

2025 Vade Mecum of Nutrients, Bioactive Compounds and other Ergogenic Substances in Sport and Health. Chapter II. Vitamins

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Summary

Vitamins are essential chemicals for our bodies and are found in food. With a balanced diet, vitamin deficiencies are unlikely to occur. Vitamin supplements are not systematically recommended for athletes unless deficiencies are identified after a nutritional assessment. Vitamin supplements are detailed here for your information and for reliable prescription based on scientific evidence of their ergogenic effects on sports and health.

For each vitamin, a sheet is described briefly containing its definition and functions, effect, RDI (Recommended Daily Intake) or dietary reference value and UL (Tolerable Upper Intake Level), dosage, level of evidence, side effects and interactions, and contraindications; where applicable, the nutrition and health claim, the conditions for use of the claim, any additional restrictions or warnings, and its UR (Uniform Resource Locator).

Vademécum 2025 de nutrientes, compuestos bioactivos y otras sustancias, con efecto ergogénico en el deporte y la salud. Capítulo II. Vitaminas

Resumen

Las vitaminas son sustancias químicas esenciales para nuestro organismo contenidas en los alimentos. Con unos hábitos alimentarios ajustados a una dieta equilibrada es poco probable padecer una carencia vitamínica. Los suplementos de vitaminas no se recomiendan sistemáticamente en los deportistas, a menos que se identifiquen deficiencias tras una valoración nutricional. Aquí se detallan para su conocimiento y prescripción fiable bajo evidencia científica en sus efectos ergogénicos en el deporte y la salud.

Por cada vitamina se describe una ficha conteniendo de forma abreviada su definición y funciones, efecto, IDR (Ingesta Diaria Recomendada) o valor dietético de referencia y UL (*Tolerable Upper Intake Level* – Límite máximo de seguridad), dosis, grado de evidencia, efectos secundarios e interacciones y contraindicaciones; si existe, la declaración nutricional y saludable, condiciones de uso para la declaración, restricciones o advertencias complementarias a la misma y su UR (*Uniform Resource Locator* – Localizador uniforme de recursos).

Palabras clave:

Vitaminas. Nutriente. Compuesto bioactivo. Sustancia. Efecto ergogénico. Salud. IDR. UL. Dosis. Grado de evidencia científica. Efectos secundarios. Interacciones. Contraindicaciones. Declaración nutricional y saludable. Condiciones de uso de la declaración. URL.

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Introduction

Vitamins are chemical substances that play an essential role for the human body. They can be found in very small quantities within foods, hence why they are classified as micronutrients. They produce no energy and are typically involved in vital metabolic processes for the growth, development and protection of cells.

Vitamins are categorised according to their solubility in water (hydrosoluble) or fat (liposoluble):

- Water-soluble vitamins. Excess water-soluble vitamins can be eliminated through urine but can also lead to health irregularities.
 - Group B. Thiamin (B1), riboflavin (B2), pyridoxine (B6), cyanocobalamin (B12), folic acid (B9), niacin or nicotinic acid (B3), biotin (B7 or H) and pantothenic acid (B5).
 - Ascorbic acid (C).
- Fat-soluble vitamins. Excess fat-soluble vitamins can cause toxicity: retinol (A), α -tocopherol (E), calciferol (D) and phyloquinone (K).

It is unlikely to suffer from a vitamin deficiency with eating habits that provide a balanced diet. Diets that provide calorie levels below individual needs and those that avoid certain food groups can lead to insufficient vitamin intake.

Generally speaking, vitamin supplements are not systematically recommended in athletes unless deficiencies are identified during a nutritional assessment. It is important for the person engaging in sport to understand that the intake of supplements cannot remedy an inadequate diet, while a well chosen diet can guarantee maximum benefits from the prescribed supplementation and help to prevent pathologies and adverse situations.

A descriptive file is provided for each vitamin containing a brief description of their definition and functions, effect, RDI (Recommended Daily Intake) or dietary reference value and UL (Tolerable Upper Intake Level), dose, grade of evidence, side effects and interactions, and contraindications. If they exist, it also includes the nutrition and health claim, conditions for use of the claim, restrictions or complementary warnings for the claim and the URL (Uniform Resource Locator).

The following criteria have been followed when classifying the grade of evidence during data updates:

- Grade A: data from numerous randomised clinical trials, meta-analyses or systematic reviews.
- Grade B: data from a single randomised clinical trial or large non-randomised clinical trials (cohort studies).
- Grade C: consensus of opinion from experts or small studies.

The following statement is considered to have grade A scientific evidence with regard to vitamins:

- Supplementation does not improve performance if the athlete has a normal intake level.

Two tables are included for reference:

- Table 1. Effect, RDI (Recommended Dietary Intake), UL (Tolerable Upper Intake Level), grade of evidence and indications for the prescription of vitamins.
- Table 2. Nutrition and health claim with the conditions for use, restrictions or warnings, in vitamins (Spanish Food Safety and Nutrition Agency - AESAN).

Vitamins. Classification and Description

- 1. Hydrosoluble vitamins
 - 1.1. Vitamin B1 (thiamin)
 - 1.2. Vitamin B2 (riboflavin)
 - 1.3. Vitamin B6 (pyridoxine)
 - 1.4. Vitamin B12 (cyanocobalamin)
 - 1.5. Vitamin B9 (folic acid)
 - 1.6. Vitamin B3 (niacin or nicotinic acid)
 - 1.7. Vitamin B7 or vitamin H (biotin)
 - 1.8. Vitamin B5 (pantothenic acid)
 - 1.9. Vitamin C (ascorbic acid)
- 2. Liposoluble vitamins
 - 2.1. Vitamin A (retinol)
 - 2.2. Vitamin E (α -tocopherol)
 - 2.3. Vitamin D (calciferol)
 - 2.4. Vitamin K (phyloquinone)

1. Hydrosoluble Vitamins

1.1. Vitamin B1 (thiamin)

Vitamin B1 is involved in important reactions that enable energy production, such as the elimination of CO₂ in the decarboxylation reactions from pyruvate to acetyl-CoA and in the Krebs cycle (citric acid cycle). It is also involved in the synthesis of acetylcholine. Thiamin concentration in serum ranges from 15 to 30 nmol/L, although it should be noted that vitamin B1 mainly circulates in the blood as thiamine pyrophosphate (TTP), which is its active form.

For the Spanish population and based on current eating habits, average thiamin intake varies between 1.7 and 2.1 mg/day.

Minimum thiamin requirements are estimated at 1 mg/day.

For the Spanish population, the RDI or dietary reference value for thiamin is estimated at 1.1 mg/day in women and 1.2 mg/day in men.

For the adult European population, the RDI or dietary reference value for thiamin is estimated at 1 mg/day.

The tolerable upper intake level (UL) has not been established.

