The effects of maternal dietary supplementation of cholecalciferol (vitamin D_3) in conjunction with 25(OH)D_3 on sow and pig performance

Morgan T. Thayer, Jim L. Nelssen, Austin Langemeier, Jodi Morton, John M. Gonzalez, Stephanie R. Kruger, Zhining Ou, Andrew J. Makowski, and Jon R. Bergstrom

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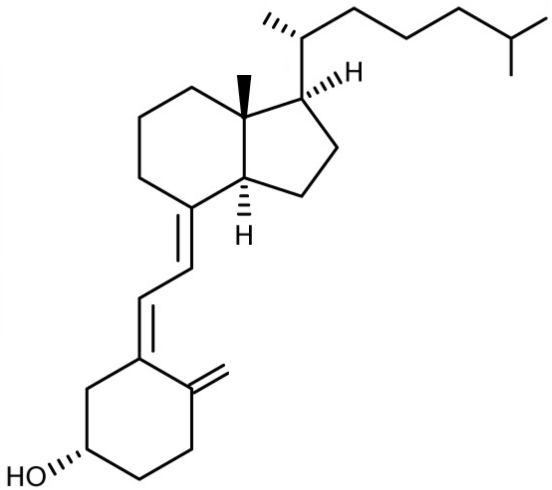
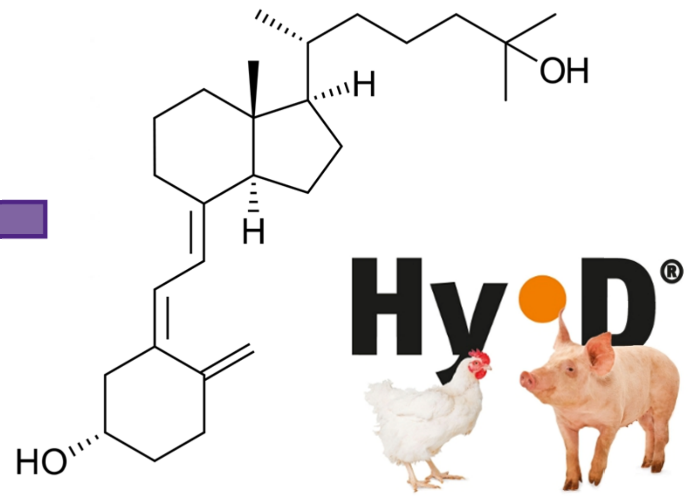
Introduction

