Lallemand Health Ingredients

UPDATE

Vitamin D

Practical technology from Lallemand Inc.

The Role of Vitamin D in Health

VITAMIN D, known as "the sunshine vitamin," is a group of fat-soluble vitamins mainly represented by vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol).

Vitamin D3 is produced during skin exposure to sunlight. Natural dietary sources are few, oily fish being the richest (Holick, 2007), but it can also be obtained from supplements made with lanolin (wool grease) (Thacher and Clarke, 2011).

Vitamin D2, found in some plants, is also produced when yeast is exposed to UVB light. Such yeast is a good source of vitamin D for vegetarians, because it contains no animal-derived ingredients.

BENEFITS

The best-understood function of vitamin D is to regulate calcium absorption from the small intestine and the growth and healthy mineralization of bone and teeth. Since vitamin-D deficiency impairs bone development and jeopardizes optimal peak bone mass, it is a problem particularly for children. Severe vitamin-D deficiency results in rickets in children and osteomalacia in adults (Bischoff-Ferrari et al., 2009; Lanham-New and Wilson, 2016).

Besides its role in skeletal development and maintenance, increasing evidence shows that vitamin D is also beneficial for tissues such as the brain, heart, stomach, pancreas, lymphatics, skin, gonads, and prostate, which are composed of cells that express the vitamin D receptor. In these tissues, vitamin D is thought to play a role in improving immune function, reducing inflammation, and maintaining normal cell division and muscle function (Zittermann and Gummert, 2010; Thacher and Clarke, 2011). This could explain why lower serum 25 (OH)D (25-hydroxy vitamin D) levels appear to be linked to increased risk of several chronic diseases, including cancer, cardiovascular disease, diabetes, and autoimmune diseases, as well as bacterial and viral infections.

The majority of studies evaluating the biochemical effects of vitamin D on cancer prevention have concluded that vitamin D does not act alone. Its mechanism of action involves the up-regulation of activities related to cellular communication, interaction, and death control, such as signaling and adherence between epithelial cells, cell-to-cell contact inhibition, cellular differentiation, stabilization of cell life cycle, and promotion of automated cell death. Vitamin D would also be involved in angiogenesis (inhibiting growth of new blood vessels in tumors) (Garland et al., 2009).

Evidence is mounting that vitamin D consumption may reduce respiratory tract infection susceptibility in children and adults. Low 25(OH)D could be linked with chronic rhinosinusitis in adults (Ginde et al., 2009; Wand et al., 2013). Insufficient vitamin D is associated with an increased risk of gestational diabetes and pre-eclampsia. Pregnant women with low 25 (OH)D levels have been found more frequently with bacterial vaginosis and lower birth weight infants (Aghajafari et al., 2013).

The contribution of vitamin D to bodily functions is summarized in the table above.

DEFICIENCY RISKS

Several factors, listed in the table below, will limit the amount of vitamin D that the body can produce from sunlight (Bosomworth, 2011; Lanham-New and Wilson, 2016). These factors, along with limited access to vitamin D-rich food sources, have contributed to the increase in vitamin-D deficiency worldwide.

The optimal serum 25(OH)D concentration for maximizing the health benefits of vitamin D is hotly debated. Based primarily on bone health outcomes, consensus is that vitamin-D deficiency symptoms are apparent with a 25(OH)D serum level of less than 25 nmol/L.

Continued

HEALTH CONDITIONS AND VITAMIN-D CONTRIBUTIONS

Calcium and phosphorus balance	• Normal absorption/utilization of calcium and phosphorus • Normal blood calcium levels
Bone health	• Maintenance of normal bones and teeth
Inflammation and immunity	• Normal immune function and inflammation response
Muscle and fitness	• Maintenance of normal muscle function
Reproduction, growth, and development	• Plays a role in the process of cell division

** Recognized health relationships based on EFSA authorized Article 13.1 health claims for vitamin D.*

RISK FACTORS FOR VITAMIN-D DEFICIENCY

Risk Factor	Mechanism
Lack of sun exposure	Reduced skin synthesis
Latitude of residence	No skin synthesis from November to March at 52° north
Sunscreen use	SPF of 15 blocks 99% of skin synthesis
Skin pigmentation	Melamine is a very efficient blocker of UVB radiation
Taking cholesterol-lowering statin drugs	Cholesterol is required by the body to synthesize vitamin D, so the statin's effects limit the body's capability to synthesize vitamin D
Urbanization	Increasing time indoors and increased automobile use limit sun exposure
Aging	75% reduction in skin production by age 70; increased institutionalization as a greater percent of the population ages

REGULATORY LANDMARKS FOR VITAMIN D

August 29, 2012 The FDA approved a petition submitted by Lallemand in 2009 on behalf of the American baking industry to allow more vitamin D into bread and baked goods, raising the maximum level from 90 to 400 IU/100 grams.

January 13, 2014 A positive scientific opinion on vitamin-D2-rich baker's yeast *(Saccharomyces cerevisiae)* was issued by the EFSA Panel on Dietetic Products, Nutrition and Allergies. The Standing Committee on Food Chain and Animal Health approved the novel food ingredient request for use in yeast-leavened bread, rolls, fine bakery wares, and food supplements. Marketing authorization was received on June 3, 2014.