Effect in sport

There are no conclusive studies on its supplementation in sports practice. It could theoretically improve the anaerobic threshold. It does not seem that supplementation improves performance, provided that athletes have an adequate diet. A deficit of this vitamin can lower the efficiency of energy systems and, therefore, physical performance.

An RCT (randomised clinical trial) from 1989 exists in which high doses of thiamin, pyridoxine and cyanocobalamin reduce anxiety and improve motor skills in target shooting, meaning they could be used in precision sports.

In combination with vitamin B6 and vitamin B12, it can increase the levels of serotonin and improve motor skills. For this reason, it has been recommended in such precision sports as Olympic shooting and archery.

This could be explained by the increase in serotonin, a neurotransmitter that could reduce anxiety at a central nervous system level.

Dose

The intake of up to 2 mg/day is permitted in athletes. It does not seem that supplementation improves performance, provided that the athletes have a normal calorie intake. Due to its involvement in energy metabolism, increasing this by a minimum of 0.4 mg/1,000 kcal would be justified in high-calorie diets.

Nonetheless, a 2011 report by the Food Scientific Committee of the Directorate-General for Health & Consumers of the European Commission (FSC) considers the possibility of enriching high-energy dietary foods for athletes with vitamin B1 and, in those cases where this is done, recommends that it be of at least 0.05 mg/100 kcal (or 0.2 mg/100 g CH).

Grade of evidence: C (the combination of B1, B2 and B12 can increase the levels of serotonin and improve motor skills in such precision sports as Olympic shooting and archery).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

- Thiamin contributes to normal energy metabolism.
- Thiamin contributes to normal nervous system function.
- Thiamin contributes to normal psychological function.
- Thiamin contributes to normal heart function.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of thiamin in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of thiamin: meats in general (pork), fish, wholegrain cereals, legumes (beans, lentils, chick peas), nuts in general and seeds (sunflower, pumpkin), vegetables, eggs, fruit, fermented products (tempeh, fermented soybean, legumes or cereals).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.
Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(1, 2, 3, 4, 5, 6, 7, 8, 9)

1.2. Vitamin B2 (riboflavin)

Vitamin B2 is involved as a coenzyme in reactions that enable energy production and helps to reduce tiredness and fatigue. In theory, it would increase the availability of energy during oxidative metabolism while protecting cells from oxidative stress. Riboflavin concentration in serum ranges from 0.013 to 0.13 µmol/L.

For the Spanish population and based on current eating habits, average riboflavin intake is 1.5 mg/day.

Minimum vitamin B2 requirements are estimated at 1.3 mg/day. Riboflavin deficiency (aribo flavinosis) is usually accompanied by other nutritional deficiencies and can lead to a deficiency of vitamin B6 and niacin. It is known that such diseases as cancer, heart irregularities and diabetes mellitus precipitate or exacerbate riboflavin deficiency.

For the Spanish population, the RDI or dietary reference value for riboflavin is estimated at 1.2 mg/day in women and 1.5 mg/day in men.

For the adult European population, the RDI or dietary reference value for riboflavin is estimated at 1.6 mg/day.

The tolerable upper intake level (UL) has not been established.

Effect in sport

There are no conclusive studies on its supplementation in sports practice.

It does not seem that supplementation improves performance, provided that athletes have an adequate diet.

In a 2017 RCT (randomised clinical trial) conducted on a small number of 32 ultra-distance runners, it was observed that supplementation with riboflavin (two doses of 100 mg) produced a reduction in muscle pain and fatigue during the trial, upon concluding the trial and in recovery during subsequent days when compared with a control group that took a placebo.

Publications exist in which riboflavin supplements are recommended alongside iron to improve and maintain serum ferritin levels, as opposed to oral iron alone.

Dose

A balanced diet that includes sufficient foods with vitamin B2 generally meets the daily vitamin B2 requirements.

At least 0.6 mg/1,000 kcal is recommended in high calorie intake situations due to its impact on energy metabolism.

Grade of evidence: B (in ultra-distance runners, supplementation at the start of the exercise and half-way through the exercise (km 90) produces a reduction in muscle pain and fatigue when compared with a placebo).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Riboflavin contributes to normal energy metabolism.

Riboflavin contributes to normal nervous system function.

Riboflavin contributes to the maintenance of mucous membrane in normal condition.

Riboflavin contributes to the maintenance of red blood cells in normal condition.

Riboflavin contributes to the maintenance of skin in normal condition.

Riboflavin contributes to the maintenance of eyesight in normal condition.

Riboflavin contributes to normal iron metabolism.

Riboflavin contributes to the protection of cells from oxidative damage.

Riboflavin helps to reduce tiredness and fatigue.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of riboflavin in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of riboflavin: dairy (milk, yoghurt, cheese), meats (beef liver, chicken, turkey), fish (salmon, trout, tuna), eggs, wholegrain cereals (oats, rice, bread), nuts and legumes (almonds, beans, lentils), greens (spinach, chard).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 10)

1.3. Vitamin B6 (pyridoxine)

Vitamin B6 is involved in the metabolism of proteins and is also necessary for the production of certain neurotransmitters, such as serotonin, dopamine and noradrenaline. It contributes towards maintaining adequate energy release and reducing tiredness and fatigue. Pyridoxine concentration in serum ranges from 20 to 125 nmol/L.

For the Spanish population and based on current eating habits, average pyridoxine intake is 2 mg/day in men and around 1.6 mg/day in women.

Minimum vitamin B6 requirements are estimated at 1.3 mg/day.

For the Spanish population, the RDI or dietary reference value for pyridoxine is estimated at 1.3 mg/day in women and 1.7 mg/day in men.

For the adult European population, the RDI or dietary reference value for pyridoxine is estimated at 1.6 mg/day.

The tolerable upper intake level (UL) has been set at 12 mg/day. Very high doses of oral pyridoxine supplements (2 mg/day or more in a chronic situation) have been linked to the development of sensory neuropathy and skin lesions.

Effect in sport

It does not seem that supplementation improves performance, provided that athletes have an adequate diet. It does not improve aerobic capacity or the accumulation of lactic acid in well nourished athletes.

An RCT (randomised clinical trial) from 1989 exists in which high doses of thiamin, pyridoxine and cyanocobalamin reduce anxiety and improve motor skills in target shooting, meaning they could be used in precision sports.

The combination of vitamins B1, B2 and B12 can increase the levels of serotonin and improve motor skills. For this reason, it has been recommended in such precision sports as Olympic shooting and archery. This could be explained by the increase in serotonin, a neurotransmitter that could reduce anxiety at a central nervous system level.

Dose

A balanced diet that includes sufficient foods with vitamin B6 generally meets the daily vitamin B6 requirements.

Grade of evidence: C (the combination of B1, B2 and B12 can increase the levels of serotonin and improve motor skills in such precision sports as Olympic shooting and archery).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin B6 contributes to normal cysteine synthesis.

Vitamin B6 contributes to normal energy metabolism.

Vitamin B6 contributes to normal nervous system function.

