Use of anions and cations in sows

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Balancing anions and cations

The acid-base balance of feed can be estimated with the anion-cation-balance (ACB) concept, for which there are several equations available. Basically it is a simplified way of expressing the dietary cation-anion difference in the diet, whereby cations have an alkalising and anions and acidifying effect. An equation to calculate the ACB for sow diets, which has been shown to be strongly related to sow urinary pH, was established by Beker (1999). The factors in the equation represent the differences in absorption and atomic weight of minerals:

$$ACB\ (mmol/kg\ DM) = 49.9{*}Ca + 82.3{*}Mg + 43.5{*}Na + 25.6{*}K - 59{*}P - 13{*}(Met+Cys) - 28.2{*}Cl$$

(Ca = calcium, Mg = magnesium, Na = sodium, K = potassium, P = phosphorus, Cl = chlorine)

As shown above the equation is based on certain minerals and amino acids. Thus the ACB for different raw materials or whole diets can be calculated from their nutrient composition. Therefore, by adding up the ACBs of the individual dietary components, one can calculate the ACB of the entire diet. Conventional sow diets have a range of +200 to +600mmol/kg.

Therefore, to lower the urinary pH to below 6.5 the ACB of the diet would have to be lowered quite considerably. The challenge is in lowering cations and/or increasing anions. Especially the calcium-phosphor-ratio is an important parameter in stability of the skeletal system and not less important is an adequate sodium and magnesia supply. Therefore, cations cannot be easily excluded from lactating sow diets and secondly via variation of raw materials only a minor manipulation of the ACB value of the diet is possible. Therefore, it is highly recommended to use urine acidifying substances wherever it makes sense to acidify the urine (for example, farrowing and insemination).

It has been shown that balancing the diet for anions and cations plays an important role in preventing milk fever in dairy cows. Therefore, why not benefit from this knowledge and use it in sows too?

Of course sows are not usually afflicted with milk fever, but delayed farrowings resulting in increased numbers of still births are a common problem in sow herds (see Table 1).

The causes include:

- Tedious labour (too weak muscle tones) as a result of too low blood calcium levels.
- Insufficient release of oxytocin, the hormone which elicits labour pains, milk flow and milk let-down.
- Too narrow birth canals due to genetics, constipation and primiparous sows.
- Parity number.

The correlation between too low blood calcium levels, decreased muscle tone and increased still births opens a second area in view of improving sow performance by using Biomin pHD.

This product line aims to increase blood calcium levels to decrease still births.

Duration of farrowing (hours)	Litters	Number of still births (%)
<4	376	4.0
4-6	161	5.8
>6	92	9.9

Table 1. Effect of duration of farrowing on still births (Hühn 2004).

Beside already published effects on preventing urinary tract infections (UTI) and minimising related metritis problems – reducing the number of still births could be an additional way to improve the number of piglets weaned per sow per year (see Fig. 1).

Calcium metabolism

The serum calcium level is regulated by hormones and has to be kept in narrow ranges (2.3-2.8 mmol/l in sows).

Hormones involved in the control mechanism are parathyroid hormone and calcitonin as well as 1.25-$(OH)_2$-vitamin D (active form of vitamin D3).

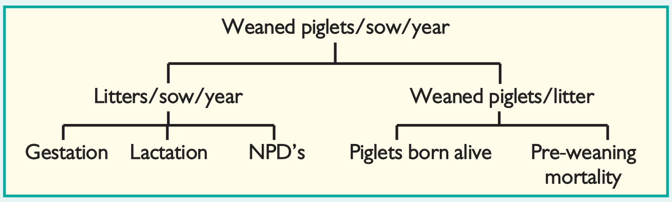
When plasma calcium concentration declines, parathyroid hormone and 1.25-$(OH)_2$-vitamin D are activated and calcium-resorption via the kidneys, calcium-adsorption from the digestive tract as well as bone mobilisation are increasing.

Since there is a permanent, overconsumption of calcium during gestation (because of a low demand) this mechanism is not trained – the parathyroid control mechanism is slowed down and cannot react in time on the changed/increased calcium demands peri-farrowing.

Consequences are declining calcium blood levels which can not be balanced in time and in the end calcium is missing for the contraction of muscles and a deficit in calcium blocks the release of oxytocin, which is important for muscle contraction too.

Declining calcium levels delay the farrowing process and in the end the livability of the piglets is decreasing and/or the piglets die prematurely.

Fig. 1. Breeding herd efficiency.



Urine acidification

Balancing the acid-base-balance and regulating the blood pH at around 7.42 (reference value for pigs) is important for the maintenance of all vital functions of the body.

