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dsm-firmenich

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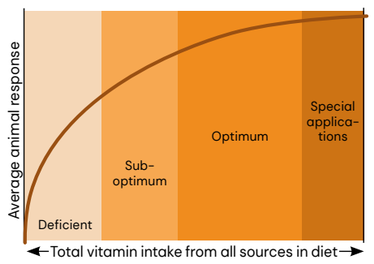
We bring progress to life

Vitamins Contribute to More Sustainable Farming

Continuous advancements in ruminant nutrition are essential to address opportunities and challenges of modern milk and 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 dairy cows, beef and other ruminants 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 animal should receive the right level of vitamins. The reason is simple: vitamins are the foundation for balanced animal nutrition.



OVN Optimum Vitamin Nutrition® is about feeding animals 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, genetics companies, independent research institutes and farmers. 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 aqua feed industry and all other stakeholders to **check** the vitamin levels in their animal 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 typical 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 animals' 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 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 to diet, amounts given are usually per head per day.

The vitamin amounts stated are those which should be provided to the animal 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. milk and meat quality and immunity. 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 Ruminants

Vitamin	Main functions	Deficiency symptoms
Vitamin A	• Essential for growth, health (immunity), reproduction (steroid synthesis), vision, development and integrity of skin, epithelia and mucosa	• Blindness or night-blindness (xeropthalmia) • Loss of appetite, poor absorption of nutrients, impaired growth and, in severe cases, death • Reproduction defects like failure of spermatogenesis and fetal resorption or death • Increased risk of infections (respiratory and intestinal) • Keratinization of epithelial tissues
Vitamin D_3	• Homeostasis of calcium and phosphorus (intestine, bones and kidney) • Regulation of bones calcification • Modulation of the immune system • Muscular cell growth	• Rickets, osteomalacia and bone disorders • Lameness • Growth retardation • Muscular weakness and occasionally tetany
$25OHD_3$	• Major serum metabolite of vitamin D_3 • More efficient absorption in the intestine • Faster response for calcium homeostasis • More efficient modulation of immune system and muscular cells than vitamin D_3	• Transition cow health (calcium homeostasis) • Colostrum quality • Calf health
Vitamin E	• Most powerful fat-soluble antioxidant • Immune system modulation • Tissue protection • Fertility • Meat quality	• Muscular dystrophy and myopathy • Reduced immune response • Increased mastitis incidence • Retained placenta • Fertility disorders • Meat quality/color case-life problems
Vitamin K_3	• Blood clotting and coagulation • Coenzyme in metabolic process related to bone mineralization (Ca binding proteins)	• Increased clotting time • Hemorrhages • Anemia • Bone disorders
Vitamin B_1	• 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	• Loss of appetite up to anorexia • Growth retardation • Neuropathies and general muscle weakness • Poor leg coordination • Mucosal inflammation
Vitamin B_2	• Fat and protein metabolism • Flavin coenzyme (FMN and FAD) essential for energy production (respiratory chain) • Involved in synthesis of steroids, red blood cells and glycogen • Integrity of mucosa membranes and antioxidant system within cells	• Reduced feed intake and growth • Reduced absorption of zinc, iron and calcium • Inflammation of the mucous membranes (corner of the mouth) of the digestive tract • Rough hair coat, dermatitis and alopecia • More severe in young ruminants
Vitamin B_6	• Aminoacids, fats and carbohydrate metabolism • Essential for DNA and RNA synthesis • Involved in the synthesis of niacin from tryptophan	• Growth retardation, lesser feed intake and protein retention • Dermatitis, rough hair coat, scaly skin • Disorders of blood parameters • Muscular convulsions followed by paralysis
Vitamin B_{12}	• Synthesis of red blood cells and growth • Essential in utilization of propionic acid (and thus the production of glucose and lactose) • Involved in methionine metabolism • Coenzyme in nucleic acids (DNA and RNA) and protein metabolism • Metabolism of fats and carbohydrates	• Anaemia • Reduced milk yield in diets with low cobalt supply • Growth retardation and lower feed conversion • Reduced production of DNA and RNA • Leg weakness • Increased excitability
Niacin or Vitamin B_3	• Coenzyme (active forms NAD and NADP) in aminoacids, fats and carbohydrates metabolism • Required for optimum tissue integrity, particularly for the skin, the gastrointestinal tract and the nervous system	• Nervous system disorders • Skin and hair disorders • Inflammation and ulcers of mucous membranes • Ulcerative necrotic lesions of the large intestine • Reduced milk yield and feed efficiency • Increased risk of ketosis • Reduced reproductive performance
Biotin or Vitamin B_7	• Coenzyme in protein, fat and carbohydrates metabolism • Normal blood glucose level • Synthesis of fatty acids, nucleic acids (DNA and RNA) and proteins (keratin)	• Loss of appetite and growth retardation • Foot problems including brittle horns and cracks in hooves • Dermatitis • Fertility disorders
d-Pantoth-enic acid or Vitamin B_5	• 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	• Skin disorders • Fatty liver • Functional disorders of nervous system • Loss of appetite and poor feed utilization
Folic acid or Vitamin B_9	• Coenzyme in the synthesis of nucleic acids (DNA and RNA) and proteins (methyl groups) • Stimulates hematopoietic system • With vitamin B_{12} it converts homocysteine into methionine	• Megaloblastic (macrocytic) anaemia • Skin damages and hair loss • Fertility disorders • Loss of appetite and growth retardation
Vitamin C	• Intracellular (water-soluble) antioxidant • Immune system modulation (phagocytosis stimulation) • Collagen biosynthesis • Formation of connective tissues, cartilage and bones • Synthesis of corticosteroids and steroid metabolism • Conversion of vitamin D_3 to its active form $1,25(OH)2D_3$	• Lower resistance to stress (e.g., low/high temperatures) • Weakness and fatigue • Reduced immune response • Haemorrhages of the skin, muscles and adipose tissues
Choline	• 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	• Fatty liver • Reduced milk yield, milk fat and protein • Ketosis • Growth retardation • Carcass characteristics
β-Carotene	• Antioxidant • Source of vitamin A • Stimulation of progesterone synthesis • Reproductive tissue maintenance and function	• Poor reproduction: prolonged estrus, retarded follicle maturation and ovulation, cysts • Embryo losses and early abortion • Poor colostrum quality • Increased somatic cell counts in milk