May 20, 2016 Changes to the nutrition facts label were announced by the FDA, adding vitamin D to the list of nutrients required to be declared. By July 26, 2018, food manufacturers must declare the actual amount of vitamin D, in addition to percent daily value, which is being updated from 400 to 600 IU based on newer scientific evidence from the Institute of Medicine.

Lalmin® Vita D® Yeast

LALLEMAND developed a process that converts the naturally occurring sterols in yeast to vitamin D2. The result is Lalmin® Vita D®, an inactive yeast with a concentration of 200 ppm or 8,000 IU/gram. Lalmin® Vita D® is a perfect supplemental source of vitamin D for vegetarians, unlike lanolin-derived D3.

BIOAVAILABILITY

The bioavailability of Lalmin® Vita D® yeast was studied at Purdue University with rats. The results show that when incorporated into food Lalmin® Vita D® yeast can significantly raise serum 25(OH)D and improve bone health markers (Hohman et al., 2011). Rats were maintained on the vitamin-D-deficient diet for 7 weeks to establish deficiency and then were randomized to different vitamin-D regimes. There were no significant differences between the D2 and D3 groups (see table below). Compared to the rats on the low vitamin-D diet, rats fed the highest doses had significantly greater trabecular bone mineral content (BMC) and bone mineral density (BMD) at the distal femur, greater bone volume and connectivity density at the distal site, and greater total area, periosteal and endosteal circumference at the midshaft site.

Although vitamins D2 and D3 differ structurally, they are absorbed in the same ways in the gastrointestinal tract. Current clinical practice guidelines consider D2 and D3 therapeutically equivalent since both can reverse rickets in infants (Eliot and Park, 1938; Holick, 2007; Borel et al., 2013).

When comparing the ability of each form to raise and maintain total serum 25(OH)D, either equal effects (Lehmann et al., 2013; Glendenning et al., 2013; Gottschlich et al., 2015) or significantly higher effects from D3 have been reported (Wilson et al., 2015; Shieh et al., 2016). These conflicting results appear related to differing rates of disappearance from the circulation, as well as metabolism and breakdown. Vitamin D2's reported faster clearance rate can be beneficial when higher doses are required to rapidly raise serum 25(OH)D levels, as higher D3 doses have been associated with greater risk of falls (Bischoff-Ferrari et al., 2010).

VITAMIN D2 AND D3 BIOAVAILABILITY

	Vitamin D3		Vitamin D2-rich Yeast Bread		ANOVA
	25 IU	1,000 IU	25 IU	1,000 IU	Dose p-value
Distal pQCT					
Trabecular BMD, mg/cm3	249.68 ± 24.5	253.05 ± 19.9	245.5 ± 15.2	276.15 ± 30.7	0.027
Trabecular BMC, mg/mm	3.62 ± 0.57	3.91 ± 0.68	3.42 ± 0.31	4.21 ± 0.82	0.010
Distal microCT					
Bone volume, mm3	1.83 ± 0.34	1.88 ± 0.25	1.72 ± 0.25	2.17 ± 0.49	0.030
Connectivity density, 1/mm3	42.3 ± 6.7	43.8 ± 7.7	41.6 ± 6.7	51.0 ± 8.7	0.027
Midshaft pQCT					
Total area, mm2	12.41 ± 0.61	12.85 ± 0.62	12.33 ± 0.53	12.86 ± 0.91	0.031
Periosteal circ, mm	12.49 ± 0.31	12.71 ± 0.31	12.45 ± 0.27	12.71 ± 0.45	0.032
Endosteal circ, mm	7.92 ± 0.27	8.19 ± 0.30	7.92 ± 0.28	8.22 ± 0.45	0.011

Femur peripheral quantitative computed tomography (pQCT) and microcomputed tomography characteristics of 11-week-old vitamin-D-deficient rats fed varying levels of vitamin-D3- or vitamin-D2-rich yeast bread for 8 weeks.

The Role of Vitamin D in Health *(Continued)*

Concentrations above 50 nmol/L are desirable in the general population—under this level the vitamin-D status is considered insufficient.

Vitamin-D insufficiency is widespread in pregnant women, women of child-bearing age, children, adolescents, and senior adults (Lanham-New and Wilson, 2016).

According to Cashman et al. (2016), 40.4% of the 55,844 Europeans surveyed had serum 25(OH)D concentrations below 50 nmol/L. Subgroups with dark skin pigmentation were shown to be 3- to 71-fold more at risk of having serum 25(OH) D below 30 nmol/L than white populations. In 2011, the prevalence rate of vitamin D insufficiency was reported to be 41.6% in US adults, with the highest rate seen in blacks (82.1%), followed by Hispanics (69.2%) (Forrest and Stuhldreher). In Canada, despite mandatory fortification of staple foods, Canadians were shown to have a high prevalence of low serum 25(OH)D levels in both winter and summer (Grant et al., 2010; Vatanparast et al., 2010). Very low serum 25(OH)D levels have been reported in the Middle East, e.g., Turkey, Lebanon, Jordan and Iran. In these countries, serum 25(OH)D was lower in women than in men and associated with clothing habits. Vitamin-D status was much better in Malaysia, but lower serum 25(OH)D was observed in Singapore, Japan, and China (Lips, 2007; Bi et al., 2016).

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Lallemand Health Ingredients Update is produced by Lallemand Inc. to provide the dietary supplement and food industries with a source of practical technology for solving problems. If you would like to be on our mailing list to receive future issues, or if you have questions or comments, please contact us at:

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