OVN®
OPTIMUM VITAMIN NUTRITION

OVN Optimum Vitamin Nutrition® Guidelines 2022

Check and adjust vitamin levels for more sustainable farming.

AQUACULTURE

ANIMAL NUTRITION AND HEALTH

- ESSENTIAL PRODUCTS
- PERFORMANCE SOLUTIONS + BIOMIN®
- PRECISION SERVICES

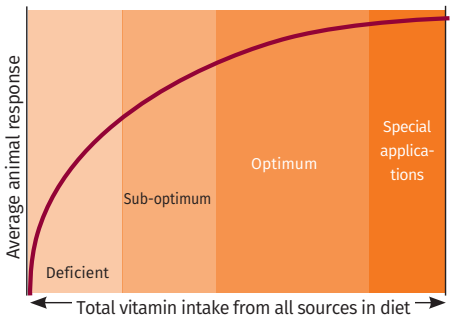
DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

Vitamins Contribute to More Sustainable Farming

Continuous advancements in aqua nutrition are essential to address opportunities and challenges of modern aquaculture, 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 believe that supporting fish and shrimp 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 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 kilogram of air-dried feed.

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 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. flesh 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 Aquaculture

Vitamin	Main functions	Deficiency symptoms
Vitamin A	• Essential for growth, health (immunity), reproduction (steroid synthesis) and vision • Development and integrity of skin, epithelia and mucosa	• Abnormal swimming (ataxia) • Ascites • Deformities (spinal, jaws, twisted gill opercula) • Edema • Erosion • Eye pathology: cataract, degeneration of retina • Growth retardation • Hematological index changes • Hemorrhage • Lesions • Lethargy • Loss of appetite up to anorexia • Skin: depigmentation, dark skin coloration
Vitamin D_3	• Absorption, fixing and homeostasis of calcium and phosphorus from the small intestine • Regulation of calcification of bones • Mobilization of calcium from bones • Regulation of immune cells	• Defects of mineralization • Deformities: soft and deformed bones • Fatty liver • Growth retardation and worse feed conversion • Loss of appetite up to anorexia • Tetany
Vitamin E	• Most powerful fat-soluble antioxidant • Immune system modulation • Tissue protection • Fertility • Meat quality • Flesh quality	• Ascites • Deformities: Lordosis, twisted gill opercula • Edema • Exudative diathesis • Fatty liver • Hematological index changes • Hemorrhage • Reduced immune response • Muscular dystrophy • Organ pathological changes (pancreas, kidney, liver , intestine) • Skin: depigmentation, dark skin coloration
Vitamin K_3	• Blood clotting and coagulation • Coenzyme in metabolic process related to bone mineralization and protein formation	• Hematological index changes: Increased clotting time • Hemorrhage
Vitamin B_1	• Coenzyme in about 25 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	• Growth retardation • Loss of appetite up to anorexia • Peripheral and central neuropathies • Muscle weakness • Hemorrhage • Hyperirritability • Loss of equilibrium • Skin: depigmentation, dark skin coloration • Tetany
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	• Abnormal swimming (ataxia) • Deformities (spinal, jaws, snout, short-body dwarfism) • Snout erosion • Growth retardation • Emaciation • Erosion • Eye pathology: cataract • Hemorrhage • Hyperirritability • Lesions of tissues and mucous membranes • Lethargy • Loss of appetite up to anorexia • Organ pathological changes (pancreas, kidney, liver, intestine) • Skin: depigmentation, dark skin coloration
Vitamin B_6	• Aminoacids, fats and carbohydrate metabolism • Essential for DNA and RNA synthesis • Involved in the synthesis of niacin from tryptophan	• Malfunction of central and peripheral nervous system • Growth retardation • Haematological index changes • Hyperirritability • Lesions • Lethargy • Loss of appetite up to anorexia • Organ pathological changes (pancreas, kidney, liver, intestine) • Tetany
Vitamin B_{12}	• 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	• Reduced production of DNA and RNA • Growth retardation • Hematological index changes: anaemia • Loss of appetite up to anorexia
Niacin or Vitamin B_3	• Coenzyme, in the active forms NAD and NADP, in aminoacids, fat and carbohydrate metabolism • Involved in glycolysis, citric acid cycle, oxidation of fatty acids and fatty acids synthesis and gluconeogenesis	• Nervous system disorders • Deformities (spinal, jaws) • Edema • Growth retardation • Hematological index changes • Hemorrhage • Lesions • Lethargy • Loss of appetite up to anorexia • Muscle dystrophy • Inflammation and ulcers of mucous membranes • Increase of disease in stress conditions
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)	• Fatty liver • Gill pathological changes • Retarded growth • Hemorrhage • Hyperirritability • Lesions • Lethargy • Loss of appetite up to anorexia • Organ pathological changes (pancreas, kidney, liver, intestine) • Skin: increase in dermal mucous cells, loss of skin mucosa, skin depigmentation, dark skin coloration • Tetany
d-Pantothenic acid or Vitamin B_5	• Present in Coenzyme A (CoA) and Acyl Carrier Protein (ACP) • Involved in carbohydrate, fat and protein metabolism • CoA is essential in the citric acid cycle • Biosynthesis of long-chain fatty acids	• Functional disorders of nervous system • Emaciation • Erosion • Gill pathological changes: swelling of the gills • Reduced growth • Hematological index changes • Hemorrhage • Hyperirritability • Lethargy • Loss of appetite up to anorexia • Organ pathological changes (pancreas, kidney, liver, intestine): fatty degeneration of the liver • Skin disorders • Tetany • Reduced antibody formation
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 B12 it converts homocysteine into methionine	• Hematological index changes : macrocytic anaemia • Mucus membrane inflammation • Lethargy • Skin: damage, dark skin coloration
Vitamin C	• Intracellular antioxidant • Immune system modulation • Collagen synthesis • Formation of connective tissues, cartilage and bones • Synthesis of corticosteroids • Conversion of vitamin D to its active form	• Abnormal swimming (ataxia) • Ascites • Black death syndrome (shrimp) • Deformities (spinal, jaws), lordosis, twisted gill opercula • Erosion • Eye pathology: cataract • Gill pathological changes • Hemorrhages of the skin, musculature and adipose tissue • Lethargy • Loss of equilibrium • Organ pathological changes (pancreas, kidney, liver, intestine) • Loss of appetite: anorexia • Reduced bone collagen, Scoliosis • Skin: depigmentation, dark skin coloration, loss of scale • Lower resistance to stress
Choline	• Phospholipids component • Fat transport and metabolism in the liver • Building and maintenance cell wall structure • Support nervous system function	• Growth retardation • Fatty liver • Hemorrhage • Organ pathological changes (pancreas, kidney, liver, intestine) • Dark skin coloration

