Herbal vitamin D metabolite helps the farrowing process

With the increasing prolificity of sows it becomes essential to adjust nutrition to cover the needs of modern breeds. An important nutrient is vitamin D, as it is a key factor in calcium (Ca) and phosphorus (P) metabolism. The mineral requirement of sows is very high from the third part of gestation until the end of lactation.

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In late gestation, Ca and P are needed to finalise the development of the skeleton of the fast-growing foetuses. Furthermore, Ca plays an essential role in muscular contractions in the uterus during farrowing. Finally, considerable amounts of Ca are secreted in milk during lactation and need to be quickly replenished via feed to avoid damage to the sow's skeletal integrity.

The vitamin D receptor (VDR) is expressed in various reproductive tissues such as the endometrium and the chorion of the embryo, indicating the crucial role of 1,25 dihydroxycholecalciferol (1,25(OH)$_2$D$_3$), the bioactive form of vitamin D, in overall reproductive performance.

Prolonged farrowing and its negative consequences

In the last decade, the increase of litter size has compromised the vitality of the piglets due to the limited intra-uterine space per piglet (crowding) and the prolonged farrowing duration.

These two factors put the life of the piglet at risk, resulting in increased incidences of intrapartum death, hypoxia and/or weak and underweight piglets born with limited chances of survival.

Increasing farrowing time (first to last piglet born), which today is on average between four and five hours, is one of the factors that leads to peri-parturient problems in sows, like an increased number of stillbirths, a higher number of interventions, excessive use of oxytocin, uterine prolapses, and reduced access to colostrum for late born piglets.

Mechanism of muscle contraction

The differences in the mechanism of contractions of a smooth muscle such as the ones present in the myometrium and a striated muscle (for example skeletal muscle, Fig. 1) is that the contraction of the smooth muscle is involuntary. The absence of troponin in smooth muscle cells, makes it highly dependent on intra-cellular Ca levels.

The uterine contraction therefore is initiated by a mechanism of uterine depolarisation that occurs before farrowing, resulting in opening of Ca channels in the cell membrane, enabling cellular Ca^{2+} influx, promoting muscle excitation (Fig. 2).

The increased contractions and consequent pressure on the cervical region induce the production of oxytocin in the hypothalamus.

To avoid a state of hypocalcaemia it is crucial to keep a high Ca level at the time of parturition to ensure myometrium contraction strength and after parturition as also lactation requires high Ca levels.

If this high Ca demand cannot be met from dietary sources, it results in bone mobilisation. This is associated with skeletal weakness, lameness or even fractures. Such bone problems are among the main causes of replacement of sows in commercial operations and are recognised as a welfare issue.

Benefit of using 1,25(OH)$_2$D$_3$-glycosides

Vitamin D requirements can be met by supplementing the feed with vitamin D. Vitamin D needs to be activated in the liver and kidneys by enzymatic processes to form 1,25(OH)$_2$D$_3$.

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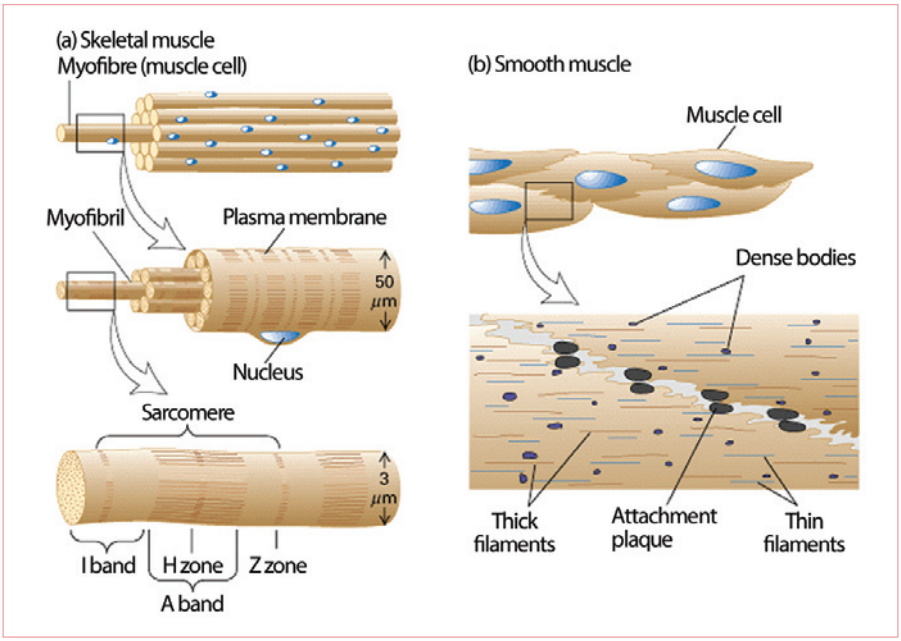
Fig. 1. General structure of skeletal (a) and smooth muscle (b). Smooth muscle is composed of loosely organised spindle-shaped cells that contain a single nucleus. Loose bundles of actin and myosin filaments pack the cytoplasm of smooth muscle cells. These bundles are connected to dense bodies in the cytosol and to the membrane at attachment plaques (after Lodish 4th edition).



