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Potassium Magnesium Citrate – best combination for sportive people

Potassium and magnesium are two essential bulk elements for human physiology. The salts of both elements exist in large quantities in nature and are component of diverse metabolic processes.

Importance for the athletically-active body

The formation of sweat varies depending on the intensity of the sporting activity and the ambient temperature. Physical activity increases the loss as well as the requirement of many mineral substances[1, 2]. On average, 10–30 mg of magnesium and 250–400 mg of potassium are eliminated per liter of sweat[3]. For this reason, a sufficient supply of potassium and magnesium of the body is essential. This is of particular importance for intensive activities such as power training and endurance training like spinning, running or rapid cycling, as well as for long-duration activities such as bicycle, canoe and hiking tours or even trekking tours.

By far the most important physiological process during athletic activity is the supply of muscles with nutrients. During long-duration activities, the energy requirement of the body rises considerably so that the body's own resources are quickly depleted (glucose, glycogen). Even an hour of training can use up to 30 % of the normal daily energy requirement[4].

Along with providing the body with sufficient energy-suppling foods, it is also important that the optimal metabolization of the ingested carbohydrates is ensured.

Potassium as well as magnesium are linked as cofactors in various carbohydrate-hydrolyzing processes such as glycolysis, the citrate cycle and the respiratory chain. Both minerals thus represent an indirect yet important contribution to the energy supply of the body.

Both minerals also take part in the stimuli transfer in the nerves. Above all, a deficiency of magnesium can lead to cramps during athletic activities, which is inconvenient at best, but can also be life threatening in the worst case, e. g. while diving.

General physiological properties of potassium

Daily requirement of potassium

The potassium requirement of a healthy adult is at least 2000 mg/day[5]. The German Nutrition Society (DGE) recommends a daily intake of 4000 mg[6]. The Linus Pauling Institute even recommends 4700 mg/day[7].

Electrochemical function

Potassium is the most important and most frequently occurring cation in terms of

quantity in the intracellular space of the human body[1, 8]. In many tissues, there is a steep gradient of potassium concentration between the cell interior (145 mmol/l K) and the extracellular fluid (3.8–5 mmol/l K)[8]. Potassium acts as an antagonist to sodium whose concentration gradient runs in the opposite direction.

These counteractive concentration gradients are sustained by an active transport mechanism, the sodium-potassium pump, and have several vital functions. A high potassium concentration in the interior of a cell helps maintain the intracellular osmotic pressure[1]. Numerous transport processes into and out of the cell are "driven" by these gradients. For example, the calcium content in muscle cells is regulated by the sodium gradients established by means of potassium, which in turn is responsible for the normal functioning of muscles. In addition, potassium and sodium concentration gradients are also essential for stimuli transfer in and to nerve cells [9].

Chemical-histological function

Organic potassium salts have an extremely important function when it comes to regulating the body's pH value. For example, the pH value is lowered after eating meat. During the metabolization of sulfurous amino acids such as cysteine and methionine, sulfuric acids are created that substantially contribute to the total quantity of non-carbonic acids produced in the body (NEAP – net rate of endogenous non-carbonic acid production).

Along with the direct elimination via the kidneys the neutralization via potassium carbonate from food is possible as well the neutralization of metabolic acids via potassium carbonate from food requires an adequate intake of organic potassium salts from the diet. This predominately is achieved by the consumption of potassium malate and potassium citrate from plant-based foods, above all fruits and vegetables. These salts are converted into potassium carbonate in the body, which can buffer the metabolic acids. Where this conversion takes place in the body is still unclear[10]; however, the improvement of the calcium balance of the body with the intake of potassium citrate is significant[11].

Enzymatic function

In general, potassium fulfils an important function in maintaining an optimal environment for various enzymatic reactions via its buffer capacity[12]. In addition, potassium also acts in numerous enzymes as a cofactor[12], for example – together with magnesium – in the pyruvate phosphokinase within the scope of the synthesis of adenosine triphosphate (ATP)[9]. In this way, potassium also takes part in glycolysis and is thus linked to another fundamental mechanism of metabolism.

Cardiological function

An acute potassium deficiency manifests itself above all in an impaired saltatory conduction in the heart as well as sometimes elevated blood pressure[1]. Athletic activities require an optimal heart function which makes the supply of the body with a sufficient amount of potassium essential.

General physiological significance of magnesium

Daily requirement of magnesium

The daily recommended amount of magnesium is 300–350 mg for adult females and 350–400 mg for adult males according to the German Nutrition Society (DGE)[13]. The American National Institute of Health recommends a higher dosage of 310–360 mg/day for women and 410–420 mg/day for men[14].

Electrochemical function

As a physiological antagonist to calcium, magnesium fulfils important functions in the control of various excitation processes. For example, it inhibits the release of acetylcholine at the motor end plates of nerve cells by blocking the calcium flow to the cell. In this way, the excitation of a muscle is regulated and permanent contractions (cramps) are prevented[1].

Histological function

Approx. 60 % of the total magnesium in the human body (approx. 20–28 g) is stored in bones and teeth in the form of hydroxyapatite. Magnesium makes a substantial contribution to the development, mineralization and stabilization of bones. These also represent the largest magnesium depot of the body. From this, it can be easily mobilized when the solution equilibrium between the bound magnesium in the bones and the extracellular dissolved magnesium shifts. The magnesium homeostasis of the body is governed by a complex hormonal control whose exact mechanism is still unclear[1].

Enzymatic function

Magnesium takes part in over 300 different enzymatic reactions as a cofactor. ATP-dependent reactions of energy metabolism such as the respiratory chain, the citrate cycle and glycolysis, especially relay on magnesium[1]. In addition, magnesium fulfils important tasks when it comes to the initialization of protein synthesis processes in the cell interior and cell nucleus. For example, magnesium catalyzes the aggregation of ribosomes to polysomes. Magnesium acts as a cofactor in ribonucleic acid enzymes (ribozymes) for the detection and splicing of target mRNA. Magnesium is also involved in the repair of damage to a cell's DNA[15].