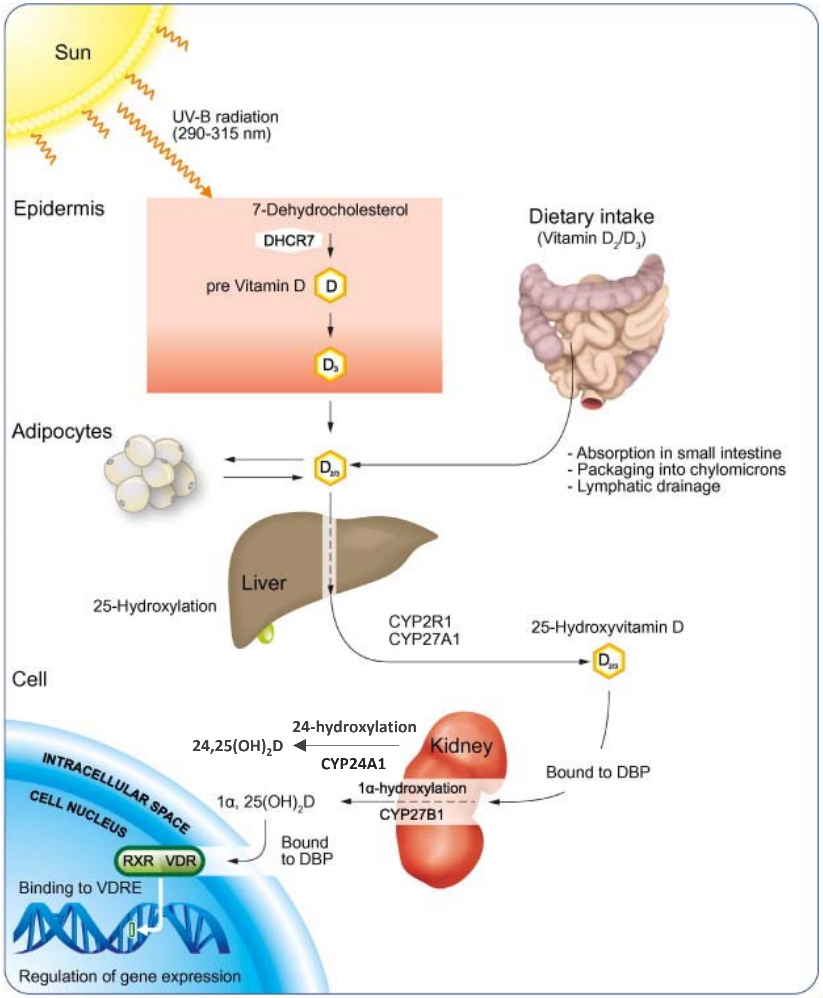
Vitamin D_3



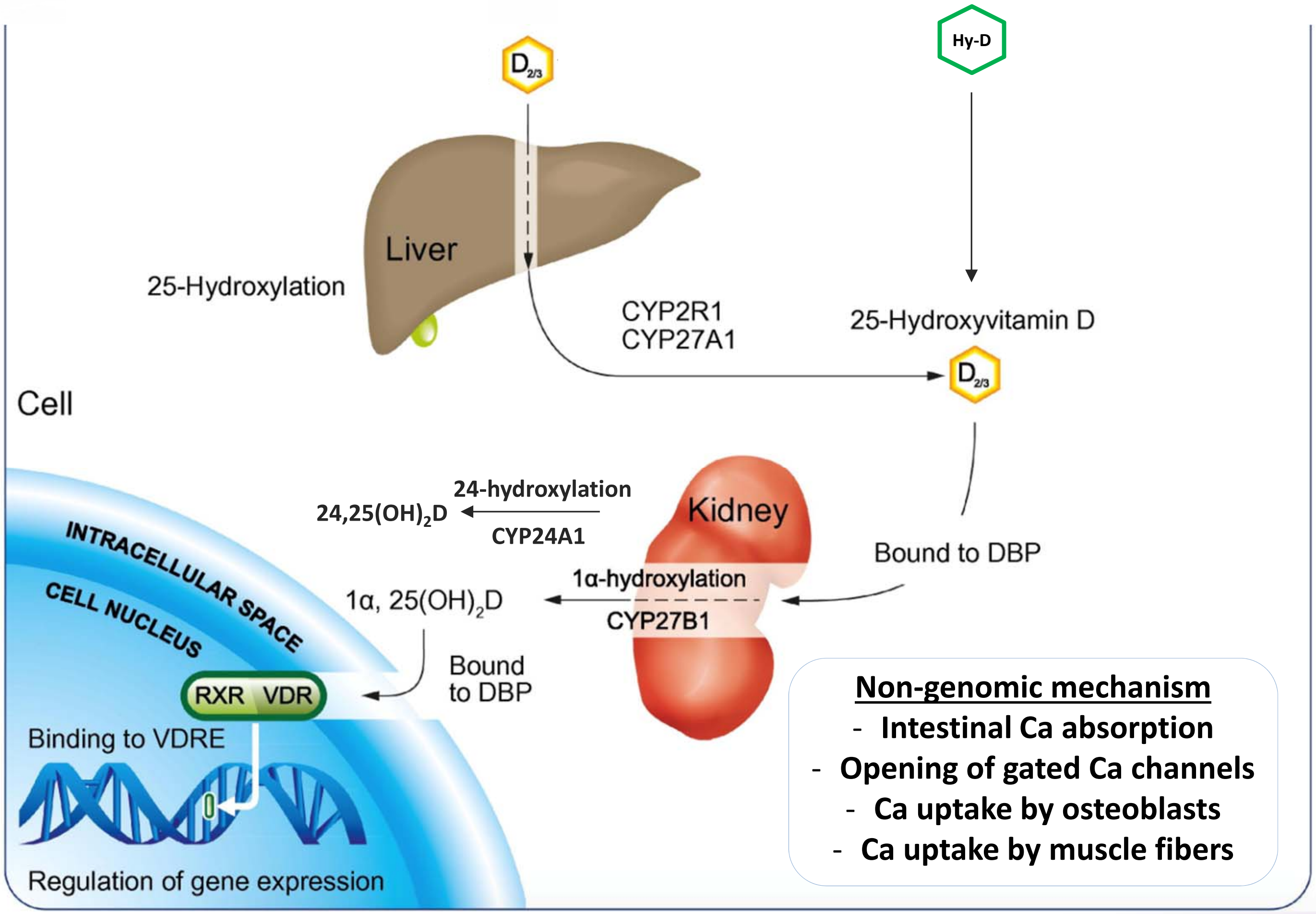
25(OH)D_3



DSM Nutritional Products, Parsippany, NJ



Kitson and Roberts, 2012



Non-genomic mechanism

- **Intestinal Ca absorption**
- **Opening of gated Ca channels**
- **Ca uptake by osteoblasts**
- **Ca uptake by muscle fibers**

Kitson and Roberts, 2012; Bar et al., 1980

Metabolites of Vitamin D_3

Vitamin D_3 (Cholecalciferol)

- Formed in the skin from sunlight
- Absorbed in the small intestine from the diet

25(OH)D_3 (Calcidiol)

- Formed in the liver
- Main circulating form
- Reflects vitamin D status of the animal

1,25$(OH)_2D_3$ (Calcitriol)

- Formed in the kidney
- Active hormone form
- Regulate Ca and P levels in the blood
- Key role during bone mineralization
- Effects cell differentiation, proliferation, and growth in many tissues

24,25$(OH)_2D_3$ (24,25-dihydroxyvitamin D_3)

- Development of bone integrity
- Healing of bone fractures

Dittmer and Thompson, 2011; Gropper et al., 2004; Seo et al., 1997

Vitamin D_3 NRC Recommendations

Sows	➢ 800 IU/kg
Nursery	➢ 220 IU/kg
Finishing	➢ 150 IU/kg

NRC, 2012

2016 Feeding Regimen Survey

- A survey of current feeding regimens for vitamins and trace minerals in the US swine industry