Vitamin B6 contributes to the normal metabolism of homocysteine.

Vitamin B6 contributes to the normal metabolism of proteins and glycogen.

Vitamin B6 contributes to normal psychological function.

Vitamin B6 contributes to the normal formation of red blood cells.

Vitamin B6 contributes to normal immune system function.

Vitamin B6 helps to reduce tiredness and fatigue.

Vitamin B6 helps to regulate hormonal activity.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin B6 in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin B6: meats (chicken, turkey, pork, beef), fish (tuna, salmon, trout, cod), nuts and seeds (almonds, peanuts, sunflower seeds), legumes (chick peas, lentils, beans), wholegrain cereals (oats, rice), vegetables (potatoes, asparagus), fruit (banana).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 11, 12)

1.4. Vitamin B12 (cyanocobalamin)

Vitamin B12 acts as a coenzyme involved in DNA production, protein and erythrocyte synthesis, and serotonin production. Vitamin B12 also contributes to the release of energy and the reduction of tiredness and fatigue. Cyanocobalamin concentration in serum ranges from 133 to 664 pmol/L.

For the Spanish population and based on current eating habits, average vitamin B12 intake is between 7 and 7.4 µg/day.

Minimum vitamin B12 requirements are estimated at 1.3 mg/day. Strictly vegetarian (vegan) athletes may present a depletion risk in this vitamin, which can affect erythropoiesis and cause megaloblastic anaemia.

For the adult Spanish population, the RDI or dietary reference value for vitamin B12 is estimated at 2.4 µg/day.

For the adult European population, the RDI or dietary reference value for vitamin B12, is estimated at 4 µg/day.

The tolerable upper intake level (UL) has not been established.

Effect in sport

No performance improvement or ergogenic effect has been observed in well nourished athletes.

In combination with vitamin B1 and vitamin B6, it can increase the levels of serotonin and improve motor skills. For this reason, it has been recommended in such precision sports as Olympic shooting and archery. This could be explained by the increase in serotonin, a neurotransmitter that could reduce anxiety at a central nervous system level.

Dose

A balanced diet that includes sufficient foods with vitamin B12 generally meets the daily vitamin B12 requirements.

Grade of evidence: C (the combination of B1, B2 and B12 can increase the levels of serotonin and improve motor skills in such precision sports as Olympic shooting and archery).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin B12 contributes to normal energy metabolism.

Vitamin B12 contributes to normal nervous system function.

Vitamin B12 contributes to the normal metabolism of homocysteine.

Vitamin B12 contributes to normal psychological function.

Vitamin B12 contributes to the normal formation of red blood cells.

Vitamin B12 contributes to normal immune system function.

Vitamin B12 helps to reduce tiredness and fatigue.

Vitamin B12 contributes to cellular division

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin B12 in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin B12: fish and shellfish (salmon, tuna, trout, sardines, clams, mussels, oysters), meats (beef and beef liver, chicken and turkey), dairy products (milk, yoghurt, cheese), eggs.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 13)

1.5. Vitamin B9 (folic acid)

Vitamin B9 acts as a coenzyme in DNA and red blood cell production. It contributes to the reduction of tiredness and fatigue. Folic acid concentration in serum is >10 nmol/L.

For the Spanish population and based on current eating habits, the average intake of folates is 266 µg/day in women and 296 µg/day in men.

Minimum vitamin B9 requirements are estimated at 250 µg/day. Vitamin B9 deficiency produces abnormal replication in the erythropoietic system, causing megaloblastic anaemia, in the same way as vitamin B12 deficiency.

For both the adult Spanish and European populations, the RDI or dietary reference value for vitamin B9 is estimated at 330 µg/day.

The tolerable upper intake level (UL) has been established at 1,000 µg/day (this applies to the combined intake of folic acid, (6S)-5-methyltetrahydrofolate acid, glucosamine and L-5-methyltetrahydrofolate acid calcium salts added to food or used in food supplements, in their authorised conditions for use; the folate naturally present in food and drink is not included).

If this limit is surpassed, there is a risk of B12 deficiency masking, gastrointestinal problems and allergic reactions (redness, irritation).

Increased intake prior to conception and during pregnancy can lower the incident rate of foetal malformations. It also seems to lower homocysteine levels.

Effect in sport

No performance improvement or ergogenic effect has been observed in well nourished athletes. It does not improve physical performance in athletes with folate deficiency but no anaemia.

Dose

A balanced diet that includes sufficient foods with vitamin B9 generally meets the daily vitamin B9 requirements.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Folates contribute to the growth of maternal tissues during pregnancy.

Folates contribute to normal amino acid synthesis.

Folates contribute to normal blood cell formation.

Folates contribute to the normal metabolism of homocysteine.

Folates contribute to normal psychological function.

Folates contribute to normal immune system function.

Folates help to reduce tiredness and fatigue.

Folates contribute to cellular division.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of folates in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of folates: greens (spinach, chard, romaine lettuce, kale, broccoli), legumes (chick peas, lentils, beans, green peas), nuts and seeds (almonds, hazelnuts, sunflower seeds), oats, fruits (avocado, oranges, strawberries).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 14, 15)

1.6. Vitamin B3 (niacin or nicotinic acid)

Vitamin B3 is involved in energy metabolism by forming part of coenzymes and contributes to the reduction of tiredness and fatigue. Supplementation with niacin can help to lower blood lipid levels and raise homocysteine levels in patients with hypercholesterolaemia. Niacin concentration in serum is not commonly measured for the assessment of nutritional status given that its levels can fluctuate greatly and do not properly reflect bodily reserves.

For the Spanish population and based on current eating habits, average niacin intake ranges from 39 mg/day to 40 mg/day in men and from 35 mg/day to 36 mg/day in women.

Minimum vitamin B3 requirements are estimated at 10.4 mg NE/day (NE: niacin equivalents (1 mg of niacin = 1 niacin equivalent = 60 mg of tryptophan in the diet) (EFSA, 2017). Classic niacin deficiency leads to pellagra, which in industrialised countries only appears in people with chronic alcoholism or in situations that prevent the metabolism of tryptophan.

For the adult Spanish and European populations, the RDI or dietary reference value for vitamin B3 is estimated at 14 mg/day in women and 17 mg/day in men.

The tolerable upper intake level (UL) has been set at 10 mg/day for nicotinic acid and at 900 mg/day for nicotinamide. The potential adverse effects of excessive niacin intake include flushing, nausea, vomiting, hepatotoxicity, blurred vision and alteration in tolerance to glucose.

Effect in sport

No performance improvement or ergogenic effect has been observed in well nourished athletes. In fact, supplementation during physical exercise seems to reduce performance capacity due to blocking the mobilisation of fatty acids, indirectly producing an increase in the use of glycogen and the respiratory quotient (Respiratory Exchange Ratio - RER) during effort.

