

Bir Nutrasötik Olarak Borun Kemik Metabolizması Üzerine Etkileri

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ÖZET

Nutrasötikler sağlık yararları olan besin ya da besin bileşikleridir. Bor üreme, embriyogenez, göz gelişimi, immun yanıt ve iltihaplanma gibi birçok yaşamsal fonksiyon için gerekli olan mikro besin ögesi ve nutrasötiktir. Bor mineralinin ana kaynakları sebze, meyve kuruyemiş ve baklagillerdir. Son

yıllarda bor ve kemik metabolizması ilişkisi üzerine birçok çalışma yapılmaktadır. Bu nedenle bu derlemede nutrasötik olarak borun kemik metabolizması üzerindeki olası etkileri hakkında bilgi verilmesi amaçlanmıştır.

Anahtar Sözcükler: Bor, eser element, kemik metabolizması.

The Effects of Boron on Bone Metabolism as a Nutraceutical: A Review

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ABSTRACT

Nutraceutical is a food or part of a food that provides health benefits. Boron is an essential micronutrient and nutraceutical for many life functions such as reproduction and embryogenesis, eye development, immune response and inflammation. The main sources of boron are vegetables,

fruits, nuts and legumes. Recent studies are about the relation of boron with bone metabolism. Therefore, in this review we aimed to give information about the possible effects of boron on bone metabolism as a nutraceutical.

Keywords: Bone metabolism, boron, trace element

INTRODUCTION

Nutraceuticals means Nutritive + Pharmaceutical: A food stuff that provides health benefits (7). Nutraceuticals refers to foods having a medicinal effect on health of human beings (33). The nutraceutical industry lies under three main parts which include functional foods, dietary supplements, and herbal/natural products (8).

Nutraceuticals are in great demand in the developed world particularly USA and Japan. Global nutraceutical market is estimated as worth USD 117 billion (30).

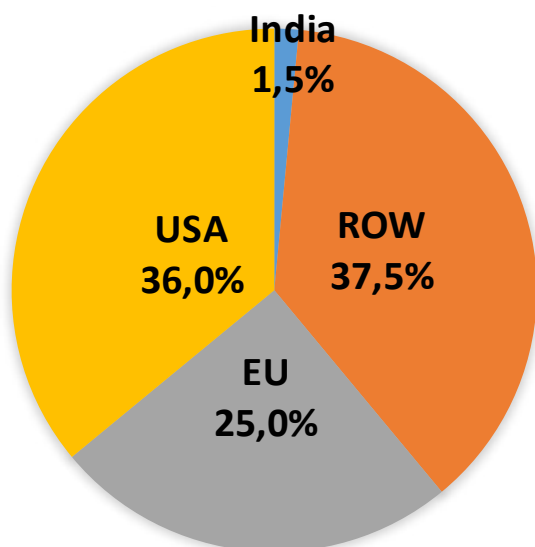


Figure 1. Global Nutraceutical Market (3) EU: European Union, USA: United States, ROW: Rest of world.

Nutraceuticals classified as:

- Substances with established nutritional functions, such as vitamins, minerals, amino acids, and fatty acids
- Herbs or botanical products as concentrates or extracts
- Reagents derived from other sources serving specific functions (7).

Table 1. Classification of nutraceuticals (10).

Class	Example
Inorganic mineral supplements	Minerals
Vitamin supplements	Vitamins
Digestive enzymes	Enzymes
Probiotics	Lactobacillus acidophilus
Prebiotics	Digestive enzymes
Dietary fibres	Fibres
Cereals and grains	Fibres
Health drinks	Fibre
Antioxidants	Natural antioxidants
Phytochemicals	Bioflavanoids

Minerals are a class of nutraceuticals and are essential in human health promotion and disease prevention (17). Calcium, magnesium, manganese, copper, zinc, boron etc. are the minerals that used as nutraceuticals (10).

