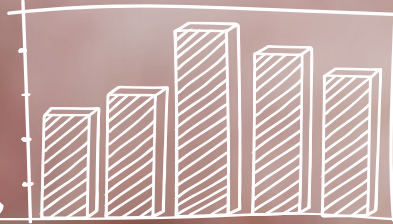


OVN Optimum Vitamin Nutrition[®] Guidelines 2022



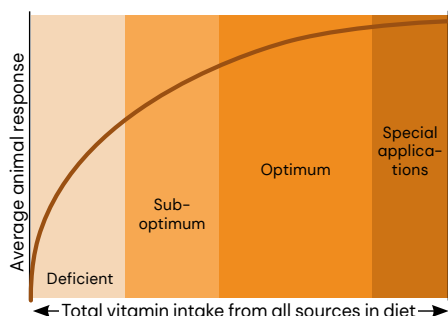
Check and adjust vitamin levels for more sustainable swine farming.

Vitamins Contribute to More Sustainable Farming

Continuous advancements in swine nutrition are essential to address opportunities and challenges of modern meat production, including countering the rise of antibiotic resistance, reducing aggressive animal diseases and making farming more sustainable in alignment with the United Nations Sustainable Development Goals (SDGs). We at dsm-firmenich believe that supporting nutrition with appropriate vitamins can help make production more sustainable (SDG 12, 13) and help get the world closer to zero hunger (SDG 2) as well as healthy lives (SDG 3).

Our Vision for Vitamin Nutrition

With these SDGs in mind, we believe that every single pig should receive the right level of vitamins. The reason is simple: vitamins are the foundation for balanced swine nutrition.



OVN Optimum Vitamin Nutrition® is about feeding pigs high quality vitamins, produced with the lowest environmental footprint, in the right amounts, appropriate to their life stage and growing conditions, to optimize:

- **Animal Health and Welfare**
 - ▶ good for animals
- **Animal Performance**
 - ▶ good for farmers
- **Food Quality & Food Waste**
 - ▶ good for consumers and the planet

To accomplish this, we are intensely engaged in research and development, and we focus on partnering with all important stakeholders – leading scientists, universities, genetic companies, independent research institutes and producers. This enables us to develop and produce a complete line of high quality vitamins and support the feed industry with our Vitamin Supplementation Guidelines.

All ingredients in animal feed are regularly evaluated and likewise vitamin levels require the same degree of attention. We therefore encourage the swine feed industry and all other stakeholders to **check** the vitamin levels in their pig feed and **adjust** them accordingly **for more sustainable farming**.

Guidelines for OVN Optimum Vitamin Nutrition®

dsm-firmenich Vitamin Supplementation Guidelines are designed to provide OVN Optimum Vitamin Nutrition® of animals under commercial industry practice.



OVN Optimum Vitamin Nutrition® is a cost-effective range of vitamin supplementation optimizing animal health and wellbeing, animal performance and the quality and nutritional value of animal-origin foods. The supplementation levels required to attain Optimum Vitamin Nutrition generally exceed the levels needed to prevent signs of clinical deficiency. OVN Optimum Vitamin Nutrition® levels compensate for the many factors which can influence pigs' requirements and corresponding feed levels, thus ensuring that vitamin fortification does not limit performance. OVN Optimum Vitamin Nutrition® levels are ranges for consideration, depending on several factors, such as health status and husbandry conditions. They are based on extensive university and industry research, published requirements and practical experience. All OVN Optimum Vitamin Nutrition® levels are expressed in terms of vitamin activity to be added per kg of feed.

The vitamin amounts stated are those which should be provided to the pig in the feed at the point of consumption. Additional vitamins should be added to the product to account for processing and shelf-life storage losses to achieve the targeted consumption amounts of vitamins. These losses can be variable. Please ask your local dsm-firmenich representative for information about typical levels of process and storage loss.

For some vitamins additional supplementation is indicated: these levels are safe and focused on improving certain attributes e.g. immunity, welfare and metabolic efficiency. The listed vitamin levels are only guidelines and, in all cases, national feed legislation must be followed.