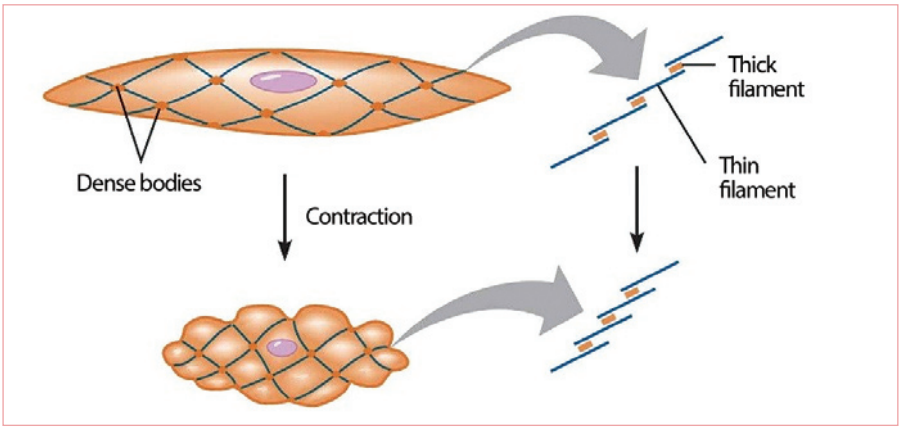


Fig. 2. Contraction of a smooth muscle (Pearson Education Inc, 2011).

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1,25(OH)$_2$D$_3$ is the bioactive form of vitamin D as in physiological conditions only this molecule interacts with the VDR.

Based on the presence of VDR in various reproductive organs in sows, it is demonstrated that 1,25(OH)$_2$D$_3$ affects many aspects of reproduction, like:

- Ovulation.
- Embryo implantation.
- Placentation.
- Colostrum and milk production and composition.

Due to these effects on sow reproductive performance and on bone quality, 1,25(OH)$_2$D$_3$ is related to the sows' longevity.

The use of 25-hydroxycholecalciferol (25(OH)D$_3$) increases circulating levels of 25(OH)D$_3$ in sows and piglets, but it still needs to be activated in the kidneys. This activation could be limited when liver or kidney metabolism is negatively affected, for example during stress, mycotoxicosis and increasing sow age.

To overcome the effects of this reduced efficacy of activation, or to support periods with large increases in Ca demands, such as at the onset of milk production, 1,25(OH)$_2$D$_3$-glycosides can be provided on top of the usual vitamin D supplementation.

This natural source of the bioactive form of vitamin D is present in the plant Solanum glaucophyllum.

In the intestinal tract the sugar molecules are cleaved from the bioactive 1,25(OH)$_2$D$_3$, which is subsequently absorbed.

In contrast to vitamin D or 25(OH)D$_3$, the absorbed 1,25(OH)$_2$D$_3$ does not need additional activation in liver and/or kidney and is therefore immediately bioactive, while being safe up to 20 times the recommended dosage.

Average results of six commercial trials showed a significant reduction of farrowing time, need for human interventions during farrowing and a lower number of stillborn piglets before and after the inclusion of 1,25(OH)$_2$D$_3$-glycosides (Fig. 3). ■

References are available from the authors on request

Fig. 3. Common parturition complications related to farrowing duration.