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Article

Magnesium Supplementation Effect on Aluminum Induced Lipid Peroxidation in the Brain of Albino Rats

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Abstract: In this research work, we examined the role of magnesium supplementation on aluminum induced lipid peroxidation in the brain of albino rats using standard protocols. Findings from this study revealed significantly ($P<0.05$), higher content (4.70±0.13ug/g) of aluminum in the brain of the group treated with only aluminum compared to the content (0.53±0.21ug/g) observed in the group treated with high magnesium supplementation. The tissue brain protein content decreased significantly in the aluminum treated group and low magnesium supplemented group compared to the control and high magnesium supplemented group ($P<0.05$). The malonyldialdehyde (measure of lipid peroxidation) content (3.04±0.09nmole MDA/mg) was significantly higher in the aluminum treated group, compared to the content (0.72±0.10 and 0.82±0.40nmole MDA/mg) observed in the control and high magnesium supplemented group respectively. Conclusively, high malonyldialdehyde content in the brain of the albino rats stimulated by aluminum intoxication was significantly lowered by high magnesium supplementation.

Keywords: Aluminum, Magnesium, Brain, and lipid peroxidation.

1. Introduction

The world at large has come to the age of aluminum where many products used on daily basis contain aluminum. It is found in cosmetics, kitchen utensils, as additives in various processed foods, and as coagulating agent used during the purification process of drinking water (Shaw and Tomljenovic, 2013; Yousef, 2004; Ochmanski and Barabas, 2000). Absorbed aluminum is widely distributed into different organs in the body, and the absorption tends to be poor via oral exposure. However, some amino acids have significantly shown to increase absorption of aluminum (Russel and Blaylock, 2012).

Magnesium is a vital mineral in human metabolic processes. More than 300 enzymes require magnesium for their catalytic action, thus, essential to the basic chemistry of living organism. It is vital for muscular system, lower incidence of stroke, regulate sugar level, excitability of the central nervous system (CNS), For treating anxiety and depression, and decreases asthma attack (Faryyadi, 2012).

The promulgation that people are directly or indirectly exposed to aluminum on daily basis, resulting to toxicological bio-injury is fast daunting. This problem has attracted the attention of the researchers to examine the role of Magnesium supplementation on lipid peroxidation stimulated by aluminum toxicity in the brain of the albino rats.

2. Material and Methods

2.1. Animal Treatment

Thirty white albino rats were obtained from the Pharmacology Departmental animal house, Ahmadu Bello University, Zaria (ABU). The albino rats were randomly divided into six groups of five animals each. They were allowed to rest, acclimatized, and fed ad libitum.

Group 1: The first group (control) was given normal saline.

Group 2: The second group was given only magnesium (0.4g) as food supplement.

Group 3: The third group received aluminum ($AlCl_3$) (1g /liter) orally via drinking water and high amount (18mg) of magnesium as food supplement.

Group 4: The fourth group was given aluminum ($AlCl_3$) (1g/liter) via drinking water, and moderate amount (0.2g) of magnesium as food supplement.

Group 5: The fifth group received aluminum ($AlCl_3$) (1g/liter) via drinking water and low magnesium supplementation (0.1g) as food supplement.

Group 6: The sixth group received only aluminum (1g/liter) orally, without magnesium supplementation.

The treatment was given for a period of thirty days. At the end, the experimental animals were fasted overnight, sacrificed (killed), followed by collection of brain samples.

2.2. Determination of Aluminum

Aluminum in the brain of the experimental rats was determined using calorimetric method with aluminon (triammonium salt of aurintricarboxylic acid) (Wolf 1982), a dye commonly used to detect the presence of aluminum ion in an aqueous solution. The compound aluminum forms a red lake colour with aluminum in neutral solution. The complex colour is reasonably stable for twenty hours.

2.3. Protein Determination

The protein content of the brain was determined according to the Lowry protein assay (Lowry *et al.*, 1951).

2.4. Measurement of Lipid Peroxidation

The method described by placer *et al.*, (1998) was used for the determination of malonyldialdehyde (measure of lipid peroxidation) in the brain of the albino rats.

3. Results and Discussion

The content of aluminum in the brain of the experimental rat is shown in table 1. Higher values (4.89±0.42 and 4.70±0.13ug/g) were respectively seen in non-magnesium supplemented (aluminum only) group and low magnesium supplemented group with no statistical significant difference ($P<0.05$).

