Special article

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

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Summary

The 2025 Vademecum of nutrients, bioactive compounds and other substances with ergogenic effects in sport and health is an updated guide, useful as a tool for understanding and prescribing sports supplements for healthcare professionals. It can be used reliably in the search for ergogenic effects in sports and health, with respect to nutrients, bioactive compounds, and other substances. Its purpose is to achieve rational consumption, maintain health, and prevent doping.
Based on scientific evidence with concise, brief, and easy-to-use concepts. For each component, the following are cited: definition, effect, RDI (Recommended Daily Intake) or dietary reference value, UL (Tolerable Upper Intake Level), dosage, level of scientific evidence, side effects and interactions, contraindications, nutritional and health claims, conditions of use for the claim, restrictions or additional warnings, and its URL (Uniform Resource Locator).

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

Resumen

El Vademécum 2025 de nutrientes, compuestos bioactivos y otras sustancias con efecto ergogénico en el deporte y la salud es una guía actualizada, útil como herramienta para el conocimiento y la prescripción de la suplementación deportiva dirigida a profesionales sanitarios. De uso fiable en la búsqueda de efecto ergogénico en el deporte y la salud con respecto a nutrientes, compuestos bioactivos y otras sustancias. Con la finalidad de conseguir un consumo racional, el mantenimiento de la salud y la prevención del dopaje.
Basada en la evidencia científica con nociones concisas, breves y de fácil manejo. Se citan por cada componente: definición, efecto, IDR (Ingesta Diaria Recomendada) o valor dietético de referencia, UL (*Tolerable Upper Intake Level* – Límite máximo de seguridad), dosis, grado de evidencia científica, efectos secundarios e interacciones, contraindicaciones, declaración nutricional y saludable, condición de uso para la declaración, restricciones o advertencias complementarias a la misma y su URL (*Uniform Resource Locator* – Localizador uniforme de recursos).

Palabras clave:
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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Presentation (of the Vade Mecum overall)

The 2025 Vade Mecum of Nutrients, Bioactive Compounds and other Ergogenic Substances in Sport and Health is an updated compilation of structured information on nutrients, bioactive compounds and other substances with indications on safe and effective ergogenic consumption in the field of sport and health.

It is a document that provides assistance on indications and prescription for supplementation in sport and is aimed at healthcare professionals in response to the existence of extensive scientific publications and the messages accompanying the commercialisation of products of questionable effect and suspect legality posing a risk to health and the real possibility of accidental doping.

It is based on data obtained about nutrients and chemical substances with ergogenic effect published in the consensus document from the Spanish Society of Sports Medicine (SEMED) entitled "Nutritional Supplements for Athletes. Ergogenic Aids in Sport, 2019".

Updates have been made by consulting randomised controlled trials (RCTs), systematic reviews and meta-analyses, alongside documents from official food safety bodies: The Spanish Food Safety and Nutrition Agency (AESAN) and the European Food Safety Authority (EFSA). No consensus document on supplementation in sports practice has been published by scientific bodies since 2019, nor by any other entity with ties to sport.

With regard to the recommended dietary intake (RDI) or dietary reference value in nutrients for the Spanish population, publications from the Department of Nutrition and Food Science of the School of Pharmacy at the Universidad Complutense de Madrid, the Spanish Food Safety and Nutrition Agency (AESAN) and the Spanish Ministry of Health have been used. With regard to the European population for the RDI and maximum safety limit (Tolerable Upper Intake Level - UL), references from the European Food Safety Authority (EFSA) were consulted.

The nutrition and health claims were obtained from the search tool for this purposes maintained by the Spanish Food Safety and Nutrition Agency, which contains all the claims authorised under Regulation 1924/2006:

Nutrition claim is any claim that states, suggests or implies that a food possesses specific beneficial nutritional properties due to the energy value, nutrients or other substances (that it contains or does not contain, or that it contains in reduced or increased proportions). Only authorised nutrition claims are permitted and only provided that they meet the required conditions

Health claims are those that link a food or one of its components to health. In turn, these are classified as follows:

– Relating to growth and health in children.
– Relating to a reduced risk of disease.
– Others beside those relating to a reduced risk of disease and/or growth and health in children.
– Based on recently obtained scientific evidence and/or with data protection.

Authorised nutrition and health claims have been subject to a procedure whereby their scientific basis has been demonstrated and to assessment by the European Food Safety Authority (EFSA). They are added to a regional Register that includes all authorised claims and their conditions for use, as well as those that have been rejected and the reasons for rejection.

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 content of this vade mecum has been split into seven groups:

1. Minerals.
2. Vitamins.
3. Carbohydrates or glucides. Mono-di-oligo-polysaccharides.
4. Proteins. Amino acids and other nitrogen-containing substances.
5. Lipids or fats. Fatty acids and other lipids.
6. Bioactive compounds.
7. Other substances.

The following is included for each component:

– Definition and functions.
– Effect.
– RDI (Recommended Dietary Intake) or recommended dietary value of nutrients.
– UL (tolerable upper intake level) of nutrients.
– Dose.
– Grade of scientific evidence.
– Side effects or interactions.
– Contraindications.
– Nutrition and health claim.
  - Conditions of use for the claim.
  - Restrictions or complementary warnings for the claim.
  - URL (Uniform Resource Locator).

Publication will take place periodically and consecutively based on the group classification system, with a brief file per item and two summary tables per group containing the indications for prescription and healthy use.

Updated versions will be released annually, which will incorporate any new knowledge and/or publications requiring changes be made to the content.

1. Minerals

1.1. Potassium
1.2. Sodium
1.3. Magnesium
1.4. Calcium
1.5. Phosphorous
1.6. Iron
1.7. Zinc
1.8. Selenium
1.9. Manganese
1.10. Chrome

1.11. Copper
1.12. Iodine
1.13. Boron

Introduction

Minerals are non-energy nutrients characterised by their functions:

- Metabolism regulation (electrolytic balance, acid-base balance regulation, oxidation-reduction, cellular and enzymatic transmembrane reactions; neuromuscular activity and muscular contraction; hormonal metabolism; neurotransmitter and immunity regulation; involvement in blood coagulation).
- Plastic, as a structural part of various tissues (bone, dental, muscular and other soft tissues).

A descriptive file is provided for each mineral 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).

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

Generally speaking, mineral 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.

The following assertions for minerals are considered as Grade A scientific evidence: The following assertions for minerals are considered as Grade A scientific evidence:

- The daily intake recommendations for the general population are applicable to anyone who engages in physical activity or practices sport.
- The tolerable upper intake levels defined for the general population are applicable to anyone who engages in physical activity or practices sport.
- Supplements may be necessary due to a risk of not ingesting sufficient quantities of these nutrients for athletes who severely restrict energy consumption by eliminating certain food groups from their diet in order to lose weight and in high carbohydrate-content diets with low micronutrient density.

1.1 Potassium (K)

Potassium is an intracellular cation that acts on the acid-base balance, muscular contraction and neuromuscular activity. Potassium concentration in serum is 3.5-5.0 mEq/L (3.5-5.0 mmol/L).

For the Spanish population and based on current eating habits, average potassium intake is 2,905 mg/day.

Minimum potassium requirements are estimated at 400-600 mg/day.

The RDI or dietary reference value for both the adult Spanish and European populations is estimated at 3,500 mg/day.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of potassium in foods have not been linked to adverse effects in children and adults.

A potassium deficit can occur through vomiting, diarrhoea and urinary incontinence caused by laxatives or diuretics. Hypokalaemia can affect the neuromuscular system, potentially leading to paralysis, arrhythmia and cardiac arrest.

