

# Boron and Medical Health

By

Jorge D. Flechas MD, MPH,  
Hendersonville, N. C.

# General Information About Boron

- Boron is a metalloid element with similar properties to silicon.
- It is best known for its role in bone health because of its effects on steroid hormones
- (Miljkonic D 2004)
- In the body the highest concentration is in the parathyroid glands, heart, spleen, and bone

# General Information about Boron

**Metals, Nonmetals, and Metalloids**

H																	He																												
Li	Be											B	C	N	O	F	Ne																												
Na	Mg											Al	Si	P	S	Cl	Ar																												
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																												
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																												
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																												
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	—	Uuq	—	—	—	—																												
<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Ce</td><td>Pr</td><td>Nd</td><td>Pm</td><td>Sm</td><td>Eu</td><td>Gd</td><td>Tb</td><td>Dy</td><td>Ho</td><td>Er</td><td>Tm</td><td>Yb</td><td>Lu</td> </tr> <tr> <td>Th</td><td>Pa</td><td>U</td><td>Np</td><td>Pu</td><td>Am</td><td>Cm</td><td>Bk</td><td>Cf</td><td>Es</td><td>Fm</td><td>Md</td><td>No</td><td>Lr</td> </tr> </table>																		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																																
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																

metals
metalloids
nonmetals

# General information about Boron

- Occurs naturally in soil, water, and food
- Daily intake in Canadian adults is .86 mg from water and 2.5mg from food: with a
- total 3.4mg / day
- Half-life of 21 hours: mostly excreted by the kidney
- accumulation mostly in the bone
- Lethal dose Adults: 15-20gm, 5-6 gram for children and 2-3 gram in infants

# Boron in the USA



# General information about Boron

- There is epidemiological evidence to suggest that levels as high as 29mg of boron/liter in drinking water (Turkey) does not cause overt symptoms of toxicity. If a person drinks 2 liters per day = 58mg / day
- [www.hc-sc.gc.ca/dhp-mps/pubs/natur/boron-bore-eng.php](http://www.hc-sc.gc.ca/dhp-mps/pubs/natur/boron-bore-eng.php)

# General information about Boron

- Oral intake of boron is readily and completely absorbed (>90%) through the human gut as boric acid(Hunt 1996; Murray 1998)
- In body blood/soft tissue ratio 1:1
- Ratio in blood/ bone is 1:4 (Murray 1998)
- In bone a steady state is reached in one week when given to rats at high doses 3000 to 9000 ppm

# Boron intake in USA

- [J Am Diet Assoc.](#) 1999 Mar;99(3):335-40.
- **Daily boron intake from the American diet.**
- [Rainey CJ](#)<sup>1</sup>, et al
- 2-3 mg per day
- Arthritis incidence about 23 %

# Boron intake in some Chinese workers

- [Reproductive Toxicology](#)
- [Volume 29, Issue 1](#), January 2010, Pages 10–24
- Review
- An overview of male reproductive studies of boron with an emphasis on studies of highly exposed Chinese workers
- [Anthony R. Scialli](#), et al.

# Boron intake in Chinese workers

- Boron workers ( $n = 75$ ) had a mean daily boron intake of 31.3 mg B/day, and a subset of 16 of these men, employed at a plant where there was heavy boron contamination of the water supply, had an estimated mean daily boron intake of 125 mg B/day. Estimates of mean daily boron intake in local community and remote background controls were 4.25 mg B/day and 1.40 mg/day, respectively.

# Boron intake in Chinese workers

- Reproductive outcomes in the wives of 945 boron workers were not significantly different from outcomes in the wives of 249 background control men after adjustment for potential confounders. There were no statistically significant differences in semen characteristics between exposure groups, including in the highly exposed subset, except that sperm Y:X ratio was reduced in boron workers.

# Boron intake in Chinese workers

- Within exposure groups the Y:X ratio did not correlate with the boron concentration in blood, semen and urine. In conclusion, while boron has been shown to adversely affect male reproduction in laboratory animals, there is no clear evidence of male reproductive effects attributable to boron in studies of highly exposed workers.

# Boron inside Borax

## **BORAX**

To make concentrate: Dissolve 1 tsp. of 20 Mule Team Borax in 1 liter of water. This is your concentrated solution.

Standard Dose: 1 tsp. (5 ml) of concentrate solution = 3 mg. of boron. Mix 1 tsp. with food or drink. Continue with 1-2 doses daily.