Boron

Boron (B) is a dark brown colored element widely found both in the hydrosphere and in the lithosphere. Sea sediments, thermal waters and in some underground waters are rich in boron. In the environment it is mainly found as boric acid and borate salts in the oceans and in seas (12). While boron is an essential metalloid necessary for plant functions is an essential micronutrient for animals and human growth (12, 15, 32).



Figure 2. Chemical Symbol of Boron Element (1).

Boron level is approximately the same in the soft tissues and in blood. However, since it is mainly stored in the bones it

was observed that boron level in the bones is higher than that in fat and muscle as well as in the organs such as the heart, the liver and the intestines (20).

The important sources of boron are vegetables, fruits (such as avocado, apricot and raisin), nuts (such as hazelnut, walnut and almond) and legumes (21). It was observed that boron supplementation is an important support in treatment of Lupus Erythematosus, Candida Albicans, parasites, allergies, irregular sex hormones, menopause symptoms, aging, osteoporosis and arthritis (25, 26). Boron supplementation has anti-inflammatory, anticancer, antiviral, antibacterial and antifungal properties (29).



Figure 3. Sources of Boron (27).

B, which affects use of many substances related with life processes such as metabolism or energy substrates such as macrominerals, triglycerides and glucose, nitrogen containing substances such as aminoacids and proteins, reactive oxygen derivatives and estrogen when at physiological amounts, can have positive impact on many systems in the body such as brain, skeleton and immune system. Boron has an essential role in cell membrane functions or stability. Its response to hormone activity can affect transmembrane signal formation or transmembrane movement of regulatory cation and anions (23, 24).

While boron can cause nutrient deficiency when it is below the optimum level it (34) it can be toxic both for the plants and humans when it is at extremely high concentrations (37). Nevertheless, the range between boron deficiency and excessiveness is a very small.

Boron intake can differ according to metabolism and age. For instance, for babies between 0-6 months it is 0.75 ± 0.14 mg/day, for men between the ages 51-70 it is 1.34 ± 0.02 mg/day and for nursing women it is 1.39 ± 0.16 mg/day (6). Upon consumption boric acid readily is cleared away in body fluids of both animals and humans (35). The toxic level of boron for human is still not known precisely, but while the lethal dose for babies is 3000-6000 mg for adults it is 15,000-20,000 mg. Boron at non-toxic concentrations is absorbed through gastrointestinal tract and it is not stored in healthy tissues. In a few hours time it is excreted via urine. Half life of boric acid in humans is about 1 day (21).

Bone Metabolism

Bone metabolism or restructuring or removal of old cells from the skeleton (bone resorption) formation of new bone cells (ossification or bone formation process) is a life-long process. In the first year of life almost 100% of the skeleton is changed. In the adults remodelling/metabolism continues at 10% in adults. Like our other cells our bones are also alive and our bones, which consist of many different cells, proteins, veins, nerves and solid mineral matrix, control life processes and this is collectively called metabolism. Bone metabolism is regulated by some hormones and is affected by many factors (2).

The function of the bones, which constitute our skeleton is to carry the body, protect internal organs, to provide connection of the muscles for movement, to provide room for blood production and to constitute a storage for the minerals. The skeleton should be light so that the bone movements would be fast, should be powerful and strong so that it would carry weight, it should not bend when carrying weight, should be solid and strong so that it would resist gravitation, should be flexible enough to absorb the energy which bumping would create. Bones are the places where hematopoiesis is made and that functions as a storage for Ca, Mg, P, Na and other ions which are necessary for the homeostatic functions serving body movements and protection of internal organs (2). 25% of bones consist of organic material and 90% of this is collagen, glucoseamines, glycoproteins, lipids and peptides.

Also 75% of bones consist of inorganic materials like Ca, P, Na, Mg, K and Cl. Bones contain 99% of calcium, 50% of magnesium, 35% of sodium and 9% of water in the body (16).