Effect in sport

Its inclusion in post-sport recovery drinks is effective given that it helps normalise hydration by facilitating water retention in the intracellular space, although its concentration should not exceed 10 mmol/L.

Dose

The usual recommended concentration in recovery drinks is 2.6 mEq/L (2.6 mmol/L or 10.14 mg/100 ml) to 5 mEq/L (5 mmol/L or 19.5 mg/100 ml).

In excessive sweating, in a quantity ≤7.5 mEq/L (7.5 mmol/L or 29.2 mg/100 ml).

Grade of evidence: B (adding potassium ion to post-physical exercise recovery drinks is advisable given that it helps water retention in the intracellular space, although its concentration should not exceed 10 mmol/L).

Side effects, interactions

It has been demonstrated that the long-term intake of approximately 3 g/day of potassium supplements, such as potassium chloride, as well as the amount contained in food, has no adverse effects.

The concentration of intracellular potassium may decrease due to caffeine, delaying the appearance of fatigue.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Potassium contributes to normal nervous system function.

Potassium contributes to normal muscle function.

Potassium contributes to the maintenance of normal blood pressure.

Conditions for use of the claim

EThis claim can only be used with regard to foods that are, at least, a source of potassium in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of potassium: fruits, greens and vegetables (banana, avocado, spinach, chard, potato, sweet potato, mushrooms, tomato), legumes and nuts (white beans, lentils, chick peas, almonds, pistachios), fish and meats (salmon, tuna, beef), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

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

1.2. Sodium (Na)

Sodium is the dominant cation in the extracellular fluid of the body. It is involved in controlling the volume and systemic distribution of total body water, enabling cells to capture solutes and generating trans-membrane electrochemical potentials via interactions with potassium. Sodium concentration in serum is 135-145 mEq/L (135-145 mmol/L).

For the Spanish population and based on current eating habits, average sodium intake is 2.5-3.0 g/day.

Minimum sodium requirements are estimated at 500 mg/day.

The RDI or dietary reference value for the adult Spanish population is 1.5 g/day, while for the European adult population this figures stands at 2 g/day. This is considered to be a safe and adequate intake of sodium. The reference value is deemed "safe" because it considers the tests that describe the relationship between the intake of sodium and the risk of CVD in the general population, and "adequate" in line with the definition of adequate intake. The figure provides guidance on a sodium intake level that is compatible with good health and can be used as the basis for sodium targets in the population.

Nonetheless, the figure is of limited use when assessing and planning the diet of individuals. If the regular intake of sodium on an individual level exceeds this figure, it could be associated with a greater risk of cardiovascular diseases, including such concurrent risk factors as primary hypertension.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of sodium in foods have not been linked to adverse effects in children and adults.

Effect in sport

Its inclusion in fluid recovery drinks is effective, both during and after physical exertion, given that it is the only electrolyte that seems essential in helping to maintain hydration alongside eunatremia in sports practice. It is involved in muscle function.

The osmolarity of these drinks should be isotonic (270-330 mOsm/kg of water) to slightly hypotonic (200-270 mOsm/kg of water). Both suitable osmolarity and a correct concentration of carbohydrates and sodium, as well as the necessary quantity, are decisive factors in improving palatability, expediting gastric emptying and obtaining optimal absorption by the intestines.

Dose

The recommended standard concentration in recovery drinks is no less than 460 mg/L (46 mg/100 ml or 20 mmol/L) and no more than 1,150 mg/L (115 mg/100 ml or 50 mmol/L) based on the heat, intensity and duration of the physical exercise performed.

Grade of evidence: A (sodium is the only ion that has demonstrated its efficacy in liquid replacement studies).

Side effects, interactions

It has been demonstrated that the long-term intake of sodium supplements, such as sodium chloride, as well as the amount contained in food, has no adverse effects. The current recommendation is to not exceed 6 g/day of sodium chloride or its equivalent 2.4 g/day of sodium.

Excessive sodium intake leads to a calcium loss equivalent to 30 mg per 2 g of excess sodium.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

*Reduced sodium consumption contributes to the maintenance of normal blood pressure.

**Carbohydrate-electrolyte solutions help to maintain stamina levels during exercises that require prolonged stamina.

**Carbohydrate-electrolyte solutions improve water absorption during physical exercise.

Conditions for use of the claim

*This claim can only be used with regard to foods that at least contain a low level of sodium or salt, in accordance with the claim LOW IN SODIUM/SALT, or a reduced level of sodium or salt, in accordance with the claim REDUCED [NAME OF THE NUTRIENT] appearing in the annex to (EC) Regulation Nº 1924/2006.

**For a product to display this claim, the carbohydrate-electrolyte solutions must contain between 80 Kcal/L and 350 Kcal/L from carbohydrates and at least 75% of the energy must stem from carbohydrates causing a high glycaemic response, such as glucose, glucose polymers and sucrose. Furthermore, these drinks must contain between 20 mmol/L (460 mg/L) and 50 mmol/L (1,150 mg/L) of sodium and have an osmolarity of between 200 mOsm/kg and 330 mOsm/kg of water.

*Foods with low or reduced sodium.

**Carbohydrate-electrolyte solutions.

Foods that are a source of sodium: products of animal origin (shellfish and molluscs, salted and smoked fish, some marine algae), processed foods (cured and semi-cured cheeses, sausages and cured meats, industrial sauces, salted snacks, bread and industrial baking products), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.

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

AI, Safe and adequate intake: https://efsa.onlinelibrary.wiley.com/doi/full/10.2903/j.efsa.2019.5778

http://www.efsa.europa.eu/sites/default/fles/assets/ndatolerableuil.pdf

Bibliography

(1, 4, 5, 6, 7)

1.3. Magnesium (Mg)

A mineral that can be found throughout the body as part of the skeleton (59%), muscle tissue-soft tissues (40%) and extracellular fluid (1%). It is involved as a co-factor in physiological and biochemical processes related to oxidative phosphorylation, glycolysis, DNA transcription, protein synthesis and membrane maintenance.

It is especially related to the processes of neuromuscular transmission, electrolytic balance and energy release, and it helps to reduce tiredness and fatigue. Magnesium concentration in serum is 1.4-2.0 mEq/L (0.7-1.0 mmol/L).

The absorption of magnesium is supported by vitamin D and the intake of calcium. Excessive intake of magnesium can cause diarrhoea.

For the Spanish population and based on current eating habits, average magnesium intake is 300-400 mg/day.

Minimum magnesium requirements in adults are 4.5 mg/kg, estimated at 300-400 mg/day.

The RDI or dietary reference value for both the adult Spanish and European populations is estimated at 350 mg/day in men and 300 mg/day in women.

The tolerable upper intake level (UL) has been set at 625 mg/day of strictly food origin and at 250 mg/day for magnesium from easily dissociable Mg (e.g. chloride, sulphate, aspartate, lactate) and such compounds as MgO in food supplements, water or added to food; this does not include Mg naturally present in foods and drinks.

Effect in sport

Its supplementation could be effective in fostering optimal muscle mass function, contraction and relaxation. So too its inclusion in recovery drinks given that magnesium is lost through sweating and reduced in plasma, a situation tied to the occurrence of muscle cramps.

Although there are no conclusive studies on its supplementation in sports practice, its links to performance, recovery and muscle pain are currently being studied.

Dose

As an increase to sport performance, helping to improve muscle contraction and relaxation, there is reference to a single dose at night of 250 mg/day. In such commercial compounds as aspartate, bisglycinate, chloride, citrate, gluconate, glycerophosphate, lactate, pidolate, carbonate, hydroxide and oxide.