Dose

A balanced diet that includes sufficient foods with vitamin B3 generally meets the daily vitamin B3 requirements.

Due to its involvement in energy metabolism, the niacin RDIs should be increased for high-calorie diets to a minimum of 6.6 mg/1,000 kcal.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Niacin contributes to normal energy metabolism.

Niacin contributes to normal nervous system function.

Niacin contributes to normal psychological function.

Niacin contributes to the maintenance of mucous membrane in normal condition.

Niacin contributes to the maintenance of skin in normal condition.

Niacin helps to reduce tiredness and fatigue.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of niacin in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of niacin: meats (chicken, turkey, beef and beef liver), fish (tuna, salmon, trout, cod), nuts and seeds (peanuts, almonds, sunflower seeds), wholegrain cereals (rice, oats, bread), legumes (lentils, beans, chick peas), potatoes.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 16)

1.7. Vitamin B7 or H (biotin)

Vitamin B7 is involved in energy metabolism and the use of macronutrients. Biotin concentration in serum ranges from 0.82 to 4.92 nmol/L.

For the Spanish population and based on current eating habits, no specific data are available regarding the average intake of biotin.

Minimum vitamin B3 requirements are estimated at 40 µg/day.

For the Spanish population, the RDI or dietary reference value for biotin is estimated at 30 µg/day.

For the adult European population, the RDI or dietary reference value for biotin is estimated at 40 µg/day.

The tolerable upper intake level (UL) has not been established.

Effect in sport

There are no conclusive studies on its supplementation in sports practice.

Dose

A balanced diet that includes sufficient foods with biotin generally meets the daily biotin requirements.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Biotin contributes to normal energy metabolism.

Biotin contributes to normal nervous system function.

Biotin contributes to the normal metabolism of macronutrients.

Biotin contributes to normal psychological function.

Biotin contributes to the maintenance of hair in normal condition.

Biotin contributes to the maintenance of mucous membrane in normal condition.

Biotin contributes to the maintenance of skin in normal condition.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of biotin in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of biotin: eggs, liver and offal (pork, beef, chicken), nuts and seeds (almonds, walnuts, sunflower seeds), legumes (beans, chick peas, lentils), vegetables (spinach, broccoli, kale).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 17)

1.8. Vitamin B5 (pantothenic acid)

Vitamin B5 contributes to the release of energy and the reduction of tiredness and fatigue. Vitamin B5 concentration in serum ranges from 1.6 to 2.7 µmol/L.

For the Spanish population and based on current eating habits, no specific data are available regarding the average intake of vitamin B5.

Minimum vitamin B5 requirements are estimated at 5 mg/day.

For the adult Spanish and European populations, the RDI or dietary reference value for vitamin B5 is estimated at 5 mg/day.

The tolerable upper intake level (UL) has not been established.

Effect in sport

There are no conclusive studies on its supplementation in sports practice.

Dose

A balanced diet that includes sufficient foods with vitamin B5 generally meets the daily vitamin B5 requirements.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Pantothenic acid contributes to normal energy metabolism.

Pantothenic acid contributes to the normal synthesis and metabolism of steroid hormones, vitamin D and certain neurotransmitters.

Pantothenic acid helps to reduce tiredness and fatigue.

Pantothenic acid contributes to normal intellectual performance.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of pantothenic acid in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of pantothenic acid: meats (chicken, turkey, beef or pork liver), fish (salmon, tuna, trout), nuts and seeds (almonds, peanuts, sunflower seeds), wholegrain cereals (oats, rice), legumes (lentils, chick peas), vegetables (chard, kale).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 18)

1.9. Vitamin C (ascorbic acid)

Vitamin C is involved in hugely important biological functions, such as the synthesis of epinephrine and the absorption of iron. It is also a powerful antioxidant. The roles played by vitamin C are highly varied given that it is involved in the release of energy, good immune system function, protection against free radicals, improvement in iron absorption (ferric salt or iron of plant origin), good nervous system function, bone and joint health, and the reduction of tiredness and fatigue. Vitamin C concentration in serum ranges from 23 to 85 µmol/L.

For the Spanish population and based on current eating habits, the average intake of ascorbic acid ranges from 126 to 136 mg/day, with a tendency to increase with age.

Minimum vitamin C requirements are estimated at 80 mg/day.

For the Spanish population, the RDI or dietary reference value for vitamin C is estimated at 75 mg/day.

For the adult European populations, the RDI or dietary reference value for vitamin C is estimated at 95 mg/day in women and 110 mg/day in men.

The tolerable upper intake level (UL) has not been established.

Effect in sport

Vitamin C fosters the maintenance of normal immune system activity during and after intense physical exercise. Such factors as altitude, high temperatures and intense physical exercise can increase requirements. However, vitamin C supplementation in athletes who maintain suitable nutrition does not seem to improve their physical performance. Vitamin C deficiency can have negative effects on various aspects of physical performance (causing fatigue, muscle weakness and anaemia).

Dose

A balanced diet that includes sufficient foods with vitamin C meets the requirements for this vitamin.

The minimum supplementation threshold recommended by the EFSA to maintain the immune system during and after intense physical exercise is 200 mg/day.

Supplementation of 500 mg/day when engaging in high-intensity exercise can reduce the incidence of upper respiratory infections and therefore improves immunity.

Furthermore, there is reference to an improvement in collagen production and reduced joint pain with supplementation of 50 mg of vitamin C, 5-15 g of gelatine and 10 g of collagen per day.

Grade of evidence: B (antioxidant effect. Vitamin C can improve the immune system when engaging in high-intensity exercise, reducing the incidence of upper respiratory infections. It seems that supplementation with gelatine, vitamin C and collagen could increase the production of collagen and reduce joint pain).

Side effects, interactions

It negatively interferes with the absorption of copper. It causes negative effects in excessive quantity.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin C contributes to normal immune system function during and after high-intensity physical exercise.

Vitamin C contributes to the normal formation of collagen for normal blood vessel function.

Vitamin C contributes to the normal formation of collagen for normal bone function.

Vitamin C contributes to the normal formation of collagen for normal cartilage function.

Vitamin C contributes to the normal formation of collagen for normal gum function.

Vitamin C contributes to the normal formation of collagen for normal skin function.

Vitamin C contributes to the normal formation of collagen for normal tooth function.

Vitamin C contributes to normal energy metabolism.

Vitamin C contributes to normal nervous system function.

Vitamin C contributes to normal psychological function.

Vitamin C contributes to normal immune system function.

Vitamin C contributes to the protection of cells from oxidative damage.

Vitamin C helps to reduce tiredness and fatigue.

Vitamin C helps to regenerate the reduced form of vitamin E.