Main Functions of Vitamins and Symptoms of Deficiency in Swine

Vitamin	Basic function(s)	Deficiency disorders/diseases
Vitamin A	<ul style="list-style-type: none"> Essential for growth, health (immunity), reproduction (steroid synthesis), vision, development and integrity of skin, epithelia and mucosa 	<ul style="list-style-type: none"> Blindness or night-blindness (xerophthalmia) Loss of appetite, poor absorption of nutrients, decreased growth and, in severe cases, death Reduced immune response and increased risk of infections (respiratory and intestinal) Reproduction defects such as failure of spermatogenesis in the male and fetal resorption or death in the female swine. Dry and scaly skin Keratinization of epithelial tissues
Vitamin D ₃	<ul style="list-style-type: none"> Homeostasis of calcium and phosphorus (intestine, bones and kidney) Regulation of bones calcification Modulation of the immune system Muscular cell growth 	<ul style="list-style-type: none"> Rickets and osteomalacia Bone disorders (e.g., soft bones) and lameness Stiff and hesitant gait Reduced growth rate Muscular weakness
25OHD ₃	<ul style="list-style-type: none"> Major serum metabolite of vitamin D₃ More efficient absorption in the intestine Faster response for calcium homeostasis More efficient modulation of immune system and muscular cells than vitamin D₃ 	<ul style="list-style-type: none"> Rickets and osteomalacia Bone disorders (e.g., soft bones) and lameness Stiff and hesitant gait Reduced growth rate Muscular weakness
Vitamin E	<ul style="list-style-type: none"> Most powerful fat-soluble antioxidant Immune system modulation Tissue protection Fertility Meat quality 	<ul style="list-style-type: none"> Muscular dystrophy and myopathy Mulberry heart disease Reduced immune response Reduced fertility and Mastitis, Metritis and Agalactia (MMA) in sows Meat quality defects: drip-loss, off-flavours
Vitamin K ₃	<ul style="list-style-type: none"> Blood clotting and coagulation Coenzyme in metabolic process related to bone mineralization (Ca binding proteins) and protein formation 	<ul style="list-style-type: none"> Increased clotting time Haemorrhages diseases, anaemia and weakness Bone disorders Hematomas or blood swelling in the ears
Vitamin B ₁	<ul style="list-style-type: none"> Coenzyme in several enzymatic reactions Carbohydrate metabolism (conversion of glucose into energy) Involved in ATP, DNA and RNA production Synthesis of acetylcholine, essential in transmission of nervous impulses 	<ul style="list-style-type: none"> Loss of appetite up to anorexia and vomiting Reduced growth rate Neuropathies (polioencephalomalacia-PEM), general muscle weakness, poor leg coordination Fatty degeneration and necrosis of heart fibers (cardiac failure) Mucosal inflammation with gastrointestinal malfunction
Vitamin B ₂	<ul style="list-style-type: none"> Fat and protein metabolism Flavin coenzyme (FMN and FAD) synthesis, essentials for energy production (respiratory chain) Involved in synthesis of steroids, red blood cells and glycogen Integrity of mucosa membranes and antioxidant system within cells 	<ul style="list-style-type: none"> Reduced feed intake and growth Reduced absorption of zinc, iron and calcium Inflammation of the mucous membranes of digestive tract Scours and ulcerative colitis Fertility impairments
Vitamin B ₆	<ul style="list-style-type: none"> Aminoacids, fats and carbohydrate metabolism Essential for DNA and RNA synthesis Involved in the synthesis of niacin from tryptophan 	<ul style="list-style-type: none"> Growth retardation, lesser feed intake and protein retention Dermatitis, rough hair coat, scaly skin Disorders of blood parameters Brown exudate of the eyes Anaemia and ascites Muscular convulsions, incoordination of movements and paralysis