AQUACULTURE[1]

OVN Optimum Vitamin Nutrition®

	Vitamin A	Vitamin D_3	250HD_3 (Hy-D®)	Vitamin E	Vitamin K_3	Vitamin B_1	Vitamin B_2	Vitamin B_6	Vitamin B_{12}	Niacin	Biotin	d-Pantothenic acid	Folic acid	Vitamin C[6]	Choline	Astaxanthin
Units	IU	IU	mcg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg
Salmon/ Trout[2]	4,000 – 8,000	2,500 – 8,000	80 – 800	200 – 600[5]	8 – 12	15 – 30	25 – 40	20 – 35	0.17 – 0.25	150 – 200	1.0 – 1.2	40 – 60	10 – 15	200 – 1,000[7]	500 – 4,000	50 – 100[8]
Tilapia[2, 9]	8,000 – 11,000	1,500 – 2,000	–	100 – 750	5 – 10	10 – 20	15 – 20	15 – 25	0.02 – 0.05	80 – 120	0.5 – 1.0	40 – 50	10 – 20	150 – 1,500	600 – 1,200	
Carp[2]	8,000 – 11,000	1,500 – 2,000	–	100 – 900	5 – 10	10 – 20	15 – 20	15 – 25	0.02 – 0.05	80 – 120	0.5 – 1.0	40 – 50	4 – 7	150 – 400	600 – 1,800	
Catfish[2]	8,000 – 11,000	1,500 – 2,000	–	100 – 300	5 – 10	10 – 20	15 – 20	15 – 25	0.02 – 0.05	80 – 120	0.5 – 1.0	40 – 50	4 – 7	150 – 1,000	600 – 1,100	
Seabass/ Seabream[2]	8,000 – 12,000	1,700 – 2,200	–	200 – 400	8 – 12	20 – 30	20 – 30	20 – 25	0.1 – 0.2	100-140	0.8 – 1.0	50 – 100	4 – 6	150 – 200	600 – 1,000	50 – 150
Eel[2]	8,000 – 12,000	1,500 – 2,000	–	150 – 300	3 – 6	15 – 25	20 – 30	10 – 15	0.1 – 0.2	80 – 120	0.3 – 0.5	50 – 60	4 – 6	150 – 900	800 – 1,200	
Shrimp[3]	7,000 – 12,000	4,000 – 6,500[4]	–	150 – 300	40 – 60	50 – 150	40 – 80	50 – 175	0.02 – 0.05	100 – 250	1.0 – 2.25	100 – 180	10 – 20	250 – 500	600 – 6,500	50 – 200