Vitamin C improves iron absorption.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin C in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin C: fruits (oranges, lemons, mandarines, kiwi, strawberries, mangos, papaya, guava, grapefruit, melon), vegetables (peppers, broccoli, cabbages, spinach, asparagus, tomatoes), fresh green peas.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 19)

2. Liposoluble vitamins

2.1. Vitamin A (retinol)

Vitamin A forms the basis of visual pigments and is involved in nocturnal vision. It also plays an important antioxidant role (β -carotenes, precursors to vitamin A). It is involved in the immune system and in the metabolism of iron. Vitamin A is stored in the liver, meaning a deficiency of this vitamin is rare with the recommended daily intakes. However, excess intake can be toxic and lead to metabolic abnormalities and liver damage. Vitamin A concentration in serum ranges from 1.05 to 2.80 $\mu\text{mol/L}$.

β -carotenes (precursors to vitamin A) have antioxidant properties.

For the Spanish population and based on current eating habits, the average intake of retinol is 750 $\mu\text{g RE/day}$ in men and somewhat lower, between 650 $\mu\text{g RE/day}$ and 740 $\mu\text{g RE/day}$ in women (RE - Retinol Equivalent: 1 $\mu\text{g RE} = 1 \mu\text{g}$ of retinol, 6 μg of β -carotene and 12 μg of other provitamin A carotenoids). The ratio between μg of vitamin A and IU (International Units) is as follows: 0.3 $\mu\text{g} = 1 \text{ IU}$.

Minimum vitamin A requirements are estimated at 570 $\mu\text{g RE/day}$.

For the Spanish population, the RDI or dietary reference value for vitamin A is estimated at 750 $\mu\text{g/day}$ in men and 650 $\mu\text{g/day}$ in women.

For the adult European population, the RDI or dietary reference value for vitamin A is estimated at 750 $\mu\text{g RE/day}$.

The tolerable upper intake level (UL) has been established at 3,000 $\mu\text{g RE/day}$ (retinol and retinol esters). Excessive intake may be toxic and cause metabolic abnormalities, liver damage and such symptomatology as vomiting and hair loss.

Effect in sport

There are no conclusive studies on its supplementation in sports practice. The interest in vitamin A supplementation is based on its antioxidant capability, but its toxicity is of greater risk.

Dose

A balanced diet that includes sufficient foods with vitamin A generally meets the daily vitamin A requirements.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

Excessive intake may be toxic, causing metabolic abnormalities, liver damage, vomiting and hair loss.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin A contributes to normal iron metabolism.

Vitamin A contributes to the maintenance of mucous membrane in normal condition.

Vitamin A contributes to the maintenance of skin in normal condition.

Vitamin A contributes to the maintenance of eyesight in normal condition.

Vitamin A contributes to normal immune system function.

Vitamin A contributes to cellular differentiation.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin A in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin A: meats (beef liver, pork or chicken), fish (salmon, tuna), dairy (whole milk, yoghurt, cured cheeses), eggs, greens (spinach, chard, kale), carrots, red peppers, pumpkin, sweet potato, fruits (mango, melon, apricots).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 20, 21)

2.2. Vitamin E (*alpha*-tocopherol)

Vitamin E acts as an antioxidant in preventing the formation of free radicals, affects the cellular response to oxidative stress during high-intensity exercise, prevents the destruction of red blood cells and seems to improve the release of oxygen to muscle during exercise. Type I muscle fibres (slow-twitch) have a higher concentration of alpha-tocopherol than type II fibres. Vitamin E concentration in serum ranges from 1.05 to 2.80 µmol/L.

For the Spanish population and based on current eating habits, average vitamin E intake is between 13 and 15 mg/day.

Minimum vitamin E requirements are estimated at 13 mg/day in men and 11 mg/day in women.

For the adult European and Spanish populations, the RDI or dietary reference value for vitamin E is estimated at 13 mg/day in men and 11 mg/day in women. Expressed as alpha-tocopherol: 1 mg of alpha-tocopherol = 1.49 IU.

The tolerable upper intake level (UL) has been set at 300 mg/day. The ULs for vitamin E are expressed in mg of α-tocopherol. The ULs apply to all stereoisomeric forms of α-tocopherol. When surpassing this limit, there is a risk of anticoagulant effect (haematomas, bleeding,

haemorrhages), difficulty in absorbing vitamin K, muscle weakness, headache, nausea, diarrhoea, fatigue and blurred vision.

Effect in sport

The presence of vitamin E alongside insulin and physical exercise increases the number and effectiveness of haematic creatine transporters to the skeletal musculature.

Past research indicates that supplementation with vitamin E can reduce the oxidative stress induced by exercise. Studies are also ongoing into its possible synergy with vitamin C. Some evidence suggests that it can reduce the risk of cardiovascular diseases. However, more studies are needed to confirm its role on performance and tolerance to sports training. It seems that supplementation with vitamin E can improve physical performance at altitude. In contrast, there would be no positive effects at sea level.

Dose

A balanced diet that includes sufficient foods with vitamin E generally meets the daily vitamin E requirements. The antioxidant effect is already produced with the RDI.

In case of supplementation:

- Generally 12 mg/day, up to 300 mg/day
- It improves performance at altitude: 300-400 mg/day, during 4-6 weeks.

Grade of evidence: B (antioxidant effect and improved performance at altitude).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin E contributes to the protection of cells from oxidative damage.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin E in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin E: oils (oil of: sunflower, walnut, almond, sesame, corn, soy, peanut, extra virgin olive, olive), nuts and seeds (almonds, hazelnuts, pine nuts, sunflower seeds).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 22, 23)

2.3. Vitamin D (calciferol)

Vitamin D increases the absorption of calcium, phosphorous and magnesium, and is involved in the growth and mineralisation of bones, muscle function and immune system function, especially in innate immunity (for example, expression of antimicrobial proteins). Vitamin D concentration in serum ranges from 75 to 250 nmol/L.

For the Spanish population and based on current eating habits, average vitamin D intake is higher in men (4.28 µg/day) than in women (3.65 µg/day).

Minimum Vitamin D requirements are estimated at 15 µg/day.

For the adult Spanish population, the RDI or dietary reference value for vitamin D is estimated at 12.5 µg/day (established for people with little sun exposure). Expressed as cholecalciferol: 1 µg of cholecalciferol = 40 IU of vitamin D.

For the adult European population, the RDI or dietary reference value for vitamin D is estimated at 15 µg/day (minimal conditions of cutaneous synthesis of vitamin D and in the presence of endogenous cutaneous synthesis of vitamin D, the dietary vitamin D requirement is lower or even nil).

The tolerable upper intake level (UL) has been set at 100 µg VDE/day (Vitamin D Equivalent: 1 µg of VDE = 1 µg of cholecalciferol - vitamin D3 = 1 µg of ergocalciferol - vitamin D2 = 0.4 µg of calcidiol monohydrate = 40 IU of vitamin D. Calcidiol monohydrate is applied in doses of up to 10 µg/day. If this limit is surpassed, there is a risk of hypercalcaemia, kidney stones, kidney damage, arrhythmia, soft tissue calcification.