Estradiol affects bone mass positively (5). Boron supplementation elevated concentration of estradiol in postmenopause women. Thus boron may be beneficial for preventing osteoporosis in postmenopause (25).

The Role of Vitamin D in Bone Metabolism

Vitamin D is a fat soluble vitamin and that is necessary for absorption of calcium and bone formation. Also this vitamin has role in use and absorption of phosphorus in the the digestion system, in thyroid functions and normal blood clotting. Many of the studies have showed that Vitamin D is essential for healthy bone development, preventing many cancer types, autoimmune, cardiovascular and infectious diseases (13).

Vitamin D₃ is made from 7-dehydrocholesterol in the skin under the sunlight. It is converted to 25 hydroxyvitamin D in the liver. Then, it becomes active by converting to 1,25-dihydroxyvitamin D in the kidney (4).

Vitamin D deficiency is related with obesity and diabetes (28, 36). This vitamin is especially important for children's growth. In case of its deficiency bone mineralization is disturbed and rickets is observed in children at the ages of growth and in adults osteomalasia (softening of bones), at later ages osteoporosis is observed (13, 14).

In a study, boron supplementation (6 mg/daily for 60 days) has increased 25-OH-D levels in vitamin D deprived (serum 25OH-D < 12 ng/ml) in the individuals (19).

Working Mechanism of Boron in Bone Metabolism

Although the working mechanism of boron is not precisely known, boron regulates the parathyroid function via phosphorus, magnesium and especially with calcium in mammals. Boron takes important role in optimum calcium and bone metabolism (18).

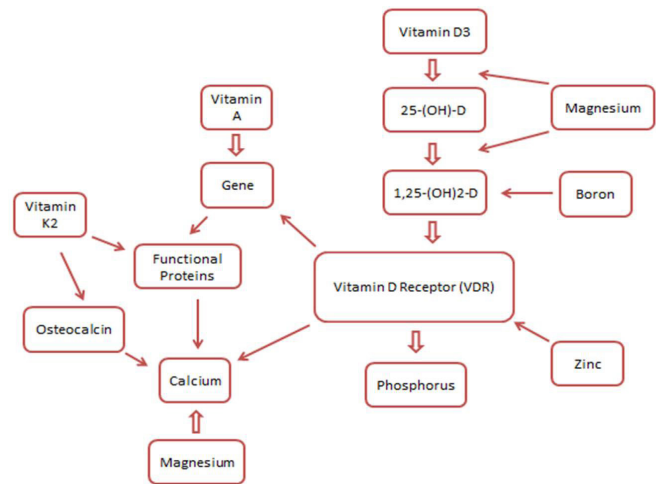


Figure 4. Relation of various micronutrients like boron, vitamin D, magnesium and phosphorus (31).

For preventing osteoporosis using of boron supplement with minerals and Vitamin D is very important.

Dessordi et al (9) has determined that bone volume fractions were higher in boron taking (40 ug / 0,5 ml of boron solution) non-obese diabetic mice when compared to not taking. Ghanizadeh et al (11) found that boron (1.23 mg/rat/day) + fluoride (0.7 mg/rat/day) supplementation for 8 weeks increased bone strength and bone mechanical properties in 34 male rats. In another study, Nielsen and Stoecker (22) showed that bone volume fraction decreased in rats fed with 0,1 mg boron/kg when compared to rats fed with 3 mg boron/kg.

A bone is a rigid organ that constitutes part of the vertebrate skeleton. Throughout life, bones change in shape and size. Bone formation continues until the peak bone mass is reached around age 30. Bone changes occur during normal aging. Nutraceutical is a food or part of a food that provides health benefits. Boron is an essential micronutrient and nutraceutical for many life functions.

As a result, nowadays bone metabolism problems like osteoporosis, rickets and deprivation of vitamin D is a common public problem. Therefore boron supplementation besides the other minerals and vitamin D can be beneficial in the prevention and treatment on disease related with bone.

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