Grade of evidence: B (the intake of 250 mg/day in a single dose at night improves muscle contraction/relaxation function).

Side effects, interactions

Excessive magnesium causes diarrhoea.

A number of studies exist on a negative effect to the phosphorous balance when exceeding 500 mg/day.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Magnesium helps reduce tiredness and fatigue.

Magnesium contributes to electrolytic balance.

Magnesium contributes to normal energy metabolism.

Magnesium contributes to normal nervous system function.

Magnesium contributes to normal muscle function.

Magnesium contributes to normal protein synthesis.

Magnesium contributes to normal psychological function.

Magnesium contributes to the maintenance of bones in normal condition.

Magnesium contributes to the maintenance of teeth in normal condition.

Magnesium 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 magnesium in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS].

Foods that are a source of magnesium: nuts and seeds (pumpkin seeds, almonds, cashew nuts, walnuts), legumes and wholegrain cereals (chick peas, lentils, wholegrain oats, wholegrain bread), vegetables (spinach, chard), dark chocolate (at least 70% cocoa), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

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

1.4. Calcium (Ca)

Calcium is the most abundant divalent cation. 1,000 g of calcium can be found in the body. It is mainly involved in energy metabolism, muscle contraction, neuromuscular excitability, nerve conduction and blood coagulation. Calcium concentration in serum is 8.5-10.5 mg/dL (2.12-2.62 mmol/L).

For the Spanish population and based on current eating habits, average calcium intake is 1,000 mg/day for men and 800 mg/day for women.

Minimum calcium requirements are estimated at 400-1,000 mg/day. A lack of calcium can be caused by insufficient dietary intake, a vitamin D deficiency or a very low Ca/P ratio (optimal calcium/phosphorous ratio in the diet varies between 1 and 2). The results are insufficient mineralisation of the bone matrix, which causes osteoporosis, and rickets and osteomalacia, depending on age.

The RDI or dietary reference value for both the adult Spanish and European populations is estimated at 950 mg/day.

The tolerable upper intake level (UL) has been set at 2,500 mg/day. Excessive calcium intake above 2,000 mg/day can cause hypercalcaemia and hypercalciuria, with urinary stones, kidney function deterioration and increased constipation, and inhibited absorption of iron, zinc and other minerals.

Effect in sport

There are no conclusive studies on its supplementation in sports practice, provided no pathology exists (osteopenia, osteoporosis).

Dose

A balanced diet that includes sufficient foods with calcium of both dairy and non-dairy origin generally meets the daily calcium requirements.

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

Grade of evidence: B. (intake of 1,500 mg/day, together with 1,500-2,000 IU vitamin D, in low availability situations or amenorrhoea in prevention of osteoporosis, fractures and muscle dysfunction).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Calcium contributes to normal blood coagulation.
Calcium contributes to normal energy metabolism.
Calcium contributes to normal muscle function.
Calcium contributes to normal neurotransmission function.
Calcium contributes to normal digestive enzyme function.
Calcium contributes to the cell division and differentiation process.
Calcium is necessary for maintaining bones in normal condition.
Calcium is necessary for maintaining teeth 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 calcium in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of calcium: dairies and derivatives (parmesan cheese, cured manchego cheese, cheddar, milk, yoghurt), fish and shellfish (canned sardines with spine, anchovies, shrimp), nuts and seeds (almonds, hazelnuts, sesame seeds), legumes and wholegrain cereals (chick peas, soya beans), greens and vegetables (spinach, chard), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 4, 5, 6, 7, 10, 11, 12)

1.5. Phosphorus (F)

Phosphorous is an essential nutrient that is involved in numerous physiological processes, such as the cellular energy cycle, acid-base balance regulation in the body, as a component of the cellular structure, cellular regulation and signalling, and the mineralisation of bones and teeth. The amount of phosphorous in the body is around 700 g. Phosphorous concentration in plasma ranges from 2.2 mg/dL to 4.4 mg/dL (0.71-1.42 mmol/L).

The same hormones and determinants are involved in its homeostasis as for calcium, which is why a phosphorous/calcium balance is so essential for optimal metabolism of both minerals.

In terms of that balance, a high intake of phosphorous with a deficient intake of calcium (calcium/phosphorous <1) can lead to secondary hyperparathyroidism with bone density loss in the long term. This situation can arise with an elevated consumption of meats, eggs, milk derivatives and food products with phosphates as additives. The optimal calcium/phosphorous ratio in the diet varies between 1 and 2.

For the Spanish population and based on current eating habits, average phosphorous intake is between 1,348 and 1,458 mg/day in men and around 1,440 mg/day in women.

Minimum phosphorous requirements are estimated at 700 mg/day.

The RDI or dietary reference value for the adult Spanish population is 700 mg/day, while for the European adult population this figures stands at 550 mg/day.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of phosphorous in foods have not been linked to adverse effects in children and adults. However, data in the reference bibliography indicate that healthy people can tolerate phosphorous intake of up to 3,000 mg/day with no adverse systemic effects.

Effect in sport

There are no conclusive studies on its supplementation in sports practice at doses beyond the RDI and UL ranges.

Studies exist on the use of sodium phosphate to prevent muscle fatigue, both in aerobic and anaerobic workouts, but the results are inconclusive given the varying doses, frequencies, references to side effects or contraindications, other substances consumed at the same time (caffeine), level of physical fitness and gender. More research is needed.

Dose

A balanced diet that includes sufficient foods with phosphorous, which is present in a large number of foods (especially those rich in protein of both animal and plant origin, nuts and cereals), generally meets the daily phosphorous requirements.

The current average intake of dietary and supplementary phosphorous in some European countries stands at 1,000-1,500 mg/day, with a number of high consumption figures (97.5 percentile) of up to 2,600 mg, with no evidence of any associated adverse effects.

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

An excessive diet of foods rich in phosphorous and additives containing phosphorous can hinder the metabolism of calcium. Evidence of a lack of exogenous phosphorous in patients with parenteral nutrition has been found.

Minor gastrointestinal symptoms may arise, such as osmotic diarrhoea, nausea and vomiting, when taking supplements at doses >750 mg of phosphorous per day.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Phosphorous contributes to normal energy metabolism.

Phosphorous contributes to normal cellular membrane function.

Phosphorous contributes to the maintenance of bones in normal condition.

Phosphorous contributes to the maintenance of teeth 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 phosphorous in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of phosphorous: meats, fish and shellfish (salmon, sardines, tuna, beef, chicken), dairies and derivatives (parmesan cheese, cheddar cheese, milk, yoghurt), nuts and seeds (sunflower seeds, almonds, cashew nuts, walnuts), legumes and wholegrain cereals (chick peas, lentils, wholegrain oats), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 3, 4, 5, 6, 7, 13)

1.6. Iron (Fe)

Iron is an essential component for cellular metabolism. It forms part of the haemoglobin and myoglobin, is a co-factor in oxidation-reduction reactions and DNA synthesis, and is involved as a carrier of oxygen in the body and of electrons in mitochondria.

Normal serum values for iron are 50 to 150 µg/dL (0.00895 - 0.02685 mmol/L). Haem iron is absorbed more easily and in a higher percentage (25%) than ferrous and ferric ions, the latter being the hardest to be absorbed. Hydrochloric acid facilitates the conversion of ferric iron to ferrous iron.

Iron of plant origin is a non-haem iron. It is found in ferric salt form that passes to a ferrous state during the digestive period for absorption, encouraged by the presence of organic acids (especially ascorbic acid) and animal proteins rich in cysteine.