Treatment Dose: For arthritis, osteoporosis and related conditions, increase intake to 3 or more tsp. of the standard dose, spaced out throughout the day, until you feel your problem has sufficiently improved. Then, drop back to the standard dose.

*Magnesium Advocacy Group, 2016*

# Arthritis and Boron

- The US, England, Australia and New Zealand generally have average soil-boron levels with an estimated intake of 1 to 2 mg of boron and arthritis rates of about 20%. But **Carnarvon** in Western Australia has **high boron levels in soil** and water, and the arthritis rate is only **1%**.

# Arthritis in Israel and New Zealand

- Ngawha Springs in New Zealand with very high boron levels in the spa water which is curative for arthritis. Actually **all spas reputedly curing arthritis have very high boron levels**. These are also high in Israel with an estimated daily boron intake of 10 to 30 mg and only 0.5 - 1% arthritis.

# Arthritis and Boron

- <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1566627/pdf/envhper00403-0084.pdf>

<http://nah.sagepub.com/content/7/2/89.full.pdf>

[http://www.arthritistrust.org/Articles/Boron and Arthritis.pdf](http://www.arthritistrust.org/Articles/Boron%20and%20Arthritis.pdf)

# How Essential is Boron ?

- NaBC1 Transporter was first identified and shown to be expressed in the kidney and salivary glands.
- In the absence of borate NaBC1 conducts sodium and OH. In the presence of borate, NaBC1 functions as a electronic Na –coupled borate cotransporter
- The presence of this transportor in humans suggest it is essential for the body function.

# How Essential is Boron ?

- Boron appears to have a regulatory role in 26 enzymes, including those involved in energy metabolism, none of them require boron as a cofactor (Devirian TA: 2003)
- Boron is essential for normal growth of plants where its functions involve sugar transport,
- Cell wall synthesis, and RNA metabolism(Nielsen 1986)