Table 1: Content of aluminum in the brain of albino rat

Group	**Brain aluminum (µg/g)**
Control	0.04 ± 0.31^{a}
Mg alone	0.03 ± 0.15^{a}
Al + high Mg	0.53 ± 0.21^{b}
Al + Med Mg	1.70 ± 0.16^{c}
Al + low Mg	4.70 ± 0.13^{d}
Al alone	4.89 ± 0.41^{d}

Values are mean ± SD (n=5).
Values with different superscript differ significantly ($P\leq 0.05$).

This implies low magnesium supplementation has no effect on aluminum accumulation in the brain of albino rat. However, statistical significant difference ($P<0.05$) was observed in the high magnesium supplemented group compared to the group treated with only aluminum table 1.

Meaning, high magnesium supplementation has potential effect in preventing accumulation of aluminum in the brain of albino rat. This observation also implies that intake of magnesium above traditionally considered normal dietary intake has a tremendous effect in the reduction of aluminum accumulation in the brain of the experimental rats, and this may have a positive effect in improving many aspects of brain functions deteriorated by aluminum. Previously published articles revealed that increasing brain magnesium leads to the enhancement of learning abilities, working memory, recovery from depression, and lower incidence of stroke (Slutsky *et al.*, 2010; Eby and Eby, 2006; Faryadi, 2012).

The high contents (4.70±0.42 and 4.89±0.13ug/g) of aluminum in the low magnesium (Al+lowMg) supplemented group and aluminum (Al only) treated group may result to serious neurological implications table 1. Elevated levels of aluminum in the brain has shown to affect some vital element (Zn, Fe, Cu, and (a), and has also been proposed as a potential risk factors in the development of Parkinson and Alzheimer's disease (Yang *et al*., 2002; Youssef; 2004).

The protein content of the brain decreases significantly ($P<0.05$) in aluminum treated group and low magnesium (low magnesium and aluminum) supplemented group compared to the control and high magnesium (high magnesium and aluminum) supplemented group respectively table 2. The decrease in the protein content is attributed to the findings that aluminum within the biological system alters cellular processes, and protein synthesis (Abreo and Glass, 1993).

Table 2: Protein content of the brain

Group	**Brain Protein (mg/g)**
Control	27.00±0.31[a]
Mg alone	29.95±0.73[a]
Al + high Mg	26.89±0.71[a]
Al + Med Mg	12.23±0.77[b]
Al + low Mg	11.06±0.68[b]
Al alone	10.58±1.06[b]

Values are mean ± SD (n=5)
Values with different superscript differ significantly ($P\leq0.05$).

The result obtained for the brain malonyldialdehyde (measure of lipid peroxidation) content is shown in Table 3. The malonyldialdehyde content (3.40±0.09nmoles MDA/mg) was significantly

(P<0.05) higher in the aluminum (only Al) treated group compared to the content (0.82±0.40nmole MDA/mg) in the high magnesium (Al plus high Mg) supplemented group table 3. However, no statistical significant difference (P<0.05) observed in the low magnesium (Al plus low Mg) supplemented group Table 3. Suggesting high magnesium supplementation reduced the level of lipid peroxidation stimulated by aluminum intoxication in the brain of the experimental rat. As such, magnesium re-mineralization is very vital for detoxifying aluminum, although the role of magnesium in such circumstance is not clearly understood. However, the mechanism may be based on competitive inhibitory activity i.e. the absorption of aluminum within the biological system is competitively altered by the presence of magnesium. Magnesium also enhances the bioavailability of nutrients antioxidant (vitamin C and E); both of which possesses detoxification properties.

Table 3: Brain malonyldialdehyde content in the brain (nmoles MDA/mg)

Group	**Malonyidialdehyde content.**
Control	0.72 ± 0.10^{a}
Mg alone	0.72 ± 0.30^{a}
Al + high Mg	0.82 ± 0.40^{a}
Al + Med Mg	1.32 ± 0.40^{b}
Al + low Mg	2.90 ± 0.09^{c}
Al alone	3.04 ± 0.09^{c}

Values are mean ± SD (n=5)
Values with different superscript differ significantly.

4. Conclusion

From present study, it is clear that lipid peroxidation stimulated by Aluminum intoxication in the brain of the albino rats is affected by high magnesium supplemented diet.

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