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Modulatory effect of cod-liver oil on Na^+-K^+ ATPase in rats' brain

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Abstract

Omega-3 fatty acids were used in the treatment of psychiatric diseases such as bipolar disorder. Na^+, K^+-ATPase is also a well-known target for these fatty acids. In this study, we investigated the impact of cod-liver oil (CLO), docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) on Na^+, K^+-ATPase, cholinesterase activities, the levels of norepinephrine (NE) and acetylcholine in different regions of rat brain. Our results showed that DHA caused a significant depression in cerebellum Na^+, K^+-ATPase, whereas CLO activated it. In addition, CLO, EPA and DHA produced a significant activation in Na^+, K^+-ATPase activity in medulla, midbrain and hypothalamus. There were non-significant changes in the activity of cholinesterase enzyme in cerebellum and medulla, while in midbrain and hypothalamus the CLO, DHA and EPA enhanced the activity by 75%, 100% and 78%, respectively. The content of NE in hypothalamus showed slight increase in different regions of the brain of animals fed CLO, DHA or EPA. In conclusion, CLO, DHA or EPA supplementation had a beneficial effect that associated with a normalization of fatty acids incorporation into phospholipid membranes and a partial restoration of Na^+, K^+-ATPase activity, suggesting that CLO supplementation may improve fatty acid composition and moderately enhance Na^+, K^+-ATPase activity.

Keywords

cod liver oil, PUFA, Na^+, K^+-ATPase, rat brain

Introduction

Reports on the use of omega-3 fatty acids in the treatment of psychiatric disorders such as bipolar disorder and schizophrenia are increasing.[1] Ca-ATPase plays a vital role in the prevention of Ca^{2+} toxicity in nerve cells by extrusion of excess intracellular calcium, thus maintaining intracellular calcium homeostasis. Modulation of this enzyme could contribute to the possible mechanisms by which omega-3 fatty acids exert their beneficial effects. A membrane Na-Ca exchanger also contributes to Ca^{2+} extrusion from the neuron.[2]

Omega-3 fatty acids have been shown to have modulating effects on Ca-ATPase in a number of tissue cells, including colon, cardiac myocytes, T cells and cortical microsomes.[3] Na^+, K^+-ATPase is also a well-known target for these fatty acids. The relationship between omega-3 fatty acids and ATPases influencing calcium transport in the neuron has prompted the following investigation. One possible omega-3 fatty acid action mechanism is a direct interaction with Ca-ATPase: polyunsaturated fatty acids have been shown to mimic the direct activating effects of calmodulin on the enzyme.[4] It has also been suggested that omega-3 fatty acids induce mood-stabilizing effects via the inhibition of neuronal protein kinase C, and since the C terminal of the plasma membrane Ca-ATPase enzyme contains a regulatory site for protein kinase C, this could be a possible mechanism by which modulating changes are produced.[5]

A main neurotransmitter within the central nervous system (CNS), norepinephrine (NE), has been implicated as a mediator for several CNS functions[6] including but not limited to arousal, depression, neural and neuroendocrine response, sleep, anxiety, memory, facilitation of behavioral and locomotors activity,

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