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

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Phosphorus is a key limiting nutrient.

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

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Low-ME</th>
<th>Med-ME</th>
<th>High-ME</th>
<th>Signif.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>LP</td>
<td>HP</td>
<td>LP</td>
<td>HP</td>
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<tr>
<td>P required (g P/day)</td>
<td>--</td>
<td>3-5</td>
<td>--</td>
<td>6-9</td>
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<tr>
<td>P intake (g P/day)</td>
<td>3</td>
<td>17</td>
<td>4</td>
<td>18</td>
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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
Results: plasma Ca to P ratio

Low P diets = higher plasma Ca to P ratio
## Results

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<tr>
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<td></td>
<td>LP</td>
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<tr>
<td><strong>Plasma P (mM)</strong></td>
<td>0.88</td>
<td>2.17</td>
<td>0.97</td>
<td>2.07</td>
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<tr>
<td></td>
<td>0.88</td>
<td>2.17</td>
<td>0.97</td>
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<tr>
<td><strong>Total Ca (mM)</strong></td>
<td>2.37</td>
<td>2.15</td>
<td>2.41</td>
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<td>2.15</td>
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<tr>
<td><strong>Plasma Ca to P</strong></td>
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<td>1.1</td>
<td>2.5</td>
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<tr>
<td></td>
<td>2.8</td>
<td>1.1</td>
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<td><strong>Plasma CTX-1</strong></td>
<td>3.7</td>
<td>1.9</td>
<td>3.0</td>
<td>1.4</td>
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<td></td>
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<td>1.9</td>
<td>3.0</td>
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<tr>
<td><strong>Plasma BALP</strong></td>
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**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
Results: Hip bone biopsies

Additional diet P improved trabecular bone volume and thickness