The blood pH is regulated via three mechanisms:

- Binding and release of H^+ via puffer systems.
- Regulating the partial pressure of carbon dioxide via respiration.
- Regulating the renal H^+ and hydrogen carbonate - excretion.

We now need to have a closer look at regulating the blood pH via renal excretion, because this mechanism is relevant for the mode of action of Biomin pHD. Excreta pH is a function of the acid-base balance of the feed and balancing for anions and cations influences the acid-base balance of the body. Increasing anions in the diet leads to an acidic stress of the animal.

Depending on the extent of acidic stress metabolic acidosis is the immediate consequence. The body tries to compensate acidosis via increasing H^+ excretion and increasing readsorption of hydrogen carbonate, which acidifies the urine.

Urine sampling.

Furthermore, it is reported that an acidic stress of the acid-base balance lead to a net-excretion of calcium from the body by increasing renal calcium excretion.

The body tries to compensate this lack via an increased mobilisation of calcium from the bones as the biggest calcium storage of the body and, at the same time, the body tries to puffer the blood pH via increasing calcium resorption (regulated by parathyroid hormone and 1.25-$(OH)_2$-vitamin D). Resulting in increasing calcium blood levels. It is assumed that by feeding anionic diets this trains the parathyroid hor-

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	Control	Biomin pHD	P-value
Parity	3.5	3.2	
pH 1 (day 108 pregnancy)	6.7	6.6	0.585
pH 2 (farrowing)	6.7	6.1	0.031
pH 3 (day 7 post farrowing)	7.2	6.0	<0.001
pH 4 (day 1 post insemination)	6.7	5.7	0.001
P<0.05			

Table 2. Urine pH in response to feeding Biomin pHD (Cyprus 2006).

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mone and 1.25-$(OH)_2$-vitamin D mechanisms to act faster and more efficiently in times of increased demands of calcium, particular pre-farrowing.

These literature surveys confirm the already proven effects of feeding Biomin pHD (see Table 2 and 3) and opens new applications for the future. Based on these new facts, a trial was carried out under farm conditions in Australia and the results are promising.

Trial results

The trial was conducted in a climate controlled breeder unit in Southern Queensland in January 2007.

The control group was fed conventionally and the trial group received additionally 0.5% Biomin pHD in the feed for 10 days pre-farrowing until mating. The main focus was on farrowing performance.

The addition of Biomin pHD pre-farrowing had a significant response in reducing still births from 1.15 down to 0.73 piglets per litter (P>0.05) + 0.4 piglets/sow/litter. The number of mummified piglets was similar in both groups.

The control had numerically less pre-weaning mortality, however this fluctuation of 1.0-1.5% is common on this farm and the difference was not significant (see Table 4).

Furthermore, it was suggested that the addition of Biomin pHD eased farrowing and reduced the number of farrow assistance as well as reduced the number of discharges post lactation.

Conclusion

In consideration of the facts mentioned above the mode of action of Biomin pHD can be extended in terms of improving piglets born alive due to its supposed effect on the acid-base-balance of the body.

Nevertheless, the main focus is still on supporting the natural defence mechanism – via preventing the invasion, multiplication and adhesion of pathogenic bacteria to the uro-genital tract of the sow.

This effect is based on two strategies:

- Creating unfavourable conditions for the bacteria and inhibiting their growth by a blend of an inorganic acid and anionic substances.
- Binding pathogenic bacteria and inhibiting their adherence to the urinary tract cell walls by proanthocyanidins (PACs) contained in cranberries.

Consequently, the addition of Biomin pHD increases productivity of the herd due to its effect against UTIs and related metritis problems and due to its supposed effect on piglets born alive. ■

	Control	Biomin pHD	P-value
Parity	2.9	3.2	
pH 1 (day 108 pregnancy)	6.1	6.1	0.984
pH 2 (day 112 pregnancy)	6.3	5.8	0.148
pH 3 (day 1 post farrowing)	6.0	5.2	0.002
pH 4 (day 1 post weaning)	6.3	5.5	0.002
pH 5 (day 1 post insemination)	6.1	5.3	0.027
P<0.05			

Table 3. Urine pH in response to feeding Biomin pHD (Philippines 2006).

Table 4. Farrowing performance (Australia 2007).

	Control	Biomin pHD
Number of sows	108	109
Average parity	3.3	3.0
Average litter size	10.6	10.3
Total born/litter	12.3	11.5
Born alive/litter	10.8	10.4
Still births	1.15	0.73
Mummified	0.35	0.37
Average birth weight	1.42	1.37
Pre-weaning mortality (%)	12.4	13.6
Litter weaning weight	57.3	56.7
Average weaning weight (21 days)	6.1	6.3