  - Journal of Swine Health and Production
  - 18 producers with approximately 40% of US sow herd participated

  - Vitamin D survey (IU/kg)
    - Gestation/lactation: 1,762
    - Nursery: 1,744
    - Early/mid finishing: 935
    - Late finishing: 770

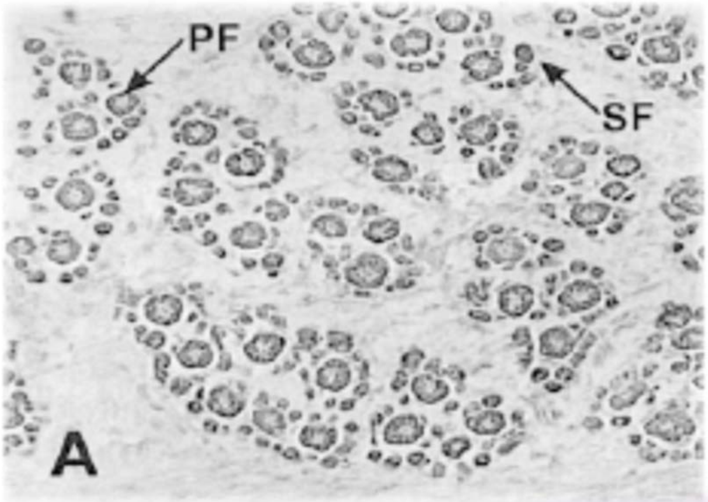
Vitamin D controls selected (IU/kg)

- Gestation/Lactation: 1,500
- Nursery: 1,500
- Early/mid finishing: 1,000
- Late finishing: 800

Flohr et al., 2016b

Impacts on Skeletal Muscle

- **Increase in muscle fiber number of the LM of d 90 fetuses** *(Hines et al., 2013)* **and pigs at birth and weaning** *(Zhou et al., 2016)* **when the maternal diet contained 25(OH)D_3**



te Pas et al., 2004

Objective

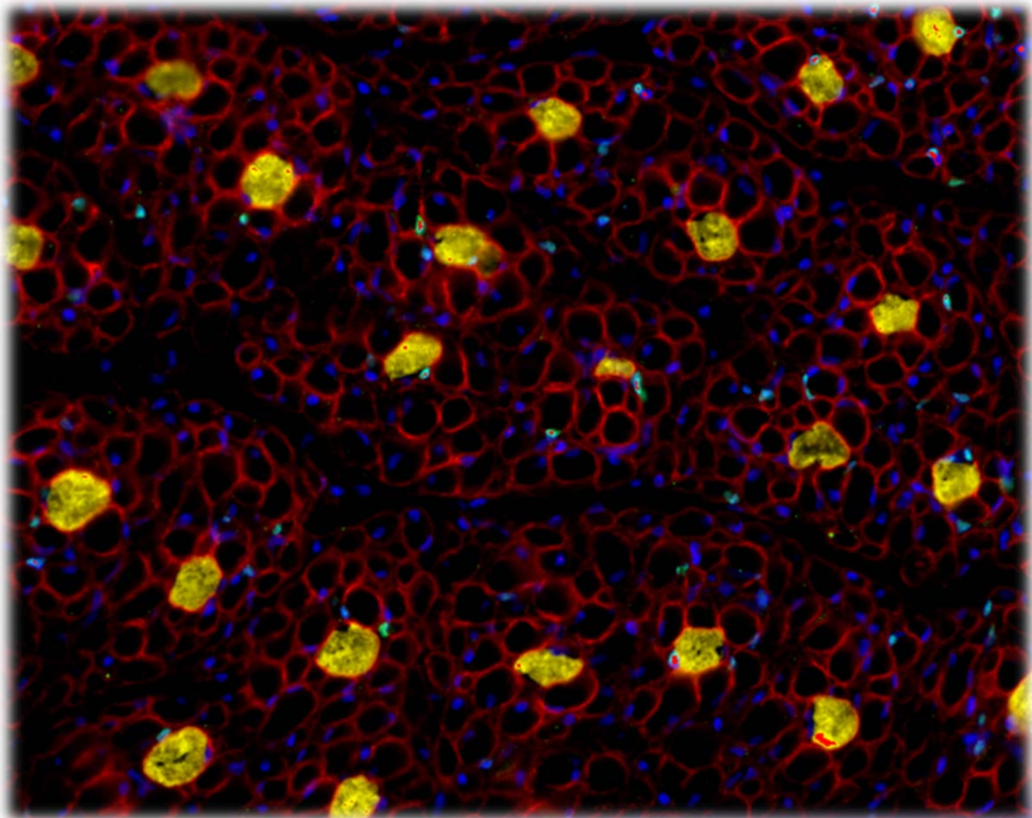
To determine if feeding a combination of vitamin D_3 (Rovimix D3, 500,000 IU/g; DSM Nutritional Products, Parsippany, NJ) and its more available metabolite, $25(OH)D_3$ (Hy-D, DSM Nutritional Products, Parsippany, NJ), influences sow performance, sow and piglet vitamin D_3 status, muscle development of the piglets, and subsequent growth performance