Certain food components, such as tannins, phytates, polyphenols (tea, coffee, bran), and excess intake of calcium and zinc, H2 blockers and antacids are considered absorption inhibiters.

A high availability of iron is calculated when more than 90 g of animal protein are ingested in a single meal mixed with plant-based foods that provide non-haem iron in adequate quantity, accompanied by more than 75 mg of ascorbic acid.

For the Spanish population and based on current eating habits, average iron intake is 15 mg/day in men and around 12-14 mg/day in women.

Minimum iron requirements are estimated at 7 mg/day in women of fertile age and 6 mg/day in men and post-menopausal women.

For the European population, the RDI or dietary reference value for iron is estimated at 16 mg/day in women of fertile age and 11 mg/day in men and post-menopausal women.

For the Spanish population, the RDI or dietary reference value for iron is estimated at 18 mg/day in women of fertile age and 9.1 mg/day in men and post-menopausal women.

Women who menstruate with high blood loss may be classified as an at-risk population group and may benefit from an additional intake of this mineral or an improvement to its availability in their diet.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of iron in foods have not been linked to adverse effects in children and adults. It should be noted that an excess of iron may increase oxidative stress by increasing free radicals, which can lead to the development of various ailments. The daily recommendation for labelling purposes in the EU is 14 mg.

Effect in sport

There are no conclusive studies on its supplementation in sports practice. There are only reports on fatigue and poor sport performance in cases of reduced blood iron and anaemia.

An iron deficit can exist in athletes due to the type of sport practised (endurance, activities at altitude) and environmental factors (digestive microhemorrhages, foot lacerations, haematurias). In such cases, 30-70% increases to the RDI are considered necessary, with monitoring and control to prevent a negative impact on health and physical performance, especially in cases of a sub-optimal iron condition with serum ferritin at the lower end of normality.

To assess the blood concentrations of this mineral, it is recommended to conduct testing 3 or 4 days after engaging in long-duration physical exercise and significant sweating due to the haemoconcentration that takes place under these conditions, with an increase to the normal reference values that can produce false results and lead to a misinterpretation of the situation.

Dose

A balanced diet that includes sufficient foods with iron generally meets the daily iron requirements. For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 6 mg for every supplementary 1,000 kcal (upper limit of 28 mg/day).

30-70% increases to the RDI may be necessary, with monitoring and control to prevent a negative impact on health and physical performance in cases of: low intake, increased need (rapid growth, training at altitude), excessive loss (menstrual, during exercise from sweat, faeces, urine).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

Excessive iron intake may increase oxidative stress by increasing free radicals, which can lead to the development of various ailments.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Iron contributes to normal cognitive function.
Iron contributes to normal energy metabolism.
Iron contributes to the normal formation of red blood cells and haemoglobin.
Iron contributes to the normal transportation of oxygen in the body.
Iron contributes to normal immune system function.
Iron helps reduce tiredness and fatigue.
Iron 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 iron in accordance with the claim SOURCE OF [NAME OF THE

VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of iron: meats and offal (pig liver, cow liver, blood sausage), fish and shellfish (clams, cockles, mussels, canned sardines), legumes and wholegrain cereals (source of non-haem iron, lesser absorption: lentils, soya beans, chick peas), nuts and seeds (source of non-haem iron, lesser absorption: pistachios, sesame), etc.

Conditions, restrictions or complementary warning

None.

URL

EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 4, 5, 6, 7, 14, 15)

1.7 Zinc (Zn)

A divalent cation that is involved in numerous enzyme systems (over 200), with the prosthetic group of which it is part being necessary for protein and nucleic acid synthesis. Zinc is involved in reactions with iron, copper and magnesium. It supports antioxidant functions and protects from peroxidation.

Between 3% and 38% is absorbed from diet, with zinc of food origin in diets with animal proteins corresponding to the higher end of the range. The presence of organic acids encourages its absorption, while calcium and phytates inhibit it. Plasma zinc concentration is 70-120 µg/dL (10.7-18.4 µmol/L).

For the Spanish population and based on current eating habits, average zinc intake is between 8 and 9 mg/day in women and between 10 and 12 mg/day in men.

Minimum zinc requirements are estimated at 7.5 mg/day for men and 6.2 mg/day for women.

For the adult European population, the RDI or dietary reference value for zinc is 11.7 mg/day for men and 9.3 mg/day for women.

For the adult Spanish population, the RDI or dietary reference value for zinc is 11 mg/day for men and 8 mg/day for women.

The tolerable upper intake level (UL) has been set at 25 mg/day given that various studies show that it can alter the metabolism of copper, the immune response and blood cells.

Effect in sport

Zinc is related to the production of testosterone, improved muscle performance, and anti-inflammatory and anti-oxidant effects.

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

Dose

A balanced diet that includes sufficient foods with zinc generally meets the daily zinc requirements. There are references for doses of 10-40 mg/day. For the French active population, a supplement recommendation of 1 mg/day for every supplementary 1,000 kcal has been set (upper limit of 25 mg/day). The dose at which no side effects are observed (NOAEL, No Observed Adverse Effect Level) is around 50 mg/day.

Grade of evidence: B (dose of 10-40 mg/day, effective in cases of deficiency).

Side effects, interactions

Chronic zinc toxicity is linked to symptoms of copper deficiency (anaemia, neutropenia, changes to the immune system), evident only after the consumption of zinc in the form of dietary supplements at doses of 150 mg/day over prolonged periods.

Excess zinc can cause a cholesterol reduction tied to high-density lipoproteins and an increased risk of cardiovascular diseases. Generally speaking, it is only effective in cases of a deficiency in these minerals.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Zinc contributes to normal acid-base balance.
Zinc contributes to the normal metabolism of carbohydrates.
Zinc contributes to normal cognitive function.
Zinc contributes to normal DNA synthesis.
Zinc contributes to normal fertility and reproduction.
Zinc contributes to the normal metabolism of macronutrients.
Zinc contributes to the normal metabolism of fatty acids.
Zinc contributes to the normal metabolism of vitamin A.
Zinc contributes to normal protein synthesis.
Zinc contributes to the maintenance of bones in normal condition.
Zinc contributes to the maintenance of hair in normal condition.
Zinc contributes to the maintenance of nails in normal condition.
Zinc contributes to the maintenance of skin in normal condition.
Zinc contributes to the maintenance of normal testosterone levels.
Zinc contributes to the maintenance of eyesight in normal condition.
Zinc contributes to normal immune system function.
Zinc contributes to the protection of cells from oxidative damage.
Zinc 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 zinc in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of zinc: fish and shellfish (oysters, crab, mussels, sardines), meats and offal (cow liver, beef, lamb, pork, chicken), nuts and seeds (pumpkin seeds, sesame, cashew nuts, walnuts), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 3, 4, 5, 6, 7, 16)

1.8. Selenium (Se)

It is as metabolically active as selenoprotein. It forms part of various enzymes, such as glutathione peroxidase, is an antioxidant that protects cellular structures from the action of lipid peroxides and free radicals.

It is involved in the metabolism of thyroid hormones and in the regeneration of reduced forms of vitamins C and E. It is involved in the synthesis of prostacyclins.

Plasma selenium concentration is 5-12 µg/dL (0.63-1.51 µmol/L).

For the Spanish population and based on current eating habits, average selenium intake is between 50 and 60 µg/day.

Minimum selenium requirements are estimated at 70 µg/day.

For the adult European population, the RDI or dietary reference value for selenium is 70 µg/day.

For the adult Spanish population, the RDI or dietary reference value for selenium is 70 µg/day for men and 55 µg/day for women.

