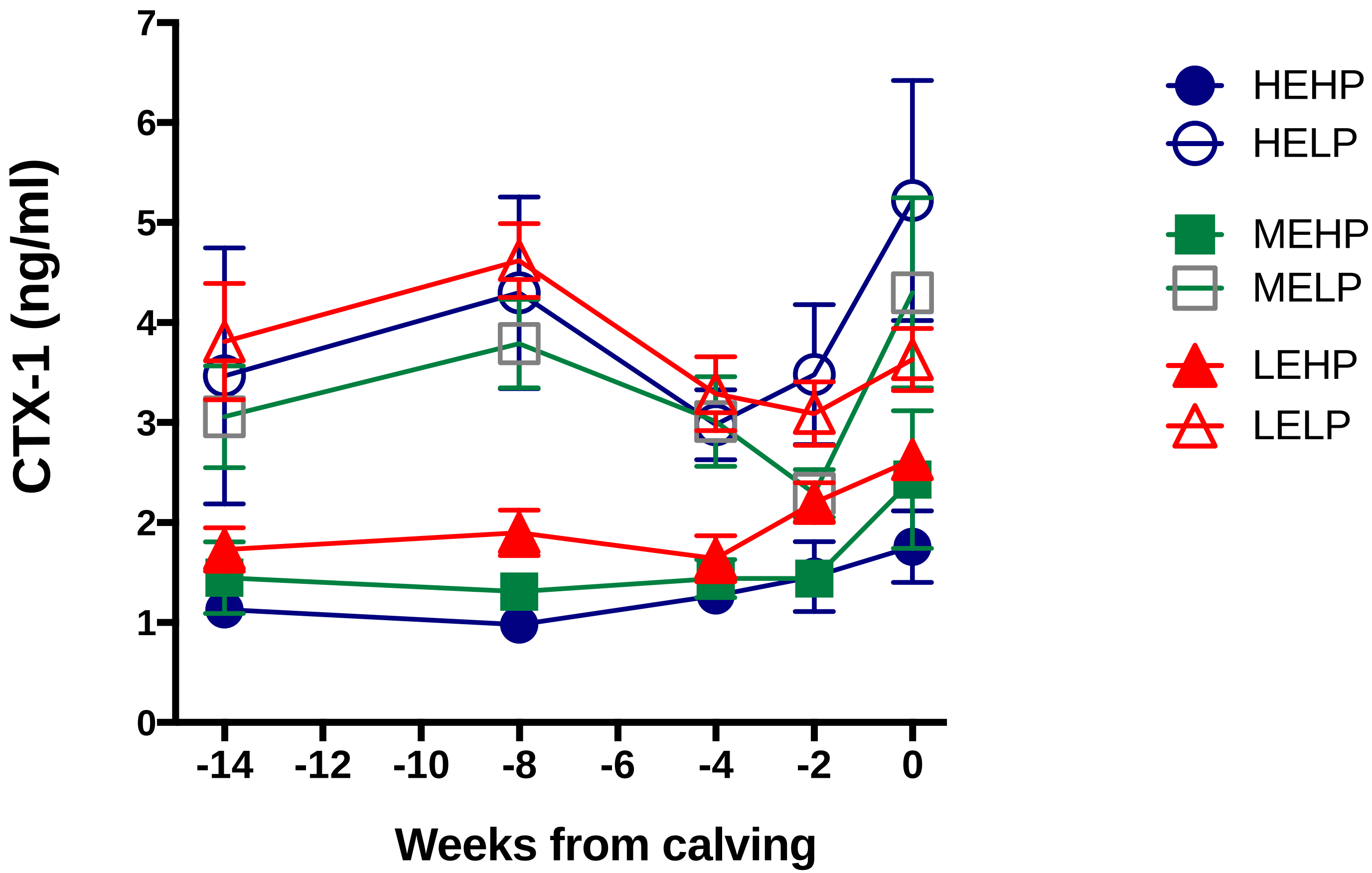
Measurement	Low-ME		Med-ME		High-ME		Signif.		
	LP	HP	LP	HP	LP	HP	E	P	Int
Plasma P (mM)	0.88	2.17	0.97	2.07	0.82	2.12	ns	***	ns
Total Ca (mM)	2.37	2.15	2.41	2.15	2.43	2.21	ns	***	ns
Plasma Ca to P	2.8	1.1	2.5	1.0	3.6	1.0	ns	***	ns
Plasma CTX-1	3.7	1.9	3.0	1.4	3.6	1.2	ns	***	ns
Plasma BALP	32	19	36	26	44	26	*	***	ns

