

Vitamin	Main Functions	Deficiency symptoms
Vitamin A	<ul style="list-style-type: none"> Essential for growth, health (immunity), reproduction (steroid synthesis) and vision Development and integrity of skin, epithelia and mucosa 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Vitamin B1	<ul style="list-style-type: none"> Absorption, fixing and homeostasis of calcium and phosphorus from the soil Regulation of calcification of bones Mobilization of calcium from bones Regulation of calcium conversion Growth retardation and worse feed conversion Loss of appetite up to anorexia Regulation of immune cells Most powerful fat-soluble antioxidant 	<ul style="list-style-type: none"> Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Reduced immune response Muscle dystrophy Organ pathological changes (pancreas, kidney, liver, intestine) Skin: depigmentation, dark skin coloration
Vitamin B2	<ul style="list-style-type: none"> Essential for growth, health (immunity), reproduction (steroid synthesis) and vision Development and integrity of skin, epithelia and mucosa 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Vitamin B3	<ul style="list-style-type: none"> Essential for growth, health (immunity), reproduction (steroid synthesis) and vision Development and integrity of skin, epithelia and mucosa 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Vitamin B6	<ul style="list-style-type: none"> Essential for DNA and RNA synthesis Essential for DNA and RNA synthesis Involved in the synthesis of niacin from tryptophan 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Vitamin B12	<ul style="list-style-type: none"> Metabolism of fats and carbohydrates Metabolism of fats and carbohydrates Involved in nucleic acids (DNA and RNA) and protein metabolism Synthesis of red blood cells and growth Reduced production of DNA and RNA 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Niacin or Vitamin B3	<ul style="list-style-type: none"> Coenzyme in the active forms NAD and NADP, in amino acids, fat and carbohydrate metabolism Involved in nucleic acids (DNA and RNA) and protein metabolism Coenzyme in nucleic acids (DNA and RNA) and protein metabolism Involved in nucleic acids (DNA and RNA) and protein metabolism 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Biotin or Vitamin B7	<ul style="list-style-type: none"> Normal blood glucose level Synthesis of fatty acids, nucleic acids (DNA and RNA) and proteins (keratin) 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Folic acid or Vitamin B9	<ul style="list-style-type: none"> Coenzyme in the synthesis of nucleic acids (DNA and RNA) Stimulates hematopoietic systems With vitamin B12 it converts homocysteine into methionine 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration
Choline	<ul style="list-style-type: none"> Phospholipid component Support nervous system function Building and maintenance cell wall structure Transport and metabolism in the liver 	<ul style="list-style-type: none"> Abnormal swimming (ataxia) Asciates Deformities: Lordosis, twisted gill opercula Hemorrhage Lesions Retina Eye pathology: cataract, degeneration of Loss of appetite up to anorexia Skin: depigmentation, dark skin coloration

Main Functions of Vitamins and Symptoms of Deficiency in Aquaculture

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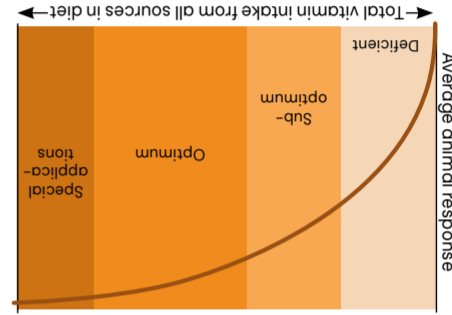
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Vitamins Contribute to More Sustainable Farming

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 more sustainable in alignment with the United Nations Sustainable Development Goals (SDGs). We at dsm-firmenich 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-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 vitamin amounts stored 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. flesh quality and immunity. The listed vitamin levels are only guidelines and, in all cases, national feed legislation must be followed.

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.







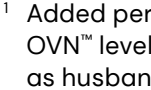
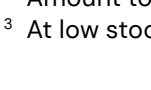

OVN Optimum Vitamin Nutrition® Guidelines 2022



Check and adjust vitamin levels for more sustainable aquaculture farming.



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	Vitamin A	Vitamin D ₃	25OHD ₃ (Hy-D ³)	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/Trout²	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	
 Carp²	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	
 Catfish²	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/Seabream²	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
 Eel²	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	
 Shrimp³	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/m²) 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-firmenich 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 crystallize 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 ³ 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, 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 K ₃ = 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-firmenich products and product forms please ask your local dsm-firmenich representative