[1] Added per kg air-dry feed. Local legal limits need to be observed OVN™ levels are ranges for consideration, depending on several factors, such as husbandry conditions and health status.
[2] Amount to be increased by 30% for fry and broodstock
[3] At low stock density (<10pl/m^2) the lower levels are recommended
[4] Upper level for low salinity rearing
[5] Additional 200 mg/kg may be required to optimise flesh quality dependent on dietary fat levels
[6] Use ROVIMIX® STAY-C®35 for reducing losses during processing
[7] During winter feeding for wound healing and immune function: total 1000 mg/kg feed
[8] For flesh pigmentation
[9] Amount to be increased by 30-50% during winter period

Conversion Factors and Standard DSM Vitamins for Aquaculture

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
			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, W
			ROVIMIX® AD3 1000/200	Vitamin A 1,000,000 IU/g Vitamin D_3 200,000 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% 25OHD3 (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, W
Vitamin K_3 (menadione)	mg	1 mg of Vitamin K_3 = 2.3 mg of Menadione Nicotinamide Bisulfite (MNB)	ROVIMIX® K_3 MNB	Menadione: 43% (430 g/kg) Nicotinamide: 30.5% (305 g/kg)	Fine crystalline powder	M, P, EXP, EXT
		1 mg of Vitamin K3 = 2 mg of Menadione Sodium Bisulfite (MSB)	K_3 MSB	Menadione: 51.5% (515 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W
Vitamin B_1 (thiamine)	mg	1 mg of Vitamin B_1 = 1.233 mg of Thiamine mononitrate	ROVIMIX® B_1	98% Thiamine mononitrate (980 g/kg)	Fine crystalline powder	M, P, EXP, EXT
Vitamin B_2 (riboflavin)	mg		ROVIMIX® B_2 80-SD	80% (800 g/kg)	Spray-dried powder	M, P, EXP, EXT, W
Vitamin B_6 (pyridoxine)	mg	1 mg Vitamin B_6 = 1.215 mg Pyridoxine hydrochloride	ROVIMIX® B_6	99% Pyridoxine hydrochloride (990 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W
Vitamin B_{12} (cyanocobalamin)	mg		Vitamin B_{12} 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, 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, 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, W
Vitamin B_9 (Folic acid)	mg		ROVIMIX® Folic 80 SD	80% (800 g/kg)	Spray-dried powder water dispersible	M, P, EXP, EXT, 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
			ROVIMIX® STAY-C® 50	50% of total phosphorylated sodium salt ascorbic acid activity (500 g/kg)	Fine crystalline powder	M, P, EXP, EXT, W
			ROVIMIX® C-EC	97.5% (975 g/kg)	Ethyl-cellulose coated powder	M, P, W (slightly)
			Ascorbic acid	99 – 100% (990 – 1000 g/kg)	Crystalline powder	W
Astaxanthin	IU		CAROPHYLL® Pink 10%-CWS	10% astaxanthin	Beadlet (Cold Water Soluble)	M, P, EXP, EXT, W
			CAROPHYLL® Pink	8% astaxanthin	Beadlet	M, P, EXP, EXT

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

For more information about further DSM products and product forms please ask your local DSM representative

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