The tolerable upper intake level (UL) has been set at 255 µg/day given that excessive intake of selenium causes selenosis, leading to skin lesions and hair and nail loss. Long-term consumption of large doses (over 900 µg/day) can cause neurological chances, including numbness, convulsions and paralysis.

Effect in sport

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

Works exist on the response from oxidative stress to antioxidants, but they do not specify the type of trials and present bias in the choice of population groups, doses and in the differentiation of the effect individualised by the antioxidants subject to study.

Dose

A balanced diet that includes sufficient foods with selenium generally meets the daily zinc requirements. For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 30 µg/day for every supplementary 1,000 kcal (upper limit of 255 µg/day).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

Excessive selenium intake can lead to neurological changes and selenosis.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Selenium contributes to normal spermatogenesis.

Selenium contributes to the maintenance of hair in normal condition.

Selenium contributes to the maintenance of nails in normal condition.

Selenium contributes to normal immune system function.

Selenium contributes to normal thyroid function.

Selenium 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 selenium in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of selenium: shellfish and fish (tuna, salmon, shrimp, mussels), meats and offal (cow liver, chicken, pork), nuts and seeds (Brazil nuts, sunflower seeds), eggs, wholegrain oats, etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 4, 5, 6, 7, 17, 18)

1.9. Manganese (Mn)

Manganese is an essential element in mitochondrial metalloenzymes (pyruvate carboxylase, superoxide dismutase) and an activator of certain cynases, decarboxylases, hydrolases and transferases.

Plasma manganese concentration is 0.04-0.1 µg/dL (7.3-18.2 nmol/L) although it should be noted that plasma concentrations of this mineral do not vary in subjects with a reduction or increase thereof.

Low manganese levels have been linked to changes in its metabolism, with clinical convulsions in childhood, dermatitis, capillary changes and changes in the coagulation factors that depend on vitamin K.

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

Minimum manganese requirements are estimated at 3 mg/day.

The RDI or dietary reference value for both the adult Spanish and European populations is estimated at 3 mg/day. On the other hand, the daily recommendation in the EU for labelling purposes is 2 mg.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of manganese in foods have not been linked to adverse effects in children and adults. However, a safe intake level of 8 mg/day has been established. Whenever a UL cannot be determined, a safe intake level represents the highest intake level for a nutrient for which there is reasonable confidence in the data about a lack of adverse effect(s).

Effect in sport

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

Dose

A balanced diet that includes sufficient foods with manganese generally meets the daily manganese requirements. The World Health Organisation (WHO) considers a daily intake quantity with no adverse effects up to 11 mg/day (0.06 mg/kg of body weight).

For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 0.6 mg/day for every supplementary 1,000 kcal (upper limit of 8 mg/day).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

No data exist on its toxicity via oral ingestion in quantities of less than 10 mg/day, but it can be toxic if inhaled or administered parenterally (neurotoxicity).

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Manganese contributes to normal energy metabolism.

Manganese contributes to the maintenance of bones in normal condition.

Manganese contributes to the normal formation of connective tissue.

Manganese 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 manganese in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of manganese: nuts and seeds (hazelnuts, walnuts, almonds, pistachios, sesame seeds), wholegrain cereals and derivatives (wholegrain oats, wholegrain rice, wholegrain bread), legumes (lentils, chick peas), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 4, 5, 6, 7, 19, 20)

1.10. Chrome (Cr)

A mineral that, in trivalent form, is a co-factor in reactions involving insulin and is necessary for the correct metabolism of glucose.

Plasma chrome concentration cannot be evaluated as there are no reliable methods for its detection in blood, making it difficult to estimate needs and identify a state of deficit. An insufficiency can be indirectly established if patients with a resistance to insulin improve with chrome supplementation in physiological quantities.

Deficiency in patients with prolonged parenteral nutrition manifests clinically via relative resistance to insulin and central or peripheral neuropathy.

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

No data are available on minimum chrome requirements, but the administration of 10-15 µg/day is recommended to prevent deficiency.

For the adult European population, the RDI or dietary reference value for chrome has not been established.

For the adult Spanish population, the RDI or dietary reference value for chrome varies according to age and gender. For individuals aged between 14 and 49, the RDI is 35 µg/day for men and 25 µg/day for women. For those aged between 50 and 59, the RDI is set at 30 µg/day for men and 25 µg/day for women. From the age of 60, the RDI remains at 30 µg/day for men but falls to 20 µg/day for women.

The tolerable upper intake level (UL) has not been established due to a lack of sufficient available data given that the quantities of chrome in foods have not been linked to adverse effects in children and adults.

Effect in sport

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

Dose

UA balanced diet that includes sufficient foods with chrome generally meets the daily chrome requirements. However, the administration of 10-15 µg/day is recommended to prevent deficiency.

No signs of deficiency or toxicity have been found with the consumption of 50-200 µg/day. For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 20 µg/day for every supplementary 1,000 kcal (upper limit of 120 µg/day).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

None.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Chrome contributes to the normal metabolism of macronutrients.

Chrome contributes to the maintenance of normal blood glucose levels.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of trivalent chrome in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of chrome: meats and fish (cow liver, beef, fish and shellfish), fruits and seeds (walnuts, hazelnuts), wholegrain cereals (wheat germ, wholegrain oats), green beans, broccoli, etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 4, 5, 6, 7)

1.11. Copper (Cu)

Copper is found forming part of caeruloplasmin and metalloenzymes. It is involved in the metabolism of iron (transferrin synthesis), bone mineralisation, the maintenance of collagen and elastin, the regulation of neurotransmitters, immunity, the oxidative metabolism of glucose, especially in the myocardium, and the elimination of free radicals through superoxide dismutase.

Copper absorption rates are 30-40%, encouraged by proteins and inhibited by vitamin C, disaccharides and excess iron and zinc.

Plasma copper concentration is 70-140 µg/dL (11.0-22.0 µmol/L).

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

Minimum copper requirements are estimated at 1.1 mg/day. Hypocupremia has been found in undernourished children with prolonged milk feeding, in patients fed exclusively parenterally and in patients with diseases caused by copper metabolism disorders or dealing with caeruloplasmin deficiency. The clinical symptoms of a copper deficiency are macrocytic hypochromic anaemia, neutropenia, bone demineralisation and changes to cutaneous pigmentation.

For the adult European population, the RDI or dietary reference value for copper is 1.6 mg/day for men and 1.3 mg/day for women.

For the adult Spanish population, the RDI or dietary reference value for copper is 1.3 mg/day for men and 1.1 mg/day for women.

The tolerable upper intake level (UL) has been set at 5 mg/day. In greater quantities, there is a risk of neurological damage, liver damage and brain damage.

Effect in sport

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

Dose

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

For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 0.6 mg/day for every supplementary 1,000 kcal (upper limit of 3.5 mg/day).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

Excessive copper intake can lead to liver damage, brain damage or neurological problems.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Copper contributes to the maintenance of connective tissue in normal condition.

Copper contributes to normal energy metabolism.

Copper contributes to normal nervous system function.

Copper contributes to normal hair pigmentation.

Copper contributes to the normal transportation of iron in the body.

Copper contributes to normal skin pigmentation.

Copper contributes to normal immune system function.

Copper 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 copper in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of copper: nuts and seeds (Brazil nuts, sunflower seeds, almonds), shellfish and fish (oysters, mussels, prawns, sardines), meats and offal (cow liver, lamb, pork), cereals and legumes (wheat germ, lentils, wholegrain oats), vegetables (spinach, mushrooms), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 3, 4, 5, 6, 7, 21)

1.12. Iodine (I)

Iodine plays an important role in the release of energy, in the production of thyroid hormones, and in nerve and cognitive function. Plasma iodine concentration is estimated at 10-20 µg/L (0.127-0.254 nmol/L).