	Dietary Treatments					
	1		2		3	
	VitaminD_3, IU	Hy-D, µg	VitaminD_3, IU	Hy-D, µg	VitaminD_3, IU	Hy-D, µg
Gestation	1500	---	500	25	1500	50
Lactation	1500	---	500	25	1500	50
Nursery 1	1500	---	500	25	1500	50
Nursery 2	1500	---	500	25	1500	50
Total vitamin D_3 activity, IU	1500		1500		3500	
Finisher 1	1000	---	---	25	---	50
Finisher 2	1000	---	---	25	---	50
Total vitamin D_3 activity, IU	1000		1000		2000	
Finisher 3	800	---	---	20	---	40
Total vitamin D_3 activity, IU	800		800		1600	

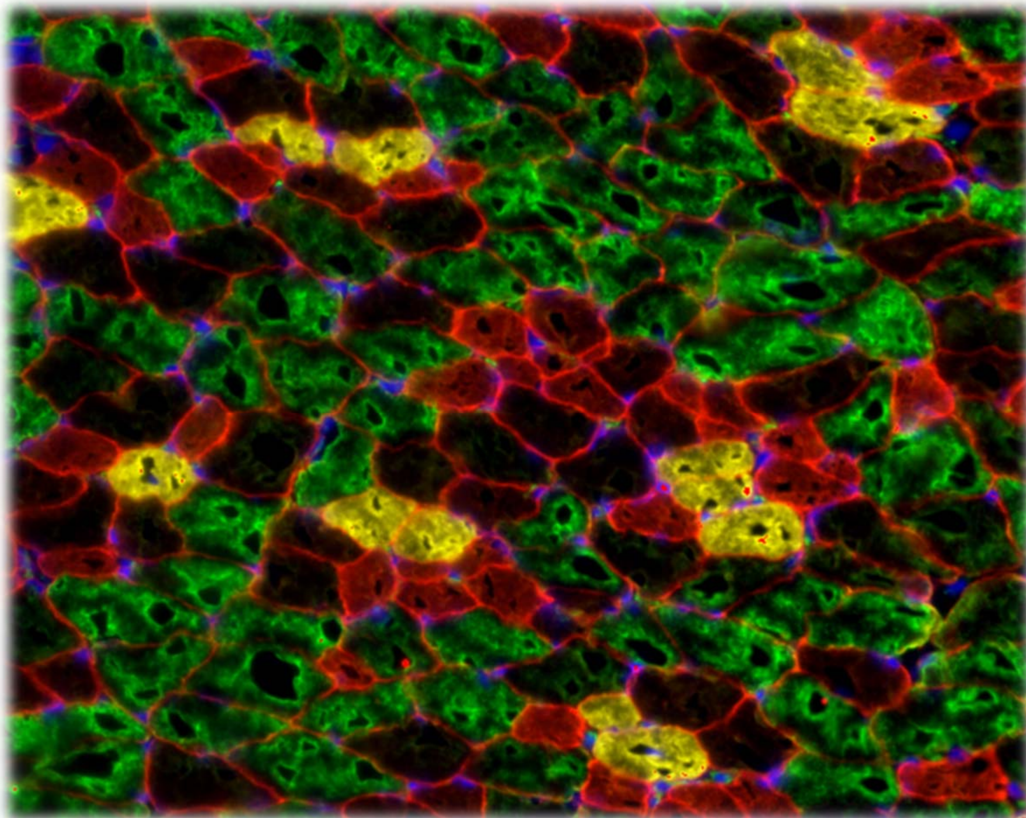
Litter Characteristics

	Diet				
	1,500 IU D_3	500 IU D_3 + 25 µg 25(OH)D_3	1,500 IU D_3 + 50 µg 25(OH)D_3	SEM	Probability, P <
Litter characteristics					
Total born, *n*	17.28	16.73	17.86	0.881	0.652
Born alive, %	87.80	92.13	89.67	1.960	0.283
Stillborn, %	9.53	6.93	9.42	5.048	0.891
Mummies, %	3.90	2.27	2.86	2.771	0.864
Standardized liter size, *n*	14.00	13.83	13.96	0.780	0.987
Weaning liter size, *n*	13.00	13.09	13.00	0.754	0.996
Survivability, %	93.08	95.07	93.57	1.766	0.706