Vitamin B ₁₂	<ul style="list-style-type: none"> Synthesis of red blood cells and growth Involved in methionine metabolism Coenzyme in nucleic acids (DNA and RNA) and protein metabolism Metabolism of fats and carbohydrates 	<ul style="list-style-type: none"> Anaemia Growth retardation and lower feed conversion Leg weakness Embryo mortality, reduced piglet survival
Niacin or Vitamin B ₃	<ul style="list-style-type: none"> Coenzyme (active forms NAD and NADP) in amino acids, fats and carbohydrates metabolism Required for optimum tissue integrity, particularly for the skin, the gastrointestinal tract and the nervous system 	<ul style="list-style-type: none"> Nervous system disorders Inflammation and ulcers of mucous membranes Reduced growth and feed efficiency Dermatitis (pellagra), hair loss Ulcerative necrotic lesions of the large intestine, diarrhoea Reduced reproductive performance
Biotin or Vitamin B ₇	<ul style="list-style-type: none"> Coenzyme in protein, fat and carbohydrates metabolism Normal blood glucose level Synthesis of fatty acids, nucleic acids (DNA and RNA) and proteins (keratin) 	<ul style="list-style-type: none"> Reduced appetite, retarded growth Fertility disorders Skin ulcers, alopecia, hair loss and dermatitis Inflammation of the hooves and hoof-sole lesions Diarrhoea, eye inflammation and changes in oral mucosa
d-Pantothenic acid or Vitamin B ₅	<ul style="list-style-type: none"> Present in Coenzyme A (CoA) and Acyl Carrier Protein (ACP) involved in carbohydrate, fat and protein metabolism Biosynthesis of long-chain fatty acids, phospholipids and steroid hormones 	<ul style="list-style-type: none"> Functional disorders of nervous system Locomotive disorders Scaly skin, dermatitis Fatty degeneration of the liver Reduced antibody formation Reduced appetite, poor feed utilization and growth depression
Folic acid or Vitamin B ₉	<ul style="list-style-type: none"> Coenzyme in the synthesis of nucleic acids (DNA and RNA) and proteins (methyl groups) Stimulates hematopoietic system With vitamin B₁₂ it converts homocysteine into methionine 	<ul style="list-style-type: none"> Megaloblastic (macrocytic) anemia Skin damages and hair loss Retarded growth and reduced appetite Compromised reproduction in sows Embryonic mortality and smaller litter size
Vitamin C	<ul style="list-style-type: none"> Intracellular (water-soluble) antioxidant Immune system modulation: stimulation of phagocytosis Collagen biosynthesis Formation of connective tissues, cartilage and bones Synthesis of corticosteroids and steroid metabolism Conversion of vitamin D₃ to its active form 1,25(OH)₂D₃ 	<ul style="list-style-type: none"> Weakness, fatigue and dyspnea Bone pain Haemorrhages of the skin, muscle and certain organs Reduced fertility in both males (reduced sperm quality) and females (termination of corpus luteum)
Choline	<ul style="list-style-type: none"> Membrane structural component (phosphatidylcholine) Fat transport and metabolism in the liver Support nervous system function (acetylcholine) Source of methyl donors for methionine regeneration from homocysteine 	<ul style="list-style-type: none"> Fatty liver Growth retardation
β-carotene	<ul style="list-style-type: none"> Source of vitamin A Stimulation of progesterone synthesis Reproductive system function 	<ul style="list-style-type: none"> Poor reproductive performance e.g., prolonged estrus, retarded follicle maturation and ovulation Increased susceptibility of young animals to infectious diseases