Effect in sport

An increasing number of studies are being conducted on the role of vitamin D in the metabolic function of the skeletal muscle, the prevention of injury, the improvement of neuromuscular performance and the control of fatigue. This knowledge would facilitate the optimisation of performance based mainly on the improvement of resistance to high-intensity training.

The role of mitochondrial regulation and skeletal muscle repair seem evident, but more research is needed in terms of muscle recovery.

Generally speaking, there are no conclusive studies on its supplementation in sports practice. However, supplementation with vitamin D and calcium can prevent the loss of mineral bone density and reduce the risk of stress fractures in athletes susceptible to deficiency or risk of osteoporosis.

Its systemic determination in blood analysis is therefore recommended due to its involvement in adaptation to high-intensity exercise.

Dose

A balanced diet that includes sufficient foods with vitamin D and exposure to the sun generally meet the daily vitamin D requirements.

An amount of 1,500-2,000 IU of vitamin D, together with 1,500 mg/day of calcium, is recommended for athletes in low availability situations (restricted or lack of dairy intake, eating behaviour disorders, relative energy deficiency in sport syndrome (REDs) or amenorrhoea in prevention of osteoporosis, fractures and muscle dysfunction.

The need for supplementation will especially depend on exposure to sunlight and the type of skin of the athletes (light or dark): 1,000-3,000 IU/day = 25-75 µg. If necessary, 1,000 IU/day are recommended between autumn and spring.

Supplementation with vitamin D (15 µ) and calcium (400 mg) can prevent bone loss in athletes susceptible to presenting osteoporosis and reduce the risk of stress fractures.

Grade of evidence: B (mitochondrial regulation and repair function in skeletal muscle. Supplementation with vitamin D and calcium can prevent the loss of mineral bone density and reduce the risk of stress fractures, where a deficiency exists).

Side effects, interactions

In deficiency situations with high doses over short periods of time: 50,000 IU/week, 8-16 weeks, control is necessary to prevent toxicity.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin D contributes to the normal absorption and use of calcium and phosphorous.

Vitamin D contributes to the maintenance of normal blood calcium levels.

Vitamin D contributes to the maintenance of bones in normal condition.

Vitamin D contributes to normal muscle function.

Vitamin D contributes to the maintenance of teeth in normal condition.

Vitamin D contributes to normal immune system function.

Vitamin D contributes to cellular division.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin D in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin D: fish (salmon, herring, mackerel, tuna), beef liver, eggs, dairy (whole milk, cured cheeses), vegetable sources (mushrooms, ergocalciferol).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9, 24, 25, 26)

2.4. Vitamin K (phylloquinone)

Vitamin K is involved in blood coagulation and in bone metabolism. Vitamin K concentration in serum ranges from 0.2 to 5.4 nmol/L.

Changes in blood coagulation that depend on vitamin K have been shown to exist in low manganese situations.

For the Spanish population and based on current eating habits, no specific data are available regarding the average intake of vitamin K.

Minimum Vitamin K requirements are estimated at 15 µg/day.

For the adult Spanish and European populations, the RDI or dietary reference value for vitamin K is estimated at 70 µg/day (solely based on phylloquinone or vitamin K1).

The tolerable upper intake level (UL) has not been established.

Effect in sport

There are no conclusive studies on its supplementation in sports practice.

Dose

A balanced diet that includes sufficient foods with vitamin K generally meets the daily vitamin K requirements.

Supplementation with vitamin K at high doses (10 mg/day) in high-level female athletes in low oestrogen situations seems to favour a balance between the formation and reabsorption of bone.

Grade of evidence: A (supplementation does not improve performance if the athlete has a normal intake level).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Vitamin K contributes to normal blood coagulation.

Vitamin K contributes to the maintenance of bones in normal condition.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of vitamin K in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation N° 1924/2006.

Foods that are a source of vitamin K. Sources of vitamin K1: greens (spinach, kale, chard, romaine lettuce, broccoli, Brussels sprouts), vegetable oils (soybean sauce and olive oil). Sources of vitamin K2: meats (chicken, beef), eggs, cured cheeses, fermented foods of plant and animal origin (fermented cabbage sauerkraut, fermented soybean tempeh, legumes or cereals, others).

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation N° 432/2012 in EUR-Lex.

Link: <http://data.europa.eu/eli/reg/2012/432/oj>

Bibliography

(2, 3, 4, 5, 6, 7, 8, 9)

ANNEXES (REGULATIONS CONSULTED)**ANNEX I**

(EC) Regulation N° 1924/2006 of the European Parliament and of the Council, of 20 December 2006, on nutrition and health claims made on foods (27).

Annex to (EC) Regulation N° 1924/2006 (27)

SOURCE OF [NAME OF VITAMIN/S] AND/OR [NAME OF MINERAL/S].

A claim that a food is a source of vitamins and/or minerals, and any claim likely to have the same meaning for the consumer, may only be made where the product contains at least a significant amount as defined in the Annex to Directive 90/496/EEC or an amount provided for by derogations granted according to Article 7 of Regulation (EC) N° 1925/2006 of the European Parliament and of the Council, of 20 December 2006, on the addition of vitamins and minerals and of certain other substances to foods.

ANNEX II

Council Directive 90/496/EEC, of 24 September 1990, on nutrition labelling for foodstuffs (28).

ANNEX to Directive 90/496/EEC

Vitamins and minerals which may be declared and their recommended daily allowances (RDAs):

- Vitamin A µg 800

- Vitamin D μg 5
- Vitamin E mg 10
- Vitamin C mg 60
- Thiamin mg 1.4
- Riboflavin mg 1.6
- Niacin mg 18
- Vitamin B6 mg 2
- Folacin μg 200
- Vitamin B12 μg 1
- Biotin mg 0.15
- Pantothenic acid mg 6

- Calcium mg 800
- Phosphorous mg 800
- Iron mg 14
- Magnesium mg 300
- Zinc mg 15
- Iodine μg 150

As a rule, 15% of the recommended allowance specified in this Annex supplied by 100 g or 100 ml or per package if the package contains only a single portion should be taken into consideration in deciding what constitutes a significant amount.

Table 1. Effect, RDI (Recommended Dietary Intake), UL (Tolerable Upper Intake Level), grade of evidence and indications for the prescription of vitamins.