For the Spanish population and based on current eating habits, average iodine intake is between 87 and 97 µg/day.

Minimum iodine requirements are estimated at 150 µg/day.

The RDI or dietary reference value for both the adult Spanish and European populations is estimated at 150 mg/day.

The tolerable upper intake level (UL) has been set at 600 µg/day given that it has been linked, among other abnormalities, to thyroiditis, goiter, hypothyroidism, hyperthyroidism, acute reactions in certain individuals, etc., but the majority of the population tolerates the excess iodine in foods.

Effect in sport

There are no conclusive studies on its supplementation in sports practice, despite iodine loss through sweat, given that there is no correlation between the reduction in physical performance and iodine deficit.

Dose

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

For the French active population, the same quantity has been set as for the general population and a supplement recommendation of 50 µg/day for every supplementary 1,000 kcal (upper limit of 300 µg/day).

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

Iodine abuse can lead to thyroiditis, goiter, hypothyroidism, hyperthyroidism, acute reactions in certain individuals, etc.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

Iodine contributes to normal cognitive function.

Iodine contributes to normal energy metabolism.

Iodine contributes to normal nervous system function.

Iodine contributes to the maintenance of skin in normal condition.

Iodine contributes to normal thyroid hormone production and normal thyroid function.

Conditions for use of the claim

This claim can only be used with regard to foods that are, at least, a source of iodine in accordance with the claim SOURCE OF [NAME OF THE VITAMINS] AND/OR [NAME OF THE MINERALS] appearing in the annex to (EC) Regulation Nº 1924/2006.

Foods that are a source of iodine: iodised salt, marine algae (kombu, wakame, alga nori), fish and shellfish (clams, salmon, cod, mussels, prawns), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliography

(1, 3, 4, 5, 6, 7, 22)

1.13. Boron (B)

Boron is a trace element that has been studied little in terms of its bioavailability, requirements, deficiency and toxicity in humans. It is naturally found in groundwater and the environment, with plant-based foods being those with the highest levels. The quantity of boron in drinking water is between 0.1 and 0.3 mg/L. Concentrations vary depending on the local geology and waste water sewage (detergents).

The WHO has estimated that the acceptable level of boron in the water is 0.5 mg/L and that the tolerable daily intake is 0.16 mg/kg.

Its supplementation has been tied to the prevention of osteoporosis in post-menopausal women due to increased plasma concentrations of estradiol and testosterone, which could suggest an insufficiently demonstrated anabolic effect. It can also play a role in improving brain function, arthritis and the lipid profile in plasma.

Plasma boron concentration is estimated at 20-60 µg/L (1.85 to 5.55 nmol/L).

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

The RDI or dietary reference value for both the adult Spanish and European populations has not been established.

The tolerable upper intake level (UL) has been set at 10 mg/day. In terms of its toxicity, it has been tied to negative effects on spermatogenesis.

Effect in sport

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

Dose

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

Grade of evidence: C (athletes will not need mineral supplements if they consume enough energy to maintain adequate body weight via a varied and balanced diet).

Side effects, interactions

Boron abuse has been tied to negative effects on spermatogenesis.

Contraindications

Unknown at the recommended dose in healthy people.

Nutrition and health claim

None.

Conditions for use of the claim

None.

Foods that are a source of boron: fruits (grapes, pears), vegetables (broccoli, kale), nuts and seeds (almonds, walnuts, sunflower seeds), etc.

Conditions, restrictions or complementary warning

None.

URL

(EU) Regulation Nº 432/2012 in EUR-Lex.
Link: http://data.europa.eu/eli/reg/2012/432/oj

Bibliografía

(1, 7)

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

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Potassium (K	- It acts on the acid-base balance, muscular contraction and neuromuscular activity. - It helps normalise hydration by facilitating water retention in the intracellular space, after exercise.	3,500 mg/day	NE	Recovery drink: - Recovery drink: - Standard, 2-6 mmol/L (2.5-6 mEq/L or 10,14-19.5 mg/100 ml) - Excessive sweating ≤7.5 mEq/L (7.5 mmol/L or 29.2 mg/100 ml). - Do not exceed 10 mmol/L	B	- No adverse effects in supplements of 3 g/day of ClNa, as well as that contained in daily intake. - Reduction of intracellular potassium, possibly due to the delaying effect of caffeine on the appearance of fatigue.	Unknown at the recommended doses in healthy people.
Sodium (Na)	- It helps maintain hydration during sports practice. - It is involved in muscle function	-1.5 g/day PES -2 g/day PEU	NE	Recovery drink: - No less than 460 mg/L (46 mg/100 ml or 20 mmol/L) and no more than 1,150 mg/L (115 mg/100 ml or 50 mmol/L).	A	- No adverse effects with the recommendation up to 2.4 g/day Na (6 g/day of ClNa). - Loss of calcium equivalent to 30 mg per 2 g of excess Na.	Unknown at the recommended doses in healthy people.
Magnesium (Mg)	- It is a co-factor in physiological and biochemical processes related to oxidative phosphorylation, glycolysis, DNA transcription, protein synthesis and membrane maintenance. - It helps to reduce tiredness and fatigue. - Related to neuromuscular transmission, electrolytic balance and the release of energy.	300-350 mg/day (lower range in women)	- 625 mg, food origin - 250 mg/day (Mg salts, not including foods and drinks with Mg).	- 250 mg/day, in a single dose, at night (salts, such as aspartate, bisglycinate, chloride, citrate, gluconate, glycerophosphate, lactate, pidolate, carbonate, hydroxide and oxide).	B	- Diarrhoea, with excess consumption. - Negative effect on the balance of phosphorous when exceeding 500 mg/day.	Unknown at the recommended doses in healthy people.
Calcium (Ca)	It is involved in energy metabolism, muscle contraction, neuromuscular excitability, nerve conduction and blood coagulation.	950 mg/day	2,500 mg/day	1,500 mg/day + 1,500-2,000 UI vit. D in low availability or amenorrhoea.	B	In amounts over 2,000 mg/day, risk of: - Hypercalcaemia and hypercalciuria with lithiasis, kidney function alteration and constipation. - Difficulty absorbing iron, zinc, other minerals and trace elements.	Unknown at the recommended doses in healthy people.
Phosphorous (F)	- It is involved in energy storage and buffer processes in blood and urine. - Necessary for cellular function and supplying oxygen to tissues.	- 700 mg/day. PES - 550 mg/day. PEU	NE	1,000-1,500 mg/day	C	- In amounts over 750 mg/day, risk of minor gastrointestinal symptomatology (osmotic diarrhoea, nausea and vomiting). - In amounts over 3,000 mg/day, risk of: · Secondary hyperparathyroidism with loss of bone density when Ca/P<1. · Difficulty metabolising calcium.	Unknown at the recommended doses in healthy people.
Iron (Fe)	- It is a co-factor in oxidation-reduction reactions and DNA synthesis. - It acts as a carrier of oxygen in the body and of electrons in mitochondria.	- 9.1-18 mg/day (lower range in men and post-menopausal women). PES - 9.1-11 mg/day (lower range in men and post-menopausal women). PEU	- NE - 14 mg (Food labelling).	- 6 mg/day per 1000 supplementary kcal (active French population). - RDI+ 30-40% RDI, in case of: low intake, increased need (rapid growth, training at altitude), excessive loss (menstrual, during exercise from sweat, faeces, urine).	C	- In excess, it may increase oxidative stress by increasing free radicals, a situation with risk of developing various ailments. - Absorption inhibited by: · Excess calcium. · Excess zinc. · H2 blockers. · Antacids. · Such food components as tannins and polyphenols.	Unknown at the recommended doses 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 minerals. ***(continuation)***