Category/phase		Duration	Vitamin A	Vitamin D ₃	25OHD ₃ (Hy-D ³)	Vitamin E ²	Vitamin K	Vitamin B ₁	Vitamin B ₂	Vitamin B ₆	Vitamin B ₁₂ ⁶	Niacin	Biotin	d-Pantothenic acid	Folic acid	Vitamin C ⁷	Choline	β-carotene
Units			IU	IU	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg
	Fattening pigs																	
	Pre-starter	< 5 kg	10,500 – 22,500	1,890 – 2,100	0.05	105 – 160 ³	8.5 – 11	3.8 – 5.8	10.5 – 16	6.4 – 8.4	0.052 – 0.072	63 – 84	0.32 – 0.52	32 – 52	1.6 – 3.3	210 – 260	525 – 840	-
	Starter	5 – 30 kg	10,500 – 16,000	1,890 – 2,100	0.05	105 – 160 ³	5.2 – 6.4	3.2 – 5.2	10.5 – 16	6.4 – 8.4	0.042 – 0.062	38 – 58	0.32 – 0.52	26 – 46	1.6 – 2.6	105 – 210	260 – 420	-
	Grower	30 – 70 kg	7,350 – 10,500	1,570 – 2,100	0.05	64 – 105 ⁴	2.1 – 4.2	2.1 – 3.1	7.3 – 10.5	2.6 – 4.7	0.032 – 0.052	21 – 50	0.2 – 0.4	26 – 47	1.1 – 1.6	-	157 – 315	-
Finisher	70 kg to market	5,250 – 8,400	1,050 – 1,570	0.05	64 – 105 ⁴	2.1 – 4.2	1.1 – 2.1	6.3 – 10.5	2.1 – 3.7	0.032 – 0.052	21 – 42	0.105 – 0.21	26 – 47	0.52 – 1.05	-	105 – 210	-	
	Breeders																	
	Replacement gilts	-	10,500 – 13,100	1,900 – 2,100	0.05	84 – 105	2.5 – 4.4	1.05 – 2.2	6.3 – 10.5	5.3 – 8.4	0.032 – 0.052	30 – 50	0.32 – 0.52	16 – 33	3.7 – 5.7	210 – 315	270 – 525	-
	Sows	Gestation	10,500 – 15,700	1,570 – 2,100	0.05	105 – 160 ⁵	4.7 – 5.2	2.1 – 2.6	6.3 – 10.5	3.7 – 5.7	0.032 – 0.052	32 – 47	0.52 – 0.84	37 – 42	3.7 – 5.7	210 – 315	525 – 840	-
		Lactation	10,500 – 15,700	1,570 – 2,100	0.05	105 – 190 ⁵	4.7 – 5.2	2.1 – 3	6.3 – 10.5	3.7 – 5.7	0.032 – 0.052	40 – 100	0.52 – 0.84	37 – 42	3.7 – 5.7	210 – 315	525 – 840	300 ⁸
Boars	-	10,500 – 15,700	1,570 – 2,100	0.05	105 – 160	4.7 – 5.2	1.05 – 2.2	6.3 – 10.5	3.7 – 5.7	0.032 – 0.052	32 – 47	0.52 – 0.84	21 – 33	3.7 – 5.7	210 – 525	525 – 840	-	