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Vitamin B1 (thiamin)	<ul style="list-style-type: none"> - It is involved in reactions that enable energy production and the synthesis of acetylcholine. - It can improve performance in precision sports (Olympic shooting, archery), increasing the levels of serotonin in combination with vitamin B6 and vitamin B12 (reduction of anxiety and optimisation of motor skills). 	<ul style="list-style-type: none"> - 1.1 - 1.2 mg/ (lower value women) PES - 1 mg/day PEU 	NE	<ul style="list-style-type: none"> - In case of supplementation: ≤ 2 mg/day - High calorie intake: 0.4 mg/1,000 kcal - Supplemented dietary foods: 0.05 mg/1,000 kcal (or also 0.2 mg/100 g CH) 	C	Unknown at the recommended dose in healthy people.	Unknown at the recommended dose in healthy people.
Vitamin B2 (riboflavin)	<ul style="list-style-type: none"> - It is involved in reactions that enable energy production. - It contributes to the reduction of tiredness and fatigue. - In ultra-distance runners, supplementation at the start of the exercise and half-way through the exercise (km 90) produces a reduction in muscle pain and fatigue. 	<ul style="list-style-type: none"> - 1.2 - 1.5 mg/day (lower value women) PES - 1.6 mg/day PEU 	NE	<ul style="list-style-type: none"> - High calorie intake: 0.4 mg/1,000 kcal - Ultra-distance: <ul style="list-style-type: none"> - 100 mg at the start of the exercise. - 100 mg half-way through the exercise (km 90). - High calorie intake: 0.4 mg/1,000 kcal - Ultra-distance: <ul style="list-style-type: none"> - 100 mg at the start of the exercise. - 100 mg half-way through the exercise (km 90). 	B	Unknown at the recommended dose in healthy people.	Unknown at the recommended dose in healthy people.
Vitamin B6 (pyridoxine)	<ul style="list-style-type: none"> - It is involved in the metabolism of proteins. - It is necessary for the production of neurotransmitters. - It contributes towards maintaining adequate energy release and reducing tiredness and fatigue. - It can improve performance in precision sports, in combination with vitamin B1 and vitamin B12. 	<ul style="list-style-type: none"> - 1.3 - 1.7 mg/day (lower value women) PES - 1.6 mg/day PEU 	12 mg/day	NE	C	Very high doses of chronic oral supplementation at 2 mg/day or more has been linked to: <ul style="list-style-type: none"> - Sensory neuropathy development - Skin lesions 	Unknown at the recommended dose in healthy people.
Vitamin B12 (cyanocobalamin)	<ul style="list-style-type: none"> - It is involved in the production of DNA and serotonin. - It contributes to the release of energy and the reduction of tiredness and fatigue. - It can improve performance in precision sports, in combination with pyridoxine and thiamin. 	<ul style="list-style-type: none"> - 2.4 μg/day PES - 4 μg/day PEU 	NE	NE	C	Unknown at the recommended dose in healthy people.	Unknown at the recommended dose in healthy people.
Vitamin B9 (folic acid)	<ul style="list-style-type: none"> - It is involved in DNA and red blood cell production. - It contributes to the reduction of tiredness and fatigue. 	330 μ g/day	1,000 μ g/day (origin added to foods and food supplements), not including the folate naturally present in foods and drinks.	NE	A	In amounts over 1,000 μ g/day UL, risk of: <ul style="list-style-type: none"> - Masking of B12 deficiency. - Gastrointestinal problems. - Allergic reactions (redness, itching). 	Unknown at the recommended dose in healthy people.

(continued)

Table 1. Effect, RDI (Recommended Dietary Intake), UL (Tolerable Upper Intake Level), grade of evidence and indications for the prescription of vitamins (continuation).

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Vitamin B3 (niacin or nicotinic acid)	<ul style="list-style-type: none"> - It is involved in energy metabolism. - It contributes to the reduction of tiredness and fatigue. - It can facilitate the reduction of blood lipid levels. - It can raise homocysteine levels in patients with hypercholesterolaemia. 	14 - 17 mg/day (lower value women)	<ul style="list-style-type: none"> - 900 mg/day nicotinamide - 10 mg/day nicotinic acid 	NE	A	<ul style="list-style-type: none"> - Supplementation during physical exercise can reduce the performance capacity by blocking fatty acid mobilisation, indirectly leading to: <ul style="list-style-type: none"> - Increased use of glycogen. - Increased respiratory quotient. - In amounts over 10 mg/day, risk of: <ul style="list-style-type: none"> - Hepatotoxicity. - Blurry vision. - Changes in tolerance to glucose. - Flushes, nausea and vomiting. 	Unknown at the recommended dose in healthy people.
Vitamin B7 or vitamin H (biotin)	<ul style="list-style-type: none"> - It is involved in energy metabolism and the use of macronutrients. 	-30 µg/day PES - 40 µg/day PEU	NE	NE	A	Unknown at the recommended dose in healthy people.	Unknown at the recommended dose in healthy people.
Vitamin B5 (pantothenic acid)	<ul style="list-style-type: none"> - It contributes to the release of energy and the reduction of tiredness and fatigue. 	5 mg/day	NE	NE	A	Unknown at the recommended dose in healthy people.	Unknown at the recommended dose in healthy people.
Vitamin C (ascorbic acid)	<ul style="list-style-type: none"> - It is involved in such biological functions as the synthesis of epinephrine and the absorption of iron. - Antioxidant function. - It is involved in the release of energy, good immune system function, protection against free radicals, improvement in iron absorption (ferric salt or of plant origin), good nervous system function, bone and joint health, and the reduction of tiredness and fatigue. - It fosters the maintenance of normal immune system activity during and after intense physical exercise. 	- 75 mg/day PES - 95 - 110 mg/day (lower value women) PEU	NE	<ul style="list-style-type: none"> - Maintenance of the immune system, reduction of upper respiratory illness incident rates: 200-500 mg/day during and after high-intensity exercise. - Improved production of collagen and reduced joint pain: 50 mg + 5-15 g of gelatine + 10 g of collagen/day. 	B	<ul style="list-style-type: none"> - It negatively interferes with copper absorption. - Negative effects with excess intake. 	Unknown at the recommended dose in healthy people.
Vitamin A (retinol)	<ul style="list-style-type: none"> - It forms the basis of visual pigments and is involved in nocturnal vision. - Antioxidant function. - It is involved in the immune system and in the metabolism of iron. 	- 650 - 750 µg/day (lower value women) PES - 750 µg RE/day PEU	3,000 µg RE/day (retinol and retinol esters).	NE	A	<ul style="list-style-type: none"> - In amounts over 3,000 µg ER/day, risk of: <ul style="list-style-type: none"> - Metabolic changes. - Liver damage. - Vomiting. - Hair loss. 	Unknown at the recommended dose in healthy people.

(continued)

Table 1. Effect, RDI (Recommended Dietary Intake), UL (Tolerable Upper Intake Level), grade of evidence and indications for the prescription of vitamins (continuation).