Ruminants[1]

OVN Optimum Vitamin Nutrition®

Category/phase		Vitamin A[4]	Vitamin D_3[4]	25OHD_3[4] (Hy-D®)	Vitamin E	Vitamin K_3	Vitamin B_1	Vitamin B_2	Vitamin B_6	Vitamin B_{12}	Niacin	Biotin	d-Pan-tothenic acid	Folic acid	Vitamin C	Choline	β–Carotene
Units		IU	IU	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg
	Calves																
	Milk replacer (0–3 months)	20,000 – 32,000	2,000 – 4,000		150 – 200	1.0 – 1.5	2.5 – 5.0	2.5 – 4.5	2.5 – 4.5	0.04 – 0.08	9.0 – 18.0	0.05 – 0.1	7.0 – 9.0	0.2 – 0.3	250 – 500	500 – 750	100[14]
	Starter dry feed	7,500 – 10,000	2,200 – 3,000		135 – 200												
	Heifers (dairy replacement)																
	Growing	20,000 – 60,000	6,000 – 16,350		300 – 500							10 – 20[12]					300 – 500[15]
	4–6 weeks precalving	80,000 – 100,000	20,000 – 25,000	3[5]	2,000 – 3,000						6,000 – 12,000[11]	20[12]					500 – 1,000[16]
	Beef Cattle																
	Growing	25,000 – 50,000	6,000 – 9,000		200 – 300		60 – 250[9]					10 – 20[12]					
	Fattening and finishing	40,000 – 80,000	5,000 – 7,000	1	500 – 2,000[6]		60 – 250[9]					10 – 20[12]					
	Beef cows	40,000 – 70,000	5,000 – 10,000		350 – 500							20[12]					300 – 500[15]
	Dairy cows																
	Dry cows, far–off[2]	80,000 – 120,000	25,000 – 30,000		1,100 – 4,000[7]						6,000 – 12,000	20 – 40[13]					500 – 1,000[17]
	Dry cows, close–up[3]	80,000 – 120,000	25,000 – 30,000	3[5]	2,000 – 4,000[7]						6,000 – 12,000	20 – 40[13]					500 – 1,000[16]
	Lactation	100,000 – 150,000	25,000 – 40,000	1	600 – 1,000[8]						6,000 – 12,000[11]	20 – 40[13]					300 – 500[18]
	Breeding bulls	50,000 – 80,000	5,000 – 10,000		300 – 500							20[12]					
	Sheep and goats	10,000 – 15,000	400 – 600		300 – 600		200[10]					5[12]					30 – 50

