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Vitamin E: The "Magic Bullet" for Neuro-Protection

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Abstract. At present our understanding of the workings of the body systems and how they respond to dietary factors have been better developed. Thus we are now better informed that we are what we eat. The brain is one of the most powerful organs of our body system, however it is prone to certain degenerative activities resulting in different forms of insults or disorders, including Parkinson's, Alzheimer's, Huntington's diseases and amyotrophic lateral sclerosis, in addition to pathological conditions such as ischemia and excitotoxicity, especially as the organism advances in age. Nutrition has been touted to be to the rescue particularly involving dietary vitamin E and more so with the tocotrienols. Dietary tocotrienols are readily made bioavailable to the brain and when present demonstrate high biopotency compared to the more prominent tocopherols. In some body systems, such as the brain tocotrienols demonstrate better antioxidant potencies in relation to inhibition of lipid peroxidation and scavenging for reactive oxygen substances and as such are better neuro-protection agents against disorder insults. This paper advances how the tocotrienols demonstrate the advances identified with tocotrienols as neuro-protectors thereby mitigating against brain insults, such as Alzheimer's disorder.

Key words: Vitamin E, Neuro-Protection and Quality of Life

Introduction

The main engine room of the nervous system is the brain. The brain tissue is highly susceptible to free radicals' damage as a result of its lipid components that are mostly polyunsaturated fatty acids (Devasagayam et al., 2004). Vitamin E is believed to playing vital roles in preserving the integrity of membranes. Foremost amongst these roles is its ability to protect polyunsaturated lipids of the lipid bilayer matrix of membranes and serum lipoproteins against oxidation (Singh, Devaraj & Jialal, 2005). Other essentials roles of vitamin E in membranes is the formation of complexes between vitamin E and products of membrane lipid hydrolysis such as lysophospholipids and free fatty acids. The complexes so formed stabilize membranes and thus prevent the detergent-like action of lipid hydrolytic products on the membrane (Kagan, 1989). Formation of complexes between vitamin E and polyunsaturated fatty acids, such as docosahexaenoic acid has been demonstrated to be particularly favorable (Stillwell, 2000).

Oxidative stress and apoptosis are highly implicated in the pathogenesis of neuro-degenerative disorders, including Parkinson's, Alzheimer's, Huntington's diseases and amyotrophic lateral sclerosis, in addition to pathological conditions such as ischemia and excitotoxicity (Browne, Ferrante & Beal 1999; Olanow, 1993). This paper intends to use the aforementioned properties of vitamin E on lipids and its antioxidant potencies to elucidate how vitamin E plays important roles in the protection of the neuro-system of the animals including those of humans. These protections aid in improving the quality of life of the living organism. Therefore, the objectives of this paper are to amplify why neuro-protective properties are conferred on vitamin E in a literature-based manner. Accordingly, vitamin E is known have eight isoforms; therefore, in this paper layouts vitamin E isoform involved in a specific study would be clearly identified and its role implication will be equally expatiated clearly upon for easy assimilation.

Vitamin E and Neuro-Protection

Tocomin is very rich in α-tocopherol as well as α-, γ- and δ-tocotrienols. Tocomin significantly inhibited H_2O_2-induced neural death. The neuro-protective impact of tocomin was mainly attributed to α-, γ- and δ-tocotrienols as α-tocopherol was not able to reduce H_2O_2-induced neural death in the rat striatal cultures (Olanow, 1993; Osakada et al., 2004). The tocotrienols demonstrated highly significant protection against superoxide and nitric oxide donors in their mode of action in the protection cascade. Furthermore, the degree of the neuro-protection efficiencies of the vitamin analogs were in the following order: α-tocotrienol > γ-tocotrienol > δ-tocotrienol, respectively (Osakada et al., 2004; Osakada et al., 2003). These data findings confer on vitamin E and particularly the α-tocotrienol was capable of exerting effective anti-apoptotic and thus neuro-protection properties in rat striatal cultures. These studies further confirmed that α-, γ- and δ-tocotrienols prevented BSO (buthionine sulfoximine)-induced cell death in rat striatal neurons. Tocotienols also provided protection against apoptosis and necrosis by significantly reducing oxidative stress in the central nervous system neurons (Osakada et al., 2003).

In another study by Sen et al. (2000), it was demonstrated that treatment of cells with α-and γ-tocotrienol resulted in a time-dependent elevation of its cellular content. It was also further established that the anti-apoptotic neuro-protective effect of α-tocotrienol appeared to be independent of its antioxidant function. Another independent in vivo study (Mishima et al., 2003), showed that α-tocotrienol highly significantly reduced the size of cerebral infarcts in the mouse middle cerebral artery (MCA) in occlusion model. This was inferred to as its non-antioxidant and anti-apoptotic mode of action as after ischemic insults, neuronal apoptosis and necrosis were shown to have participated in brain damage (Choi, 1996; Mattson, 2000).

Receptor-mediated glutamate excitotoxicity was speculated to be the primary mechanism of damage in most of the pathologies referenced above as well as glutamate-induced oxidative stress have been shown to be the major cytotoxic mechanisms in most cell lines, including C6 glial cells (Han et al., 1997), PC-12 neural cells (Pereira & Oliveira, 1997), immature cortical neuron cells (Murphy, Schnaar & Coyle, 1990) and oligodendroglia cells (Oka et al., 1993). Mitochondrial electron transport chain is the origin of reactive oxygen substances production in glutamate-induced apoptosis (Tan et al., 1998). The studies of Khanna et al. (2003) and Sen, Khanna and Roy (2004) showed that minute or small amounts of palm-derived α-tocotrienol blocked glutamate-induced nerve cell death.

From the fore-discussed, it can be seen that glutamate toxicity is a major candidate in pathological cell death within the nervous system. It has been demonstrated that high levels of glutamate blocked cystine uptake via amino acid transporter Xc, leading to a significant depletion of cellular glutathione. More importantly, tocotrienols effectively inhibited the activation of pp60 c-src kinase known to be centrally involved in glutamate-induced cell death during the progression of breast cancer (Muthuswamy & Muller, 1995) and in human skin tumors (Barnekow, Paul & Schartl, 1987). During symptoms of primary vitamin E deficiency, it was shown that vitamin E has a major role in maintaining neurological integrity and function. α-Tocotrienol and γ-tocopherol were very potent and effective for preventing and blocking cerebral infarction induced by MCA occlusion. Different independent studies, such as those of (Muthuswamy & Muller, 1995; Barnekow, Paul & Schartl, 1987; Roy et al., 2002), have demonstrated that dietary supplementation of tocotrienol fed orally reached the brain. Indeed, dietary tocotrienol has been confirmed to be bioavailable to both mother and fetal brain with the brain tissues of the fetus being more enriched. To this point, specific types of vitamin E sensitive genes have been identified in the rat fetal brain using a GeneChip microarray expression profiling approach (Roy et al., 2002). Therefore, it is not a gainsaying that tocotrienols are potential candidates in the therapy of neurodegenerative disorders and diseases, such as Parkinson's, Alzheimer's, Huntington's and amyotrophic lateral sclerosis.

Conclusions

Vitamin E and particularly the tocotrienols are readily made bioavailable to the brain and when present demonstrate high biopotency compared to the more prominent tocopherols. In some systems, such as the brain tocotrienols demonstrate better antioxidant potencies in relation to inhibition of lipid peroxidation and scavenging for reactive oxygen substances and as such are better neuro-protection agents compared to the tocopherols.

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