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Zinc (Zn)	- It is involved in enzyme systems and is necessary for protein and nucleic acid synthesis. - It is involved in reactions with iron, copper and magnesium. - It supports antioxidant functions and protects from peroxidation. - It is related to the production of testosterone, improved muscle performance, and anti-inflammatory effects.	- 8-9.3 mg/day (lower range in women). PES - 11-11.7 mg/day (lower range in women). PEU	25 mg/day	10-40 mg/day, in case of deficit.	B	- In excess, risk of: · Reduced HDL cholesterol. · Increased cardiovascular irregularities. - In prolonged consumption at 150 mg/day, risk of Cu deficiency: · Anaemia · Neutropenia · Changes to the immune system. - The presence of organic acids encourages absorption. - Calcium and phytates inhibit absorption.	Unknown at the recommended dose in healthy people.
Selenium (Se)	- It forms part of various enzymes, such as glutathione peroxidase. - It is involved in the metabolism of thyroid hormones and in the synthesis of prostacyclins.	- 55-70 µg /day (women-men). PES - 70 µg/day. PEU	255 µg/day.	- 30 µg/day per 1,000 supplementary kcal (active French population).	C	In amounts over 900 µg/day, risk of: - Neurological changes (numbness, convulsions and paralysis). - Selenosis (skin lesions and hair and nail loss).	Unknown at the recommended dose in healthy people.
Manganeso (Mn)	- It activates certain cynases, decarboxylases, hydrolases and transferases.	3 mg/day	- NE - Safe intake level: 8 mg/day (active French population).	- 0.6 mg/day per 1,000 supplementary kcal (active French population).	C	- No adverse effects when ingesting through diet <11 mg/day (0.06 mg/kg of body weight) (WHO). - Toxic if inhaled or administered parenterally (neurotoxicity).	Unknown at the recommended dose in healthy people.
Chrome (Cr)	- In trivalent form, it is a co-factor in reactions involving insulin and is necessary for the correct metabolism of glucose.	- NE PEU - PES based on age and gender (lower range in women): · 14-49: 25-35 µg/day · 50-59: 25-30 µg/day · >60: 20-30 µg/day	- NE - Safe intake level: 20 µg/day (active French population).	- 10-15 µg/day deficit prevention - 20 µg/day per 1,000 supplementary kcal (active French population).	C	No signs of toxicity when consuming 50-200 µg/day.	Unknown at the recommended dose in healthy people.
Copper (Cu)	- It acts on the metabolism of iron (transferrin synthesis), bone mineralisation. - It is involved in the maintenance of collagen and elastin. - It presents an important role in the regulation of neurotransmitters, immunity, the oxidative metabolism of glucose, especially in the myocardium, and the elimination of free radicals.	- 1.3-1.1 mg/day (lower range in women) PES - 1.3-1.6 mg/day (lower range in women) PEU	5 mg/day	0.6 mg/day per 1,000 supplementary kcal and up to 3.5 mg/day (active French population).	C	- In amounts over 5 mg/day, risk of: · Neurological. · Hepatic. · Cerebral. - Absorption encouraged by: proteins. - Absorption inhibited by: · Vitamin C. · Disaccharides. · Excess iron and zinc.	Unknown at the recommended dose in healthy people.
Iodine (I)	It plays an important role in the release of energy, in the production of thyroid hormones, and in nerve and cognitive function.	150 µg/day.	600 µg/day.	50 µg/day per 1,000 supplementary kcal (active French population).	C	In amounts over 600 µg/day, risk of: - Thyroiditis, goiter, hypothyroidism, hyperthyroidism. - Acute reactions in certain individuals.	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 minerals. ***(continuation)***

Nutrient, bioactive compound and other substances	Effect	RDI	UL	Dose	Evidence grade	Side effects, interactions	Contraindications
Boron (B)	- It increases plasma concentrations of estradiol and testosterone (insufficiently demonstrated anabolic effect). - It also plays a role in improving brain function, arthritis and the lipid profile in plasma.	- NE - Tolerable daily intake in water is 0.16 mg/kg (WHO).	10 mg/day.	NE	C	Excess boron consumption is related to negative effects on spermatogenesis.	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. ClNa: Sodium chloride. WHO: World Health Organisation.

Table 2. Nutrition and health claim with the conditions for use, restrictions or warnings, in minerals (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)
Potassium	- Contributes to normal nervous system and muscle function. - Contributes to the maintenance of normal blood pressure.	Can only be used with regard to foods that are, at least, a source of potassium, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Sodium	- Reduced sodium consumption contributes to the maintenance of normal blood pressure. - Carbohydrate-electrolyte solutions contribute to the maintenance of stamina levels during exercises that require prolonged stamina. - Carbohydrate-electrolyte solutions improve water absorption during physical exercise.	Can only be used with regard to foods that appear, as reduced sodium or salt content, that appear in the annex to (EC) Regulation Nº 1924/2006. They must contain: - Na 20 mmol/L (460 mg/L) -50 mmol/L (1,150 mg/L) - CH ~ 80-350Kcal/L with 75% (G, its polymers and sucrose) - 200-300 mOsm/kg	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Magnesium	Helps reduce tiredness and fatigue. Contributes to electrolytic balance, normal energy metabolism, normal nervous system and muscle function, to protein synthesis and normal psychological function, to the maintenance of bones and teeth in normal condition and to the cellular division process.	Can only be used with regard to foods that are, at least, a source of magnesium, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Calcium	Contributes to blood coagulation and normal energy metabolism, to normal muscle function, neurotransmission and digestive enzymes, and to the cell division and differentiation process. Necessary for the maintenance of bones and teeth in normal condition.	Can only be used with regard to foods that are, at least, a source of phosphorous, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Phosphorous	Contributes to normal energy metabolism, normal cellular membrane function and to the maintenance of bones and teeth in normal condition.	Can only be used with regard to foods that are, at least, a source of phosphorous, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.

(continued)

Table 2. Nutrition and health claim with the conditions for use, restrictions or warnings, in minerals (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)
Iron	Contributes to cognitive function and normal energy metabolism, to the normal formation of red blood cells and haemoglobin, to the normal transport of oxygen in the body and to normal immune system function. Helps reduce tiredness and fatigue, and contributes to the cellular division process.	Can only be used with regard to foods that are, at least, a source of iron, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Zinc	Contributes to normal acid-base balance, to the normal metabolism of carbohydrates, to normal cognitive function, to normal DNA synthesis, to normal fertility and reproduction, to the normal metabolism of macronutrients, fatty acids and vitamin A. Contributes to normal protein synthesis, to the maintenance of bones, hair and nails in normal condition. Contributes to the maintenance of normal testosterone levels and to the maintenance of eyesight in normal condition, to normal immune system function, to the protection of cells against oxidative damage and to the cell division process.	Can only be used with regard to foods that are, at least, a source of zinc, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Selenium	Contributes to spermatogenesis, to the maintenance of hair and nails in normal condition, to normal immune system function, to normal thyroid function and to the protection of cells against oxidative damage.	Can only be used with regard to foods that are, at least, a source of selenium, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Manganese	Contributes to normal energy metabolism, to the maintenance of bones in normal condition, to normal connective tissue formation and to the protection of cells against oxidative damage.	Can only be used with regard to foods that are, at least, a source of manganese, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Chrome	Contributes to the normal metabolism of macronutrients. Contributes to the maintenance of normal blood glucose levels.	Can only be used with regard to foods that are, at least, a source of chrome, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Copper	Contributes to the maintenance of connective tissue in normal condition, to normal energy metabolism, to normal nervous system function, to normal hair and skin pigmentation, to the normal transport of iron in the body, to normal immune system function and to the protection of cells against oxidative damage.	Can only be used with regard to foods that are, at least, a source of copper, as appearing in the annex to (EC) Regulation Nº 1924/2006.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Iodine	Iodine contributes to normal cognitive function, to normal energy metabolism, to normal nervous system function, to the maintenance of skin in normal condition, to normal thyroid hormone production and to normal thyroid function.	Can only be used with regard to foods that are, at least, a source of iodine, as appearing in the annex to (EC) Regulation Nº 1924/2006.	With regard to intense sports practice, the need for supplementation has not been demonstrated to date despite iodine loss through sweat, given that there is no correlation between the reduction in physical performance and iodine deficit.	(EU) Regulation Nº 432/2012 in EUR-Lex.
Boron	None.	None.	None.	(EU) Regulation Nº 432/2012 in EUR-Lex.