¹ Added per kg air-dried feed. Local limits need to be observed. OVN™ levels are ranges for consideration, depending on several factors, such as husbandry conditions and health status.

² When dietary fat is higher than 3% then add 5 mg/kg feed for each 1% dietary fat

³ For optimum immune function increase level up to 250 mg/kg

⁴ For optimum meat quality increase level up to 250 mg/kg for 90 to 120 days before slaughter

⁵ For optimum piglet health increase level up to 250 mg/kg during late pregnancy and lactation

⁶ Use upper level as reference for animal protein free diets and when cobalt is supplemented at very low levels or removed

⁷ Recommended under heat stress condition and to enhance reproductive performance in breeders. Use ROVIMIX® STAY-C35 for reducing loss during feed processing

⁸ For improved sow fertility the suggested level must be fed **per animal per day** immediately after weaning until confirmed conception



Conversion Factors and Standard dsm-firmenich Vitamins for Swine

Vitamin (active substance)	Unit	Conversion factor active substance form to vitamin form	Product form	Content (min.)	Formulation technology	Application*
Vitamin A (retinol)	IU	1 IU Vitamin A = 0.344 µg Vitamin A acetate (retinyl acetate)	ROVIMIX® A 1000	1,000,000 IU/g	Beadlet	M, P, EXP, EXT
			ROVIMIX® A 500 WS	500,000 IU/g	Spray-dried powder, water dispersible	W/MR
			ROVIMIX® A Palmitate 1.6	1,600,000 IU/g	Oily liquid, may crystallize on storage	Oily solution
			ROVIMIX® AD3 1000/200	Vitamin A 1,000,000 IU/g Vitamin D3 200,000 IU/g	Beadlet	M, P, EXP, EXT
Vitamin D3 (cholecalciferol)	IU	1 IU Vitamin D3 = 0.025 µg Vitamin D3	ROVIMIX® D3-500	500,000 IU/g	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
			ROVIMIX® AD3 1000/200	Vitamin A 1,000,000 IU/g Vitamin D3 200,000 IU/g	Beadlet	M, P, EXP, EXT
25OHD3 (25 hydroxy-cholecalciferol)	mg	1 µg 25OHD3 = 40 IU Vitamin D3	ROVIMIX® Hy-D® 1.25%	1.25% 25OHD3 (12.5 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
Vitamin E (tocopherol)	mg	1 mg Vitamin E = 1 IU Vitamin E = 1 mg all-rac-α-tocopheryl acetate	ROVIMIX® E-50 Adsorbate	50% (500 g/kg)	Adsorbate on silicic acid	M, P, EXP, EXT
			ROVIMIX® E 50 SD	50% (500 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
Vitamin K3 (menadione)	mg	1 mg of Vitamin K3 = 2 mg of Menadione Sodium Bisulfite (MSB)	K3 MSB	Menadione: 51.5% (515 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W/MR
		1 mg of Vitamin K3 = 2.3 mg of Menadione Nicotinamide Bisulfite (MNB)	ROVIMIX® K3 MNB	Menadione: 43% (430 g/kg) Nicotinamide: 30.5% (305 g/kg)	Fine crystalline powder	M, P, EXP, EXT
Vitamin B1 (thiamine)	mg	1 mg of Vitamin B1 = 1.233 mg of Thiamine mononitrate	ROVIMIX® B1	98% (980 g/kg)	Fine crystalline powder	M, P, EXP, EXT
Vitamin B2 (riboflavin)	mg		ROVIMIX® B2 80-SD	80% (800 g/kg)	Spray-dried powder	M, P, EXP, EXT, W/MR
Vitamin B6 (pyridoxine)	mg	1 mg Vitamin B6 = 1.215 mg Pyridoxine hydrochloride	ROVIMIX® B6	99% (990 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W/MR
Vitamin B12 (cyanocobalamin)	mg		Vitamin B12 1% Feed Grade	1% (10 g/kg)	Fine powder	M, P, EXP, EXT
			ROVIMIX® B12 1% Feed Grade	1% (10 g/kg)	Spray-dried powder	M, P, EXP, EXT
Vitamin B3 (Niacin; nicotinic acid and nicotinamide)	mg	1 mg Nicotinic acid = 1 mg Niacin	ROVIMIX® Niacin	99.5% (995 g/kg)	Fine crystalline powder	M, P, EXP, EXT
		1 mg Nicotinamide (or Niacinamide) = 1 mg Niacin	ROVIMIX® Niacinamide	99.5% (995 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W/MR
Vitamin B7 (d-Biotin)	mg	1 mg of Biotin = 1 mg D-Biotin	ROVIMIX® Biotin ROVIMIX® Biotin HP	2% (20 g/kg) 10% (100 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
Vitamin B5 (d-Pantothenic acid)	mg	1 mg d-Pantothenic acid = 1.087 mg Calcium d-pantothenate or 2.174 mg Calcium dl-pantothenate	ROVIMIX® Calpan	98% Calcium d-pantothenate (980 g/kg) Calcium 8.2 – 8.6% (82 – 86 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
Vitamin B9 (Folic acid)	mg		ROVIMIX® Folic 80 SD	80% (800 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W/MR
Vitamin C	mg	1 mg Vitamin C = 1 mg L-Ascorbic acid	STAY-C® 35	35% of total phosphorylated ascorbic acid activity (350 g/kg)	Spray-dried powder	M, P, EXP, EXT
			STAY-C® 50	50% of total phosphorylated sodium salt ascorbic acid activity (500 g/kg)	Spray-dried powder	M, P, EXP, EXT, W/MR
			ROVIMIX® C-EC	97.5% (975 g/kg)	Ethyl-cellulose coated powder	M, P, W/MR
			Ascorbic acid	99 – 100% (990 – 1000 g/kg)	Crystalline powder	W/MR
β-Carotene	mg		ROVIMIX® β-Carotene 10%	10% (100 g/kg)	Encapsulated beadlet	M, P, EXP, EXT
			ROVIMIX® β-Carotene 10% P	10% (100 g/kg)	Cross linked beadlet	M, P, EXP, EXT

* M: Mash; P: Pellet; EXP: Expansion; EXT: Extrusion; W: Water

For more information about further dsm-firmenich products and product forms please ask your local dsm-firmenich representative

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