Low P diets = higher plasma CTX-1 and BALP

bone resorption

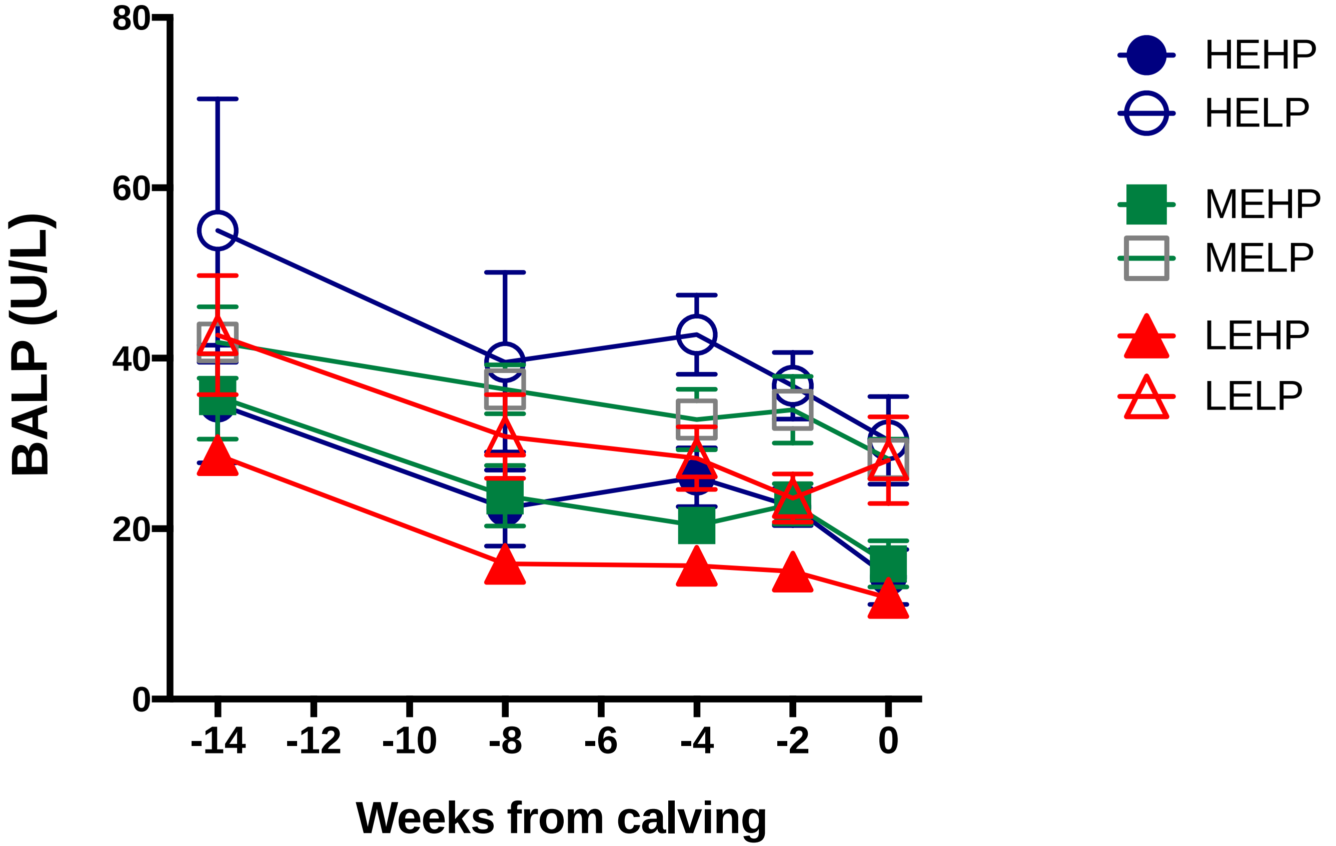
bone mineralisation

Results: CTX-1



Low P diets = higher plasma CTX-1

Results: BALP



Low P diets = higher plasma BALP

Conclusions

Plasma CTX-1 and Ca to P ratio concentrations are increased in dietary P deficiency.