ANNEXES (REGULATIONS CONSULTED)

ANNEX I

(EC) Regulation Nº 1924/2006 of the European Parliament and of the Council, of 20 December 2006, on nutrition and health claims made on foods (22).

Annex to (EC) Regulation Nº 1924/2006 (22)

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) Nº 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 (23).

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.

Bibliography

1. EFSA. Overview on Tolerable Upper Intake Levels as derived by the Scientific Committee on Food (SCF) and the EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA). 2024. (Consultado el 26/03/205). Disponible en: https://www.efsa.europa.eu/sites/default/files/2024-05/ul-summary-report.pdf
2. EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA), Turck D, Bresson JL, Burlingame B, Dean T, Fairweather-Tait S, Heinonen M, *et al.* Dietary reference values for potassium. 2016. (consultado 14/03/2025). Disponible en: https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/j.efsa.2016.4592.
3. European Food Safety Authority. Scientific Committee on Food. Tolerable upper intake levels for vitamins and minerals. 2006. (consultado 14/03/2025). Disponible en: https://www.efsa.europa.eu/sites/default/files/efsa_rep/blobserver_assets/ndatolerableuil.pdf.
4. Martínez JA, Cámara M, Giner RM, González E, López E, Mañes J, *et al.* Ingestas nutricionales de referencia (INR) de minerales y vitaminas para la población española. *Rev Esp Salud Pública*. 2019. e202203034.
5. Calleja CA, Cámara Hurtado M, Daschner A, Fernández Escámez P, Franco Abuín CM, Giner Pons RM, *et al.* Alimentaria y Nutrición (AESAN) sobre Ingestas Nutricionales de Referencia para la población española. (consultado 15/03/2025). Disponible en: https://www.aesan.gob.es/AECOSAN/docs/documentos/seguridad_alimentaria/evaluacion_riesgos/informes_comite/INR.pdf.
6. Ortega RM, Requejo AM, Navia B, López-Sobaler AM, Aparicio A. Ingestas diarias recomendadas de energía y nutrientes para la población española. Departamento de Nutrición, Universidad Complutense de Madrid, Madrid, 2019. (consultado 15/03/2025). Disponible en: https://www.ucm.es/idinutricion/file/ir-2019-actualizadas?ver.
7. Palacios Gil de Antuñano N, Manonelles Marqueta P, Blasco Redondo R, Contreras Fernández C, Franco Bonafonte L, Gaztañaga Aurrekoetxea T, *et al.* Grupo de Trabajo sobre Nutrición en el Deporte de la Federación Española de Medicina del Deporte. Suplementos nutricionales para el deportista. Ayudas ergogénicas en el deporte - 2019. Documento de Consenso de la Sociedad Española de Medicina del Deporte. *Arch Med Deporte*. 2019;36(Supl. 1):7-83.
8. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al.* Scientific Opinion on Dietary Reference Values for magnesium. 2015. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4186.
9. Tarsitano MG, Quinzi F, Folino K, Greco F, Oranges FP, Cerulli C, Emerenziani GP. Effects of magnesium supplementation on muscle soreness in different type of physical activities: a systematic review. *J Transl Med*. 2024;22:629.
10. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al.* Scientific Opinion on Dietary Reference Values for calcium. 2015. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4101.
11. Agostoni C, Bresson JL, Fairweather-Tait S, Flynn A, Golly I, Korhonen H, *et al*. Scientific Opinion on the Tolerable Upper Intake Level of calcium. 2012. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2012.2814.
12. Gil A, Mañas M, Martínez de Victoria E. Ingestas dietéticas de referencia, objetivos nutricionales y guías. En: Gil A, editor. Tratado de nutrición. 2ª ed. Tomo III: *Nutrición humana en el estado de salud*. Madrid: Ed. Médica Panamericana. 2010.
13. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al*. Scientific Opinion on Dietary Reference Values for phosphorus. 2015. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4185.
14. Turck D, Bohn T, Castenmiller J, de Henauw S, Hirsch-Erns KI, Knutsen HK, *et al*. Scientific opinion on the tolerable upper intake level for iron. 2024. (consultado 15/03/2025). Disponible en: https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2024.8819.
15. Bresson JL, Burlingame B, Dean T, Fairweather-Tait S, Heinonen M, Hirsch-Ernst KI, *et al.* Scientific Opinion on Dietary Reference Values for iron. 2015. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4254.
16. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al.* Scientific Opinion on Dietary Reference Values for zinc. 2014. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2014.3844.
17. Turck D, Bohn T, Castenmiller J, de Henauw S, Hirsch-Ernst KI, Knutsen HK, *et. al.* Scientific Opinion on the tolerable upper intake level for selenium. 2023. (consultado 15/03/2025). Disponible en: https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2023.7704.
18. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al.* Scientific Opinion on Dietary Reference Values for selenium. 2014. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2014.3846.

19. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et al*. Scientific Opinion on Dietary Reference Values for manganese. 2013;11(11):3419. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2013.3419.
20. Turck D, Bohn T, Castenmiller J, de Henauw S, Hirsch-Ernst KI, Knutsen HK, *et al*. Scientific opinion on the tolerable upper intake level for manganese. 2023. (consultado 15/03/2025). Disponible en: https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2023.8413.
21. Bresson JL, Burlingame B, Dean T, Fairweather-Tait S, Heinonen M, Hirsch-Ernst KI, *et al*. Scientific Opinion on Dietary Reference Values for copper. 2015. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4253.
22. Agostoni C, Berni Canani R, Fairweather-Tait S, Heinonen M, Korhonen H, La Vieille S, *et. al*. Scientific Opinion on Dietary Reference Values for iodine. 2014. (consultado 15/03/2025). Disponible en: https://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2014.3660.
23. Reglamento (CE) Nº 1924/2006 del Parlamento Europeo y del Consejo, de 20 de diciembre de 2006, relativo a las declaraciones nutricionales y de propiedades saludables en los alimentos. (consultado 15/03/2025). Disponible en: https://eur-lex.europa.eu/eli/reg/2006/1924/oj.
24. Directiva 90/496/CEE del Consejo, de 24 de septiembre de 1990, relativa al etiquetado sobre propiedades nutritivas de los productos alimenticios. (consultado 15/03/2025). Disponible en: https://eur-lex.europa.eu/eli/dir/1990/496/oj.