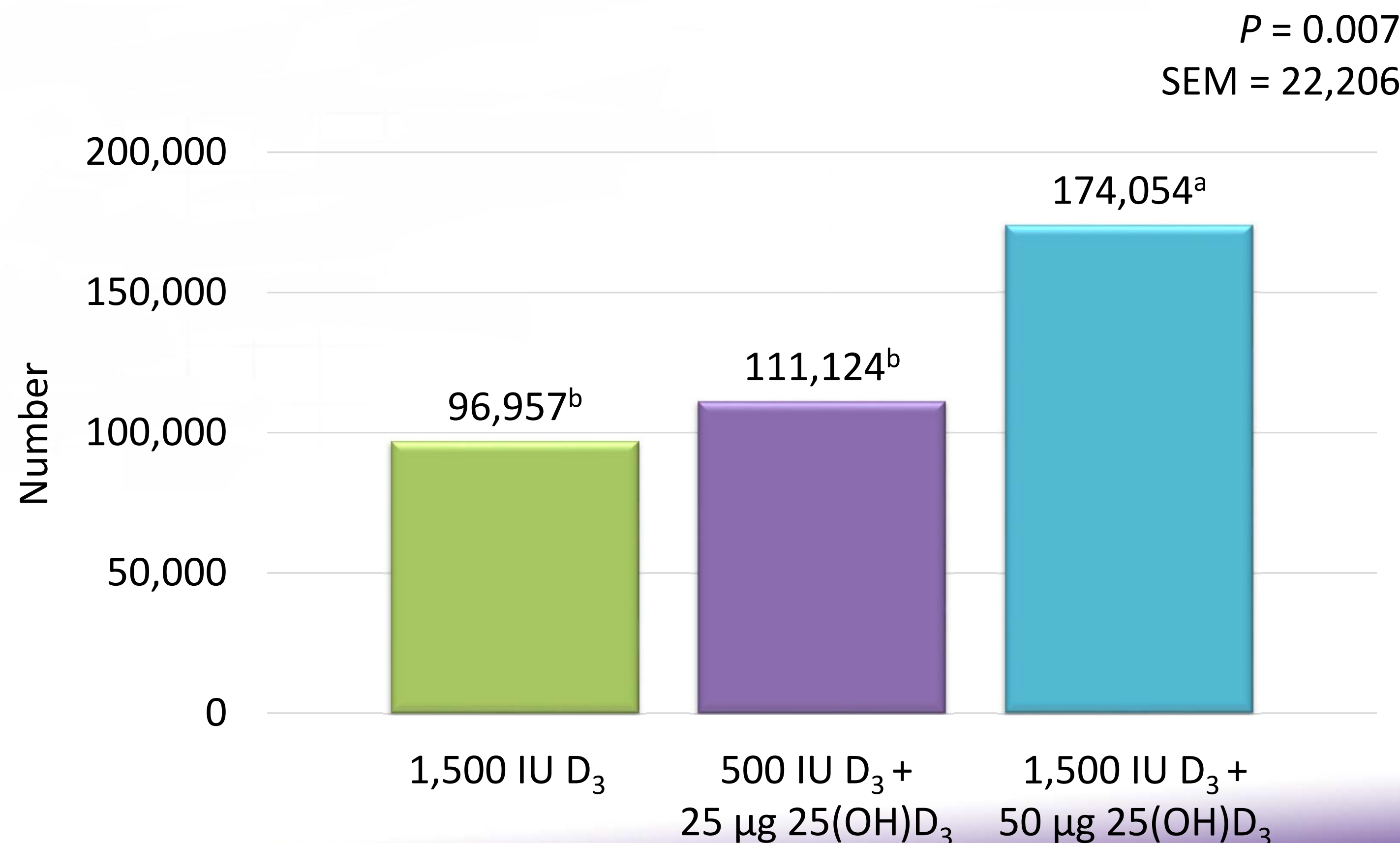
Immunohistochemistry
Birth



Immunohistochemistry
Weaning

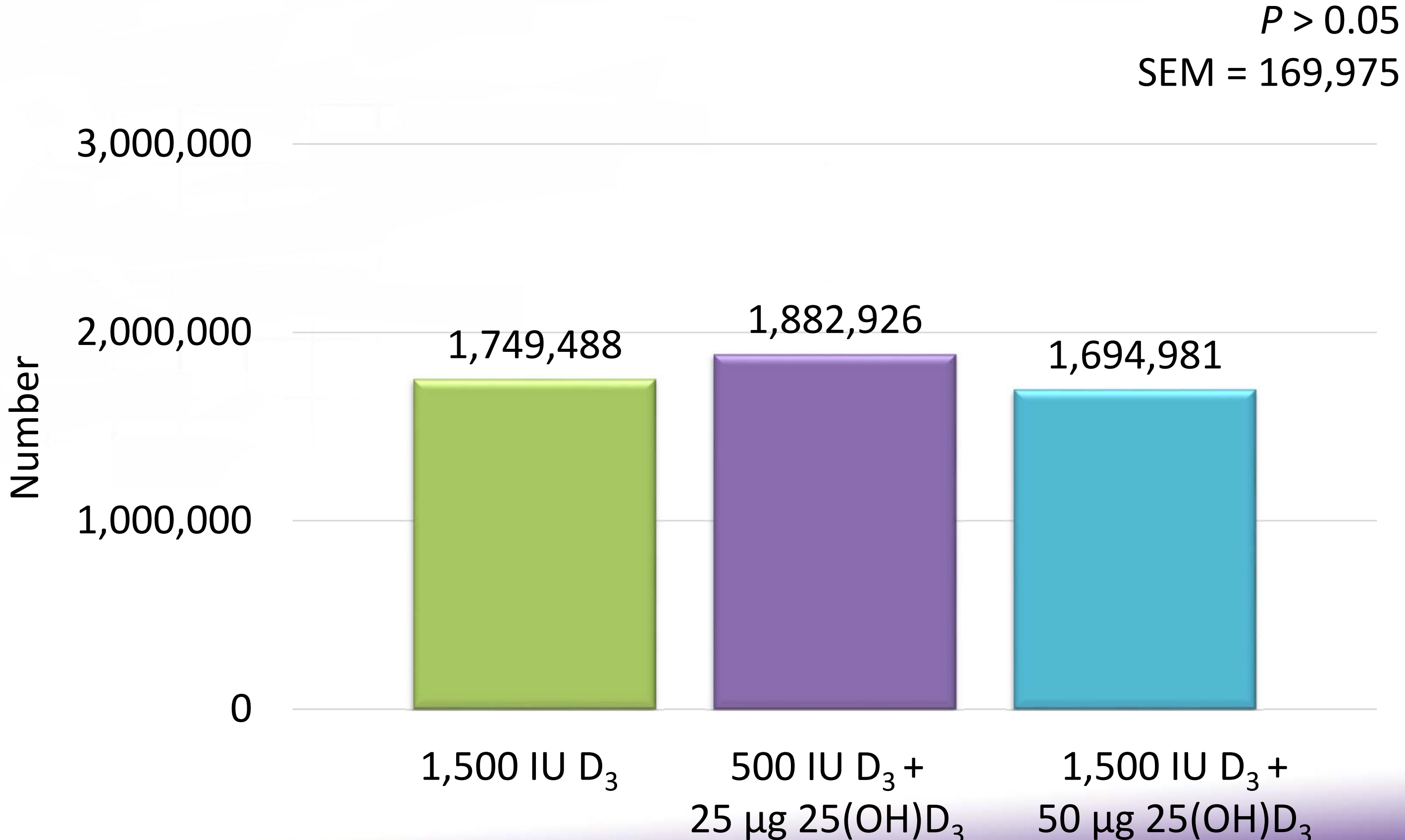


Primary Muscle Fiber Number
Birth



[ab]Means with different superscripts differ ($P < 0.05$)