Plasma BALP is increased by low P diets, but also with increased energy intake.

Useful biomarkers for P deficiency in heifers, in addition to PiP

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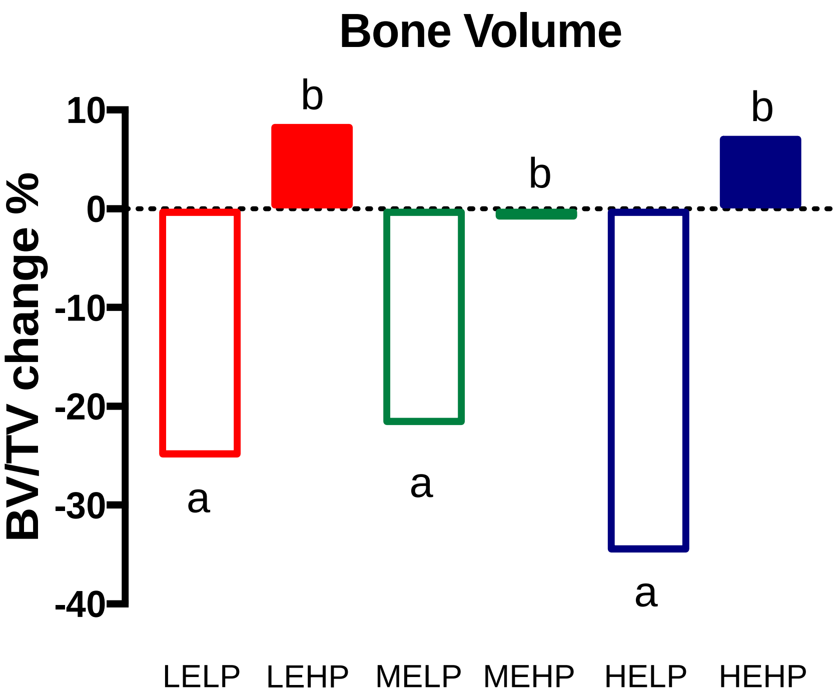
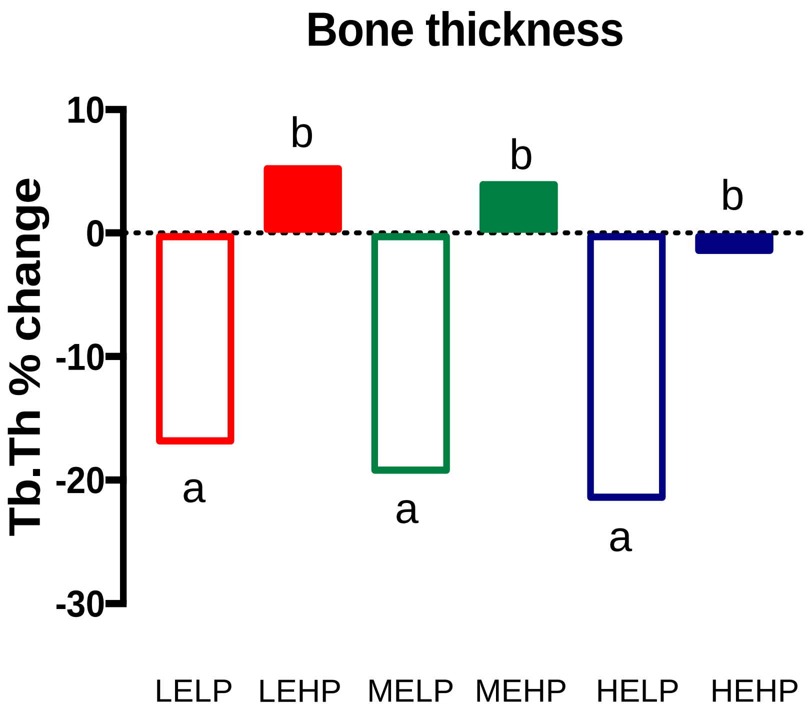
Results: Hip bone biopsies





Additional diet P improved trabecular bone volume and thickness