[1] Supplementary amount/head/day except **calves** amount/kg air-dried feed. OVN™ levels are ranges for consideration, depending on several factors, such as husbandry conditions and health status.
[2] From dry-off to 4 weeks before calving
[3] From 3 weeks before calving to calving
[4] Local limits need to be observed
[5] 3 weeks before calving
[6] Upper level for improved color case-life, 100 to 120 days pre-slaughter
[7] Upper level from 3 weeks pre-partum until 4 weeks post-partum
[8] Upper level for optimum udder health
[9] Upper level for cattle on high concentrate rations
[10] In high concentrate diets
[11] From 2 weeks before calving until peak lactation
[12] For optimum hoof health and optimum meat marbling
[13] For optimum hoof health and milk yield
[14] For 2 weeks after colostral period
[15] 6-8 weeks before 1st insemination/mating when intake of green forage is low
[16] Lower level 8 weeks before 1st calving, upper level 4 weeks before 1st calving when intake of green forage is low
[17] Lower level during entire dry period (Far-off and Close-Up); upper level 3-4 weeks before calving (close-up only)
[18] Dry and fresh beginning during the dry period until pregnancy is confirmed

Conversion Factors and Standard dsm-firmenich Vitamins for Ruminants

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	MR/W
			ROVIMIX® A Palmitate 1.6	1,600,000 IU/g	Oily liquid, may crystalize on storage	Oily solution
			ROVIMIX® AD3 1000/200	Vitamin A 1,000,000 IU/g Vitamin D_3 200,000 IU/g	Beadlet	M, P, EXP, EXT
Vitamin D_3 (cholecalciferol)	IU	1 IU Vitamin D_3 = 0.025 µg Vitamin D_3	ROVIMIX® D3-500	500.000 IU/g	Spray-dried powder, water dispersible	M, P, EXP, EXT, MR/W
			ROVIMIX® AD3 1000/200	Vitamin A 1,000,000 IU/g Vitamin D3 200,000 IU/g	Beadlet	M, P, EXP, EXT
25OHD_3 (25 hydroxy- cholecalciferol)	mg	1 µg 25OHD_3 = 40 IU Vitamin D_3	ROVIMIX® Hy-D® 1.25%	1.25% 25OHD_3 (12.5 g/kg)	Spray-dried powder, water dispersible	M, P, EXP, EXT, W
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, MR/W
Vitamin K_3 (menadione)	mg	1 mg of Vitamin K_3 = 2 mg of Menadione Sodium Bisulfite (MSB)	K3 MSB	Menadione: 51.5% (515 g/kg)	Fine crystalline powder	M, P, EXP, EXT, MR/W
		1 mg of Vitamin K_3 = 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 B_1 (thiamine)	mg	1 mg of Vitamin B_1 = 1.233 mg of Thiamine mononitrate	ROVIMIX® B1	98% (980 g/kg)	Fine crystalline powder	M, P, EXP, EXT
Vitamin B_2 (riboflavin)	mg		ROVIMIX® B2 80-SD	80% (800 g/kg)	Spray-dried powder	M, P, EXP, EXT, MR/W
Vitamin B_6 (pyridoxine)	mg	1 mg Vitamin B_6 = 1.215 mg Pyridoxine hydrochloride	ROVIMIX® B6	99% (990 g/kg)	Fine crystalline powder	M, P, EXP, EXT, MR/W
Vitamin B_{12} (cyanocobalamin)	mg		Vitamin B12 1% Feed Grade	1% (10 g/kg)	Fine powder	M, P, EXP, EXT
			ROVIMIX® B_{12} 1% Feed Grade	1% (10 g/kg)	Spray-dried powder	M, P, EXP, EXT
Vitamin B_3 (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, MR/W
Vitamin B_7 (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, MR/W
Vitamin B_5 (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, MR/W
Vitamin B_9 (Folic acid)	mg		ROVIMIX® Folic 80 SD	80% (800 g/kg)	Spray-dried powder water dispersible	M, P, EXP, EXT, MR/W
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, MR/W
			ROVIMIX® C-EC	97.5% (975 g/kg)	Ethyl-cellulose coated powder	M, P, MR/W
			Ascorbic acid	99 – 100% (990 – 1000 g/kg)	Crystalline powder	MR/W
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; MR/W: Milk replacer/Water
For more information about further dsm-firmenich products and product forms please ask your local dsm-firmenich representative

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