Secondary Muscle Fiber Number
Birth



[ab]Means with different superscripts differ ($P < 0.05$)

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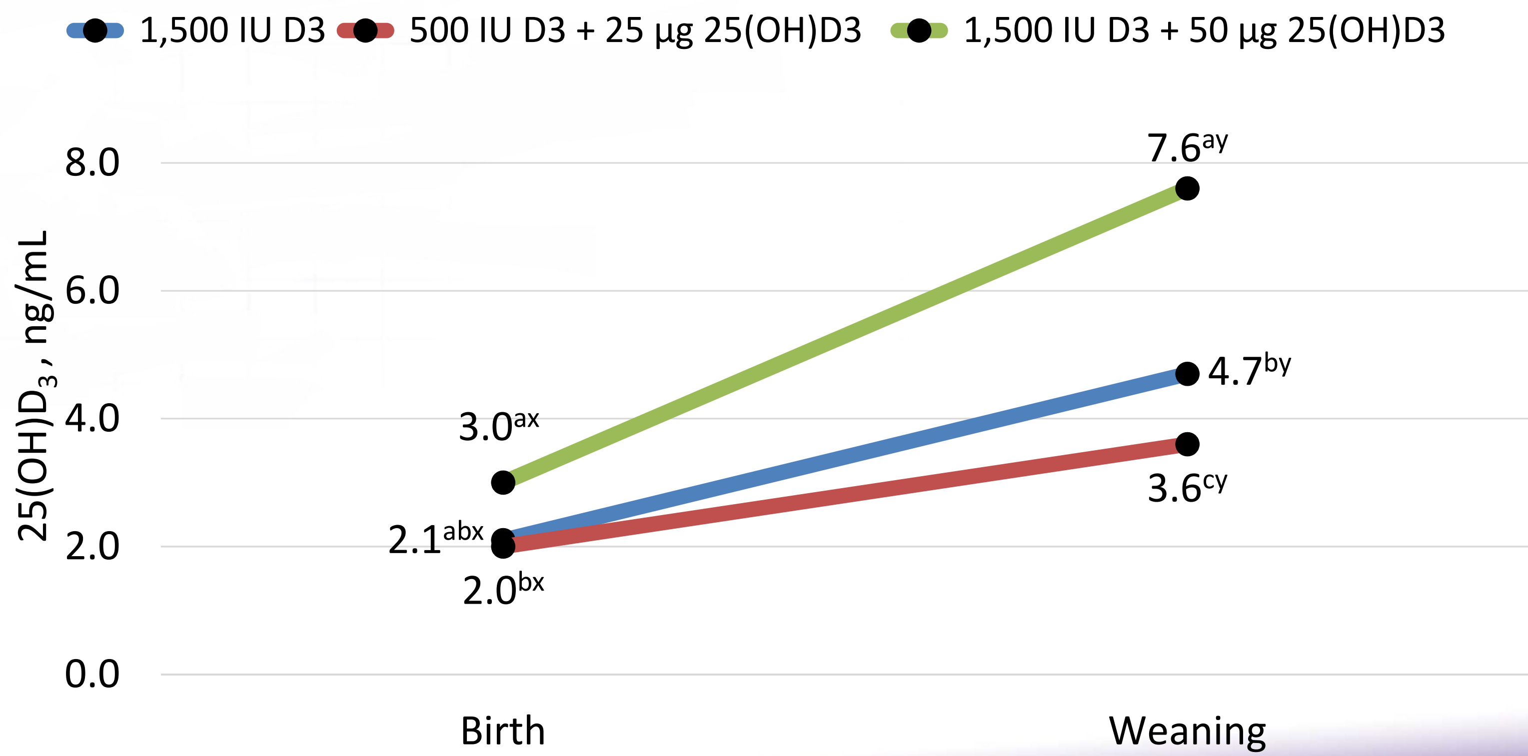
Piglet Serum 25(OH)D_3