# Sugar Content affected

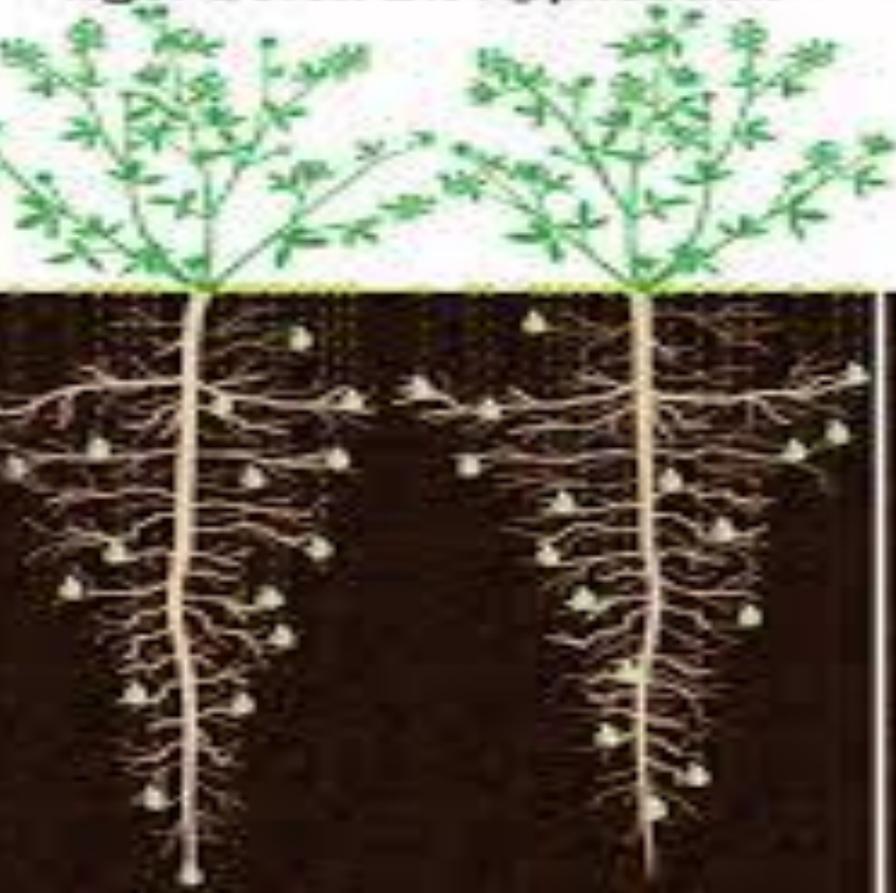


# Central Core of seed DNA Affected

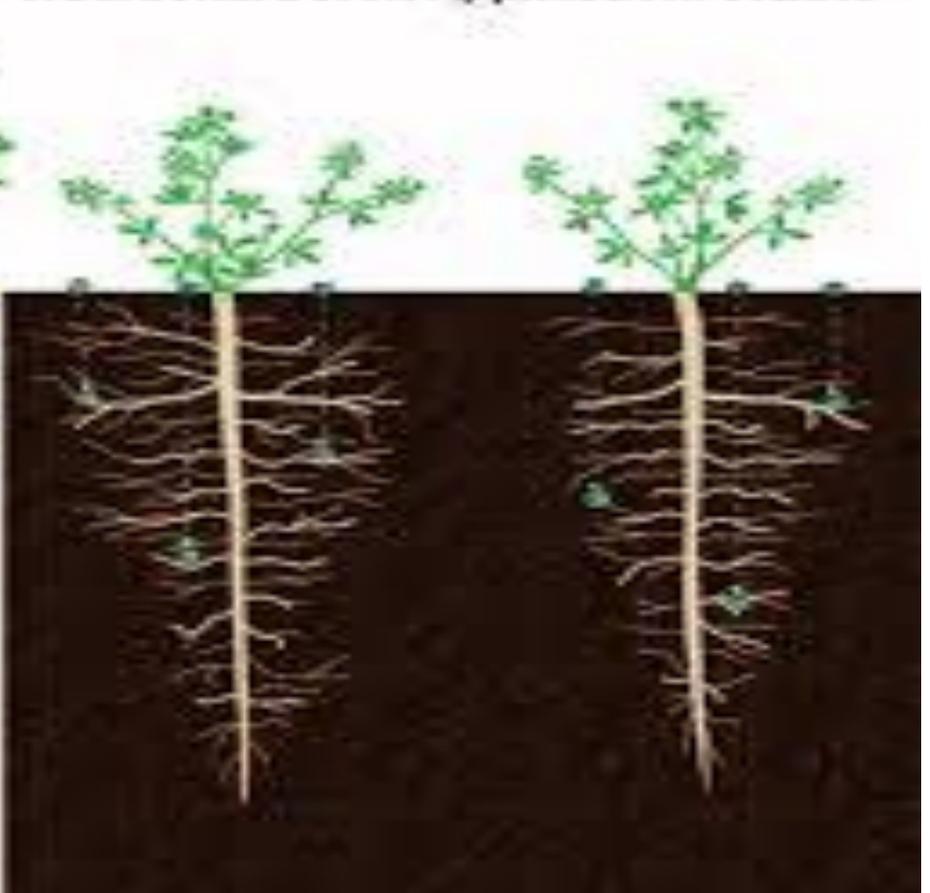


# Root hairs affected

**Tiger Boron 2% Application**



**Traditional Boron Application: Ulexite**



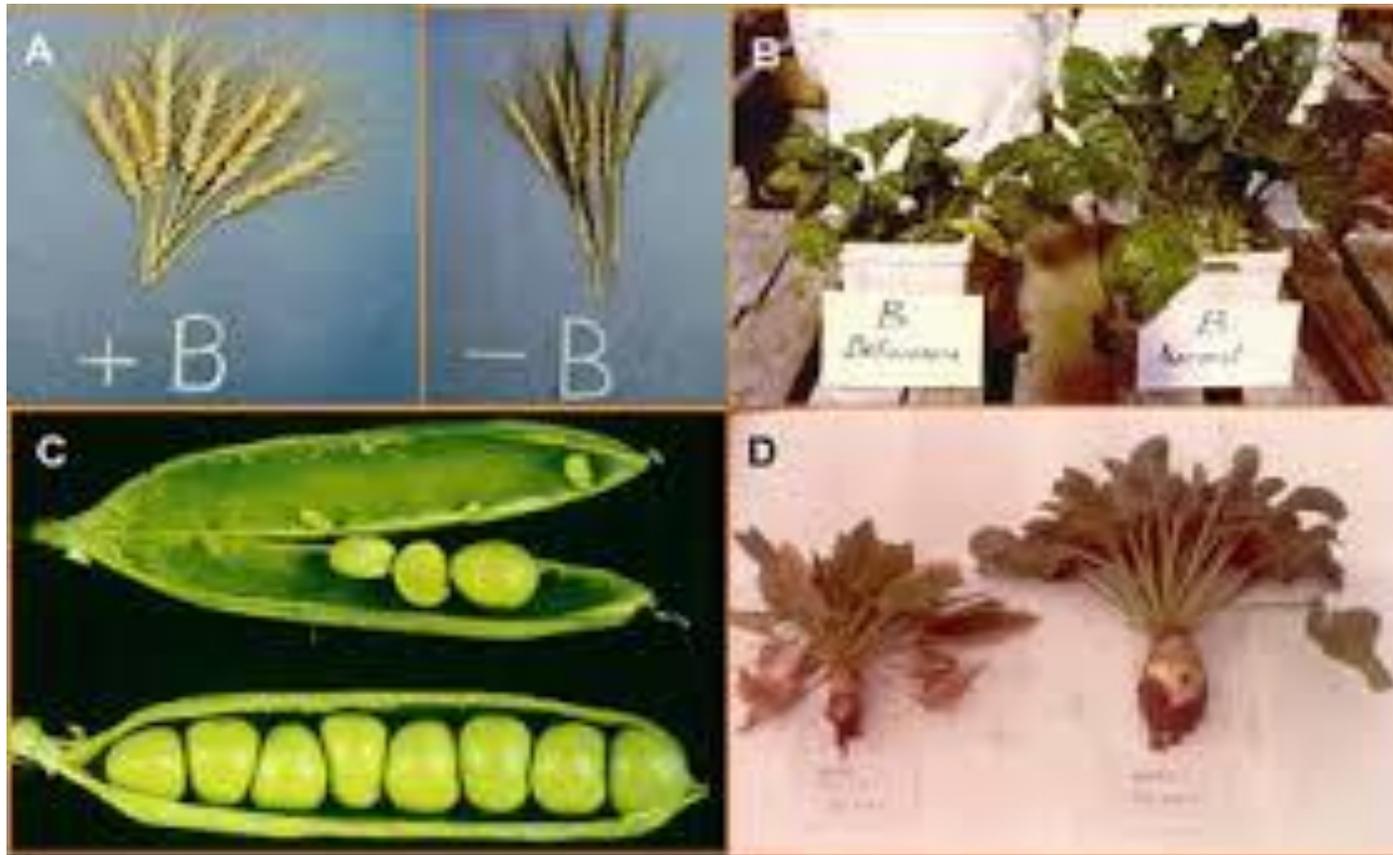
# Lack of Boron in Corn



# Lack of Born in Corn



# Boron needed for root development and healthy seeds



# Boron and Inflammation

- There is evidence that dietary boron helps control the normal inflammatory process
- Boron may serve as a signal suppressor that down-regulates specific enzymatic activities typically elevated during inflammation at the inflammation site.
- Suppression, but not elimination, of these enzyme activities by boron is hypothesized to reduce the incidence and severity of inflammatory disease.
- Boron insufficiency is related to the inflammatory process, including joint swelling, restricted movement, fever, antibody production, hemostasis, serine protease (PSA) and lipoxygenase activities, and leukotriene metabolism (Hunt DH; 1999)

# Boron and inflammation

- Boron has anti-inflammatory activity when it combines with the amino acids of the body to form amine cyanoboranes (Iris H. Hall et al 1980)
- Arthritic bone is associated with almost a 20-fold decrease in boron content. (Newnham RE 1991)