Cardiological function

Magnesium helps to reduce arterial blood pressure by lowering the container muscle tone. In addition, magnesium decreases the platelet aggregation and has a positive influence on hyperglycemia[1, 16].

Optimized mineral intake

People that are physically active normally eat a healthy diet. With a varied diet and one that is attuned to the activity level, the body is adequately supplied with minerals.

However, a supplement may be required for load spikes or deficiency symptoms, for example, due to a potassium deficiency after a bout of diarrhea, which can quickly occur when traveling. Even an unbalanced diet can make an additional supply of both potassium and magnesium necessary, e.g. when an adequate food is unavailable. The necessity of a long-term, sufficient supply of the body,

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both with potassium and magnesium, mainly stems from the function of both minerals and/or their salts in bone mineralization. Organic potassium salts efficiently buffer metabolic acids. Magnesium is an integral part of the bone substance and essential for building and maintaining stable bones. A sufficient supply of the body with potassium and magnesium helps to minimize the risk of fractures by maintaining an optimal bone density, especially for injury-prone sports such as ball sports, martial arts or cycling[2, 10].

Fortified sports drinks or preparations from enriched drink powders are available for acute requirements for short-term peak loads such as running, cycling or various forms of these workouts (classic strength training, spinning, freeletics, etc.). Even powder in sachets or chewable tablets are an option for quick and easy supplementation in this area.

Consuming both minerals together in one product offers numerous advantages both regarding their function as well as additional space-savings while traveling. Potassium Magnesium Citrate is one such material that contains both minerals and is well-suited as a basic material and/or additive for numerous sports nutrition products, enriched beverages and dietary supplements.

Along with both minerals, potassium and magnesium, Potassium Magnesium Citrate also provides an important organic anion, namely citrate, for the maintenance of bone density. This is converted to hydrogen carbonate in the body and increases the buffer capacity of the body. In this way, metabolic acids are neutralized and an excessive demineralization of the bones is minimized[10, 11]. This makes Potassium Magnesium Citrate a wonderfully well-suited salt for sports nutrition and for dietary supplements in the field of sports.

Potassium Magnesium Citrate has a pleasant taste contrary to most other potassium compounds. It is easily soluble and suitable for the mineral enrichment of beverages and beverage powders. Potassium Magnesium Citrate is a free-flowing, non-hygroscopic powder and contains 26 % potassium and 4 % magnesium. Two minerals can be supplied with only one fully reacted mineral salt.

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References

[1]Hahn, A., Schuchard, J.: Mineralstoffe. B.Behr´s Verlag Hamburg 2011
[2]Tucker, K.L., Hannan, M.T., Chen, H., Cupples, L.A., Wilson, P.W.F., Kiel, D.P.: Potassium, magnesium, and fruit and vegetable intakes are associated with greater bone mineral density in elderly men and women. Am J Clin Nutr April 1999 vol. 69 no. 4 727-736
[3]http://www.nestmann.de/PDF/Artikel/Magnesium_u_Kalium_VascuSel.pdf
[4]Brotherhood, JR.: Nutrition and sports performance. Sports Med. 1984 Sep-Oct;1(5):350-89.
[5]Nagel, G.: Kalium. http://www.onmeda.de/naehrstoffe/kalium.html, Zugriff vom 30.03.2017, 17:55
[6]https://www.dge.de/wissenschaft/referenzwerte/kalium/; Zugriff vom 30.03.2017, 13:35
[7]http://lpi.oregonstate.edu/mic/minerals/potassium, Zugriff vom 31.03.2017, 12:30
[8]Food and Nutrition Board, Institute of Medicine: Potassium. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, D. C. National Academies Press; 2004:173–246, aus: http://www.nap.edu/openbook.php?record_id=10925&page=186, Zugriff vom 25.03.2017, 18:15
[9]Eckert, R.: Tierphysiologie. Georg Thieme Verlag, Stuttgart 1986
[10]Buchwald, M.: Kalium - Eine Übersicht über die physiologischen Wirkungen. Deutsche Lebensmittel-Rundschau, 104. Jahrgang, Heft 8, 2008, pp. 372 – 376
[11]Moseley, K., Weaver, C., Appel, L., Sebastian, A., & Sellmeyer, D. E. (2013). Potassium citrate supplementation results in sustained improvement in calcium balance in older men and women. Journal of Bone and Mineral Research: The Official Journal of the American Society for Bone and Mineral Research, 28(3), 497–504. http://doi.org/10.1002/jbmr.1764
[12]Vašák, M. , Schnabl, J: Sodium and Potassium Ions in Proteins and Enzyme Catalysis. The Alkali Metal Ions: Their Role for Life. Volume 16 of the series Metal Ions in Life Sciences pp 259-290. http://link.springer.com/chapter/10.1007%2F978-3-319-21756-7_8; Zugriff vom 25.03.2017, 21:40
[13]https://www.dge.de/wissenschaft/referenzwerte/magnesium/; Zugriff vom 01.04.2017, 16:40
[14]https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/; Zugriff vom 01.04.2017, 16:45
[15]Pasternak, K., Kocot, J., Horecka, A.: Biochemistry of Magnesium. J. Elementol. 2010, 15(3): 601–616
[16]Houston M.: The role of magnesium in hypertension and cardiovascular disease. J Clin Hypertens (Greenwich). 2011 Nov;13(11):843-7. doi: 10.1111/j.1751-7176.2011.00538.x. Epub 2011 Sep 26.