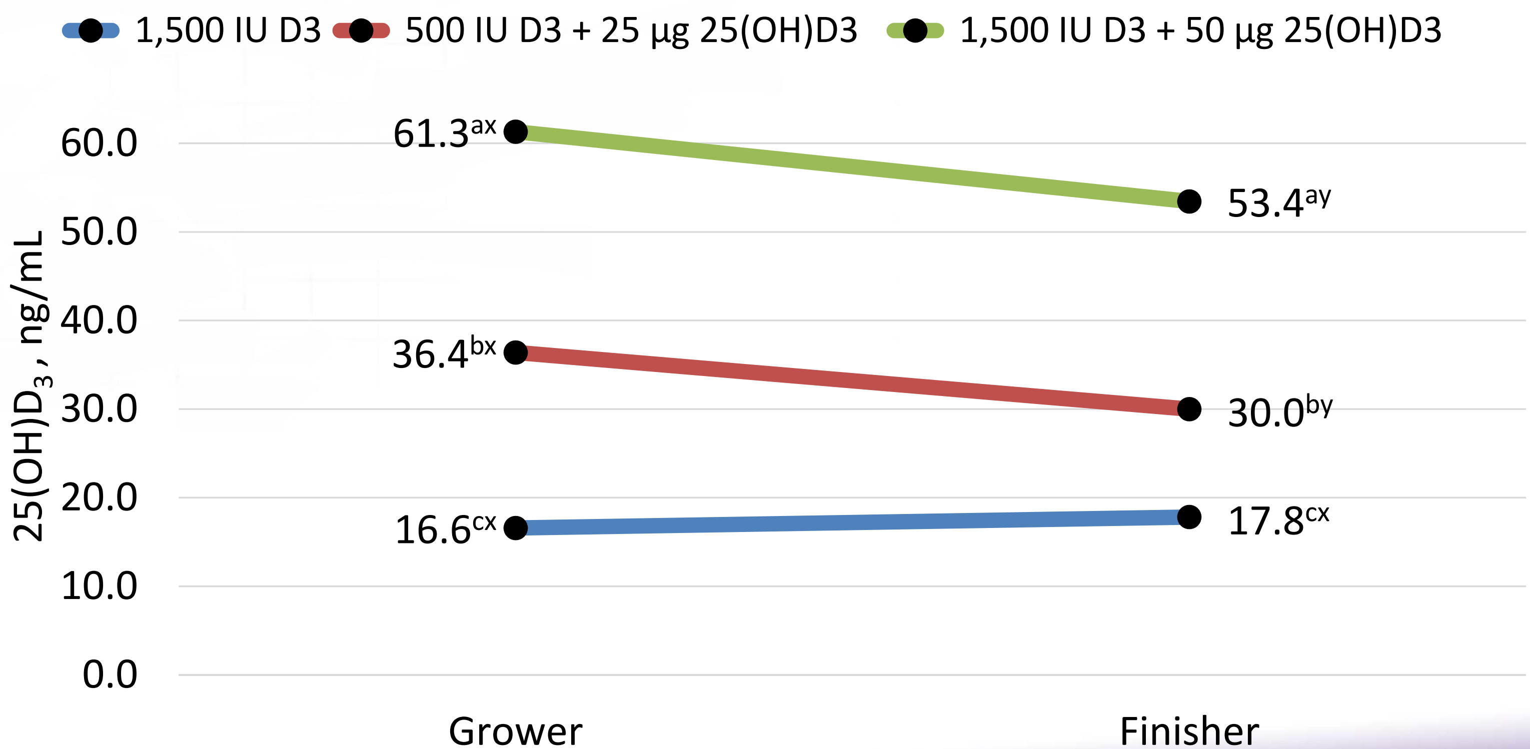
Trt × Time, $P < 0.001$
Trt, $P < 0.001$
Time, $P < 0.001$
SEM = 0.27



^{xyz}Indicates an effect of time within treatment ($P < 0.05$)
^{abc}Indicates an effect of treatment at that time point ($P < 0.05$)

Pig Serum 25(OH)D_3

Trt × Time, $P < 0.001$
Trt, $P < 0.001$
Time, $P < 0.001$
SEM = 1.76



^{xyz}Indicates an effect of time within treatment ($P < 0.05$)
^{abc}Indicates an effect of treatment at that time point ($P < 0.05$)

