

Stand Tall: The Impact of Tocotrienols on Bone Health

Bone tissue is dynamic and constantly being remodeled in a balanced cycle of bone loss and bone formation. Bone diseases arise when this cycle goes out of flux and tips in favour of bone loss and inflammation.

How do Tocotrienols Maintain Bone Health?

In bone disease like osteoporosis, oxidative stress and inflammation lead to increased activity of osteoclast cells that promote bone tissue degradation. Pre-clinical studies have shown that tocotrienol supplementation reduces the amounts of oxidative stress in bone tissue, as evidenced by a reduced amount of bone lipid peroxidation marker (Figure 1) and increased amounts of antioxidative enzyme activity (Figure 2).

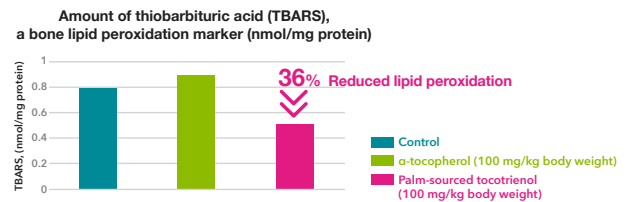


Figure 1: Impact of palm tocotrienol supplementation on lipid peroxidation in the femur of adult rats (Maniam *et al.*, 2008)

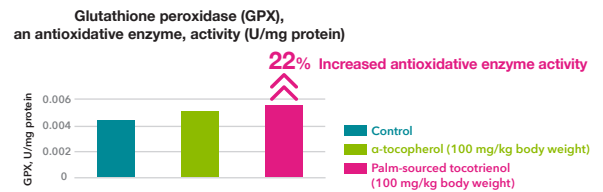


Figure 2: Impact of palm tocotrienol supplementation on antioxidative enzyme activity in the femur of adult rats (Maniam *et al.*, 2008)

In menopause, oestrogen levels drop which leads to an increase in the amounts of pro-inflammatory cytokines like interleukin-1 (IL-1) and interleukin-6 (IL-6) in the body. This leads to low-grade chronic inflammation that further drives osteoclast cell-mediated bone tissue degradation. Pre-clinical studies have found that tocotrienol supplementation is able to prevent this rise in cytokines (Figures 3 and 4).

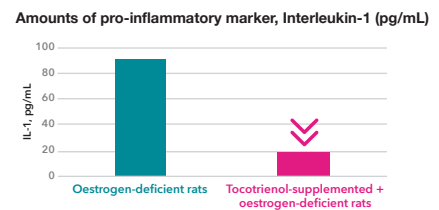


Figure 3: Amounts of interleukin-1 (IL-1) (Muhammad *et al.*, 2013)

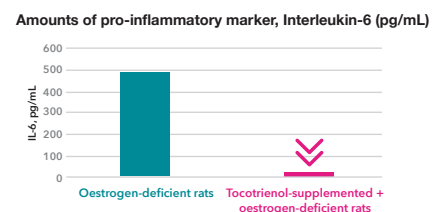


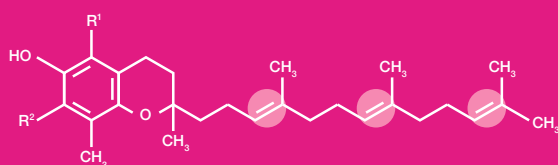
Figure 4: Amounts of interleukin-6 (IL-6) (Muhammad *et al.*, 2013)

Tocotrienols, The Extraordinary Vitamin E

Vitamin E is not just a single molecule, but a family of eight fat-soluble substances that are sub-divided into two classes of structurally-similar molecules. These two classes are tocopherol and tocotrienol, each of which have four structurally and chemically diverse molecules termed as alpha (α), beta (β), delta (δ), and gamma (γ) respectively.



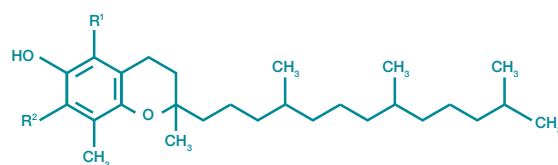
Tocotrienols have up to **60X** more antioxidative potency compared to α -Tocopherol, and have **unique anti-inflammatory properties** not seen in α -Tocopherol¹.



TOCOTRIENOLS

Tocotrienols have unsaturated isoprenoid side chains with three double bonds. This unique property gives it better flexibility with a higher efficiency of penetrating into the cell membrane. Tocotrienols are potent **ANTIOXIDANTS*** with unique **ANTI-INFLAMMATORY** properties.

α : $R' = CH_3$, $R'' = CH_3$
 β : $R' = CH_3$, $R'' = H$
 γ : $R' = H$, $R'' = CH_3$
 δ : $R' = H$, $R'' = H$



TOCOPHEROLS

Tocopherols, in contrast, have saturated side chains. They also function as antioxidants, but this chemical structure gives them a lower antioxidative capacity as compared to tocotrienols.

α : $R' = CH_3$, $R'' = CH_3$
 β : $R' = CH_3$, $R'' = H$
 γ : $R' = H$, $R'' = CH_3$
 δ : $R' = H$, $R'' = H$

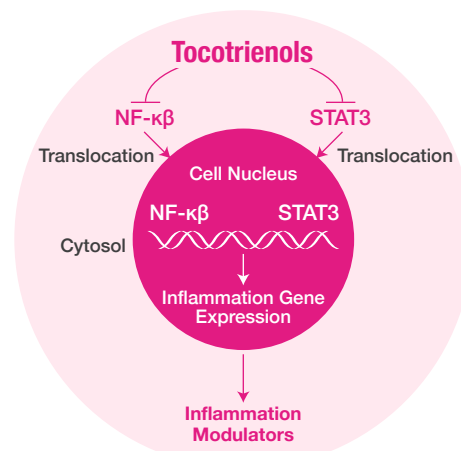
Tocotrienols have Unique Properties that Positively Impact Different Areas of the Body

Tocotrienols are naturally sourced from plant species like oil palm, rice and Annatto seed.

Each analogue of tocotrienol are functionally unique, with α -, β -, δ -, and γ -tocotrienol each exerting different beneficial effects on health and disease that are separate from the biological functions of α -tocopherol.



Potent Anti-Inflammatory Agent



Tocotrienols have pronounced and potent effects on NF- κ B (key master regulator of inflammation) and STAT3 (master inflammatory transcriptional factor) to reduce inflammation^{2,3,4}.

Reference:
 1. Serbinova, E., Kagan, V., Han, D., and Packer, L. (1991). Free radical recycling and intramembrane mobility in the antioxidant properties of alpha-tocopherol and alpha-tocotrienol. *Free Radical Biology and Medicine*, 10: 263 – 275.
 2. Guang et al. (2015). *Am J Transl Res*; 7(9): 1612-1620
 3. Ng et al. (2012). *Food Chemistry*; 134: 920-925
 4. Aggarwal et al. (2010). *Biochem Pharmacol.*; 80(11): 1613-1631.

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