# Borage plants and Arthritis



# Boron and oral health

- Histomorphometric Study of Alveolar Bone Healing in Rats Fed a Boron-Deficient Diet (ALEJANDRO A. GORUSTOVICH et al 2008)
- A study to determine the effects of boron (B) deficiency on bone healing
- The first lower right molar of weanling Wistar rats was extracted under anesthesia. The animals were divided into two groups: 1B (adequate; 3 mg B/kg diet), and 2B (boron-deficient; 0.07 mg/kg diet).
- The animals in both groups were killed in groups of 10 at 7 and 14 days after surgery.
- The mandibles were resected, fixed, decalcified, and embedded in paraffin. Buccolingually oriented sections were obtained at the level of the mesial alveolus and used for histometric evaluations.

# Boron and oral Health

- Total alveolar volume (TAV) and trabecular bone volume per total volume (BV/TV) in the apical third of the alveolus were determined. Percentages of osteoblast surface (ObS), eroded surface (ES), and quiescent surface (QS) were determined.
- No statistical significant differences in food intake and body weight were observed.
- Histomorphometric evaluation found 2B rats had 36% and 63% reductions in BV/TV at 7 and 14 days, respectively.
- When compared with 1B rats, 2B rats had significant reductions (57% and 87%) in ObS concomitantly with increases (120% and 126%) in QS at 7 and 14 days, respectively.
- The findings show that boron deficiency results in altered bone healing because of a marked reduction in osteogenesis.