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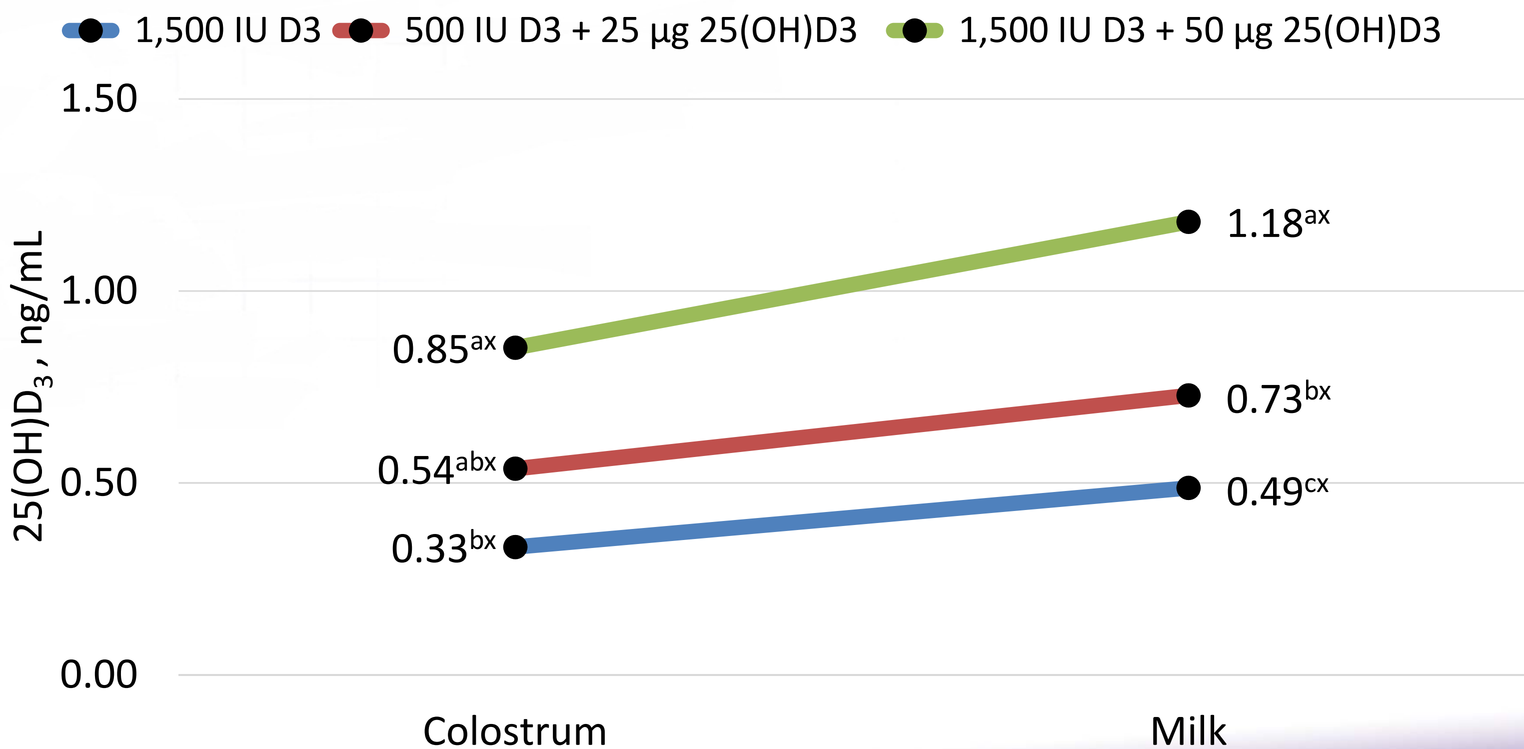
Colostrum/Milk 25(OH)D_3

Trt × Time, $P = 0.518$
Trt, $P < 0.001$
Time, $P = 0.001$
SEM = 0.09



xyzIndicates an effect of time within treatment ($P < 0.05$)
abcIndicates an effect of treatment at that time point ($P < 0.05$)

Discussion

- No effect on sow and litter performance due to ⇧ vitamin D

- ⇧ Primary muscle fiber number in piglets at birth from sows fed 1,500 IU D_3 + 50 µg 25(OH)D_3 compared to others
  - longer prenatal period of primary myogenesis which delayed the onset of secondary myogenesis

Discussion

- Milk concentrations of 25(OH)D_3 ⇧ above the colostrum 25(OH)D_3
  - ⇧ milk 25(OH)D_3 concentrations consumed by the piglets contributed to the increase in progeny vitamin D_3 status from birth to weaning

Conclusion

- Combining vitamin D_3 + 25(OH)D_3 in the maternal diet:
  - Improves vitamin D_3 status of the dam and progeny
  - Increases primary muscle fibers at birth
  - Does not change growth performance to market

- To our knowledge, this is the first study investigating the effect of improving maternal vitamin D status on serum 24,25$(OH)_2D_3$ of the piglets

Implications

- Feeding combinations of vitamin D_3 and 25(OH)D_3 may eliminate the practice of orally dosing newborn piglets and could potentially improve carcass characteristics