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Vitamin E (α-tocopherol)	<ul style="list-style-type: none"> - Antioxidant function. - It affects the cellular response to oxidative stress during high-intensity exercise. - It prevents the destruction of red blood cells. - It can improve the release of oxygen to the muscle during exercise. - It increases the number and effectiveness of haematic creatine transporters to the skeletal musculature alongside insulin and physical exercise. - Possible improvement to physical performance at altitude with supplementation, and not at sea level. 	- 11 - 13 mg/day (lower value women)	300 mg/day.	<ul style="list-style-type: none"> - In case of supplementation: 12-300 mg/day. - Altitude: 300-400 mg/day, during 4-6 weeks. 	B	<ul style="list-style-type: none"> - Pro-oxidative effect with excessive intake. - In amounts over 300 mg/day, risk of: <ul style="list-style-type: none"> - Anticoagulant effect (haematoma, bleeding, haemorrhages). - Hinders the absorption of vitamin K. - Muscle weakness, headache, nausea, diarrhoea, fatigue and blurred vision. 	Unknown at the recommended dose in healthy people.
Vitamin D (calciferol)	<ul style="list-style-type: none"> - It increases the absorption of calcium and phosphorous. - It is involved in the growth and mineralisation of bones, muscle function and immune system function. - It is involved in the metabolic function of skeletal muscle, the prevention of injury, the improvement of neuromuscular performance and the control of fatigue. 	<ul style="list-style-type: none"> - 12.5 µg (500 IU)/day PES - 15 µg (600 IU) /day PEU 	100 µg VDE (4,000 IU)/day	<ul style="list-style-type: none"> - Assessing exposure to sunlight and skin type: 1,000-3,000 IU/day (25-75 µg) - Autumn to spring: 1,000 IU/day. - Risk of osteoporosis: 15 µ + 400 mg calcium 	B	<ul style="list-style-type: none"> - In amounts over 100 µg VDE/day (4,000 IU), risk of: <ul style="list-style-type: none"> - Hypercalcaemia. - Kidney stones. - Kidney damage. - Arrhythmia. - Calcification of soft tissues. - In deficiency situations with high doses over short periods of time: 50,000 IU/week, 8-16 weeks, conduct checks to prevent toxicity. 	Unknown at the recommended dose in healthy people.
Vitamin K (phylloquinone)	<ul style="list-style-type: none"> - It is involved in blood coagulation. - It affects bone metabolism. 	- 70 µg/day	NE	NE	A	<ul style="list-style-type: none"> - Changes to blood coagulation in low manganese situations. 	Unknown at the recommended dose in healthy people.

RDI: For the adult Spanish and European populations; PES: Adult Spanish population; PEU: Adult European population; UL: For the adult European population; NE: Not Established; RE: Retinol Equivalent; VDE: Vitamin D Equivalent.

Table 2. Nutrition and health claim with the conditions for use, restrictions or warnings, in vitamins (Spanish Food Safety and Nutrition Agency - AESAN).

Nutrient, bioactive compound and other substances	Nutrition and health claim	Conditions applying to the use of claims	Conditions, restrictions or complementary warnings	URL (Uniform Resource Locator)
Vitamin B1 (thiamin)	- It contributes to normal energy metabolism, normal nervous system and heart function and normal psychological function.	It can only be used with regard to foods that are, at least, a source of thiamin, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B2 (riboflavin)	- It contributes to normal energy metabolism, normal nervous system function, the maintenance of eyesight, mucous membrane, skin and red blood cells in normal condition, the normal metabolism of iron and the protection of cells against oxidative damage. - It helps reduce tiredness and fatigue.	It can only be used with regard to foods that are, at least, a source of riboflavin, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B6 (pyridoxine)	- It contributes to the normal synthesis of cysteine, normal energy metabolism, normal nervous system and immune system function, the normal metabolism of homocysteine, proteins and glycogen and normal psychological function. - It helps reduce tiredness and fatigue, and to regulate hormonal activity.	It can only be used with regard to foods that are, at least, a source of pyridoxine, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B12 (cyanocobalamin)	- It contributes to normal energy metabolism, normal nervous system and immune system function, the normal metabolism of homocysteine, normal psychological function and the normal formation of red blood cells. - It helps reduce tiredness and fatigue. - It contributes to cellular division.	It can only be used with regard to foods that are, at least, a source of vitamin B12, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B9 (folic acid)	- It contributes to the growth of maternal tissues during pregnancy, the normal synthesis of amino acids, the normal formation of blood cells, the normal metabolism of homocysteine, normal psychological function, normal immune system function and cell division. - It helps reduce tiredness and fatigue.	It can only be used with regard to foods that are, at least, a source of vitamin B9, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B3 (niacin or nicotinic acid)	- It contributes to normal energy metabolism, normal nervous system function, normal psychological function and the maintenance of mucous membrane and skin in normal condition. - It helps reduce tiredness and fatigue.	It can only be used with regard to foods that are, at least, a source of vitamin B3, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B7 or vitamin H (biotin)	- It contributes to normal energy metabolism, normal nervous system function, the normal metabolism of macronutrients, normal psychological function and the maintenance of skin, hair and mucous membrane in normal condition.	It can only be used with regard to foods that are, at least, a source of biotin, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin B5 (pantothenic acid)	- It contributes to normal energy metabolism, normal intellectual performance and the normal synthesis and metabolism of steroid hormones, vitamin D and certain neurotransmitters. - It helps reduce tiredness and fatigue.	It can only be used with regard to foods that are, at least, a source of vitamin B5, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin C (ascorbic acid)	- It contributes to normal immune system function during and after high-intensity physical exercise. It contributes to the normal formation of collagen for normal function of blood vessels, bones, cartilage, gums, skin and teeth. - It contributes to normal energy metabolism, normal nervous system and immune system function, normal psychological function and the protection of cells against oxidative damage. - It helps to reduce tiredness and fatigue, and to regenerate the reduced form of vitamin E. - It improves iron absorption.	It can only be used with regard to foods that are, at least, a source of vitamin C, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin A (retinol)	- It contributes to the normal metabolism of iron, the maintenance of eyesight, mucous membrane and skin in normal condition, normal immune system function and the cellular differentiation process.	It can only be used with regard to foods that are, at least, a source of vitamin A, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex

(continued)

Table 2. Nutrition and health claim with the conditions for use, restrictions or warnings, in vitamins (Spanish Food Safety and Nutrition Agency - AESAN) (continuation).

Nutrient, bioactive compound and other substances	Nutrition and health claim	Conditions applying to the use of claims	Conditions, restrictions or complementary warnings	URL (Uniform Resource Locator)
Vitamin E (α-tocopherol)	- It contributes to the protection of cells against oxidative damage.	It can only be used with regard to foods that are, at least, a source of vitamin E, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin D (calciferol)	- It contributes to the normal absorption and use of calcium and phosphorous, the maintenance of normal levels of blood calcium, the maintenance of bone and teeth in normal condition, normal muscle function, normal immune system function and cell division.	It can only be used with regard to foods that are, at least, a source of vitamin D, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex
Vitamin K (phyloquinone)	- It contributes to normal blood coagulation and to the maintenance of bones in normal condition.	It can only be used with regard to foods that are, at least, a source of vitamin K, as appearing in the annex to (EC) Regulation N° 1924/2006.	None.	(EU) Regulation N° 432/2012 in EUR-Lex

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