# Boron and Bones

- Boron supplementation markedly reduced the urinary excretion of calcium and magnesium
- The depression seemed more marked when dietary magnesium was low
- Boron supplementation depressed the urinary excretion of phosphorus by the low magnesium, but not by the adequate-magnesium, women.

# Boron and Bones

- Boron supplementation markedly elevated the serum concentrations of  $^{17}\text{B}$ -estradiol and testosterone : the elevation seemed more marked when dietary magnesium was low.
- Low Boron showed depressed plasma ionized calcium and calcitonin.
- F.H. Nielsen in FASEB J. 1: 394-397; 1987
- F. H. Nielsen in Magnesium Trace Elem 1990;9 : 61-69

# Boron and Mental Health

- Increase cognition
- Spectral analysis of EEG data showed effects of dietary boron in two of the three studies.
- When the low boron intake was compared to the high intake, there was a significant ( $p < 0.05$ ) increase in the proportion of low-frequency activity, and a decrease in the proportion of higher-frequency activity,
- an effect often observed in response to general malnutrition and heavy metal toxicity. Performance (e.g., response time) on various cognitive and psychomotor tasks also showed an effect of dietary boron.

# Boron and Mental Health

- When contrasted with the high boron intake, low dietary boron resulted in
- significantly poorer performance ( $p < 0.05$ ) on tasks emphasizing manual dexterity (studies II and III);
- eye-hand coordination (study II);
- attention (all studies);
- perception (study III);
- encoding and short-term memory (all studies);
- long-term memory (study I).
- Collectively, the data from these studies indicate that boron may play a role in human brain function and cognitive performance,
- provide additional evidence that boron is an essential nutrient for humans. — Environ Health Perspect 102(Suppl 7): 65-72 (1994)

## Boron and Arthritis: The Results of a Double-blind Pilot Study

- (Travers RL ; 1990)
- This report describes the results of a double-blind trial
- comparing oral intake of 6 mg of boron per day to placebo in the treatment of arthritis.
- The results indicate that boron may well be beneficial.
- 10 patients on boron, five improved and five did not,
- Only one of the 10 patients on the placebo improved.

# Boron and Arthritis: The Results of a Double-blind Pilot Study

- This was essentially a pilot trial which showed that a small quantity of boron would greatly relieve severe osteo-arthritis.
- Of those starting the trial, 50% using boron improved as compared with 10% on placebo
- If we consider those who completed the trial, 71% improved while using boron.
- There were no side-effects and these were sought. The indication is that boron is safe and beneficial in the treatment of osteo-arthritis

# Boron and Cancer

- Dietary boron intake and prostate cancer risk

**Authors:** Yan Cui et al

**Affiliations:** *Department of Epidemiology, UCLA School of Public Health, Los Angeles, CA, USA*

- Boron affects human steroid hormone levels.
- Circulating testosterone and estradiol levels have been proposed to modify prostate cancer risk.
- The association between dietary boron intake and the risk of prostate cancer has not been evaluated by any epidemiological study.
- Explored the association between dietary boron intake and the risk of prostate cancer in the USA.
-

# Boron and Cancer

- Analysis was based on data from (NHANES III). Boron intake of 95 prostate cancer cases with that of 8,720 male controls.
- After controlling for age, race, education, smoking, body mass index, dietary caloric intake, and alcohol consumption,
- Increased dietary boron intake was associated with a decreased risk of prostate cancer with a dose-response pattern. Boron-PSA-PBIGF-1
- The adjusted odds ratio was 0.46 (95% confidence interval: 0.21-0.98) for the highest quartile of boron intake comparing to the lowest quartile (P for trend = 0.0525).

# Boron Limitations

- Boron toxic levels go lower the younger that a human is.

Boron greater than 30mg /day not recommended in young women of child bearing age, due to the potential of toxicity to a developing fetus.

# Boron and Steroids

- Boron helps control the hydroxylation of steroids
- D2 to D3 to D4
- Testosterone to DHT : T stimulates Nitric oxide 4000%
- E1 to E2 to E3 Estrogen very important in both male and female to stimulate nitric oxide.
- Use of boron supplements to increase in vivo production of hydroxylated steroids US Patents # 4849220 A Abstract
- The oral administration of boron compounds such as sodium borate and boric acid increases the amounts of hydroxylated steroids in human plasma. This will help prevent or alleviate pathology, such as osteoporosis, caused by suboptimal circulating hydroxylated steroids such as 17 $\beta$ -estradiol and testosterone

Boron helps inactive Testosterone  
become active DHT

