Advances In Multidisciplinary & Scientific Research
A Multidisciplinary & Interdisciplinary Journal
Volume 9, No 2, June 2023 Series

Effects of Omega-3 Oil on Aluminum Chloride-Induced Toxicity on the Histology of the Skin of Adult Wistar Rats

[1]Akpan, Matthew Obot & [2]Imosemi, Innocent O.
[1]Department of Veterinary Anatomy
[2]Department of Anatomy
University of Ibadan, Ibadan, Nigeria
Emails: apanobot@yahoo.com & akpanmatthew980@gmail.com
Phone: +2348035737442

ABSTRACT

Aluminium is presents in many manufactured foods and medicines, and is also added to drinking water, for purification purposes. Its presence has so heavily contaminated the environment that exposure to it is virtually inescapable. The effect of omega-3 oil on aluminium chloride-induced toxicity on the histology of the rat skin was studied. Forty adult female Wistar rats weighing between 150 and 180g used for this study were divided into four groups; Group 1 rats received distilled water and served as the control, group II rats were administered 100mg/kg body weight of aluminum chloride, intraperitoneally, group III rats were administered 200mg/kg of omega-3 oil orally and group IV rats were administered 200mg/kg of omega-3 oil and 100mg/kg of aluminum chloride. Administration was done for 28 days. The rats were weighed and sacrificed, and the skin dissected out, fixed in 10% neutral buffered formalin for histological evaluation. Data were analyzed using ANOVA at $p<0.05$. From the data gathered, results show that differences in weights of animals of various groups are significantly different. Animals given feed that contained omega-3 have more weight followed by animals in the group fed with $AlCl_3$+ omega-3 laden feed and group for $AlCl_3$ in that order, while rats in control group had the least in weight when compared with other groups. Histologically, there was congested dermal capillaries, structural changes in dermal collagen and distorted sweat glands in the skin of group IV rats compared with the control rats. Our observations in this work highlight explicitly that aluminium chloride administration combined with oral omega-3 oil was detrimental to the skin of Wistar rats, as indicated by congested dermal capillaries, structural changes in dermal collagen and distorted sweat glands.

Keywords: Aluminium Chloride, Omega-3 oil, Skin Histology, Wistar Rats, Toxicity, Collagen

Aims Research Journal Reference Format:
Akpan, M.O. & Imosemi, I.O. (2023): Effects of Omega-3 Oil on Aluminum Chloride-Induced Toxicity on the Histology of the Skin of Adult Wistar Rats. Advances in Multidisciplinary and Scientific Research JournalVol. 9. No. 2. Pp 73–80.
www.isteams.net/aimsjournal. dx.doi.org/10.22624/AIMS/V9N2P6

1. INTRODUCTION

The skin covers the body of man and animals and the internal body parts are continuous with it via mucous membranes which include the buccal cavity, anus, and vulva (Slominski *et al.*, 2012). Grossly, the skin is the largest organ in the body and constitutes about 15% of the total body weight (Bolognia *et al.*, 2008).

The interface between the epidermis and the dermis is formed by raised ridges of the dermis, the dermal ridges (papillae), which interdigitate with invaginations of the epidermis called epidermal ridges or pegs. This predisposition enhances structural stability thereby preventing easy detachment of the skin from the underlying structures especially the hypodermis. Reinforcement of the dermal-epidermal junction is ensured especially in skin subject to frequent pressure.

Aluminium is ubiquitous element and the third most prevalent (abundant) element in the earth's crust, comprising approximately 8% of the earth's crust, exceeded only by oxygen (47%) and silicon (28%). The elemental aluminium does not occur in its pure state but is always combined with other elements such as chloride, hydroxide, silicate, sulphate and phosphate. The wide distribution of this element ensures the potential for causing human exposure and harm (Berthon, 1996; Williams, 1996; Candura *et al*., 1998; Zang and Zhou, 2005).

Evidence for contribution of aluminium to Alzheimer's Disease (AD) remains contradictory (Flaten, 2001; Gupta *et al*., 2005). Epidemiological studies have indicated a link between aluminium in drinking water and AD and a variety of human and animal studies have implicated learning and memory deficits after aluminium exposure (Yoke, 2000; Schmidt *et al*., 2001; Exley, 2005; Buraimoh *et al*., 2011a).

Aluminium chloride was implicated to negatively alters the behaviour of Wistar rats as it increased the rate of anxiety, had neurodegenerative effects on the histology of cerebral cortex, especially at higher dose and detrimental to the integrity of the testes of Wistar rats, and also decrease the level of sperm count, which however, did not result in infertility (Buraimoh et al, 2011b, 2011c, 2012a, 2012b and 2012c). It has been reported that prolonged aluminium sulphate intake accelerate features of senescence in the adult mice liver.

In Aluminium-treated mice as in senescent mice, endothelial thickness was increased and porosity was decreased like perisinusoidal actin. Furthermore, aluminium stimulated the deposition of collagen and laminin, mainly in acinar zones 1 and 3. Pseudocapillarization and periportal laminin in senescent mice were similar to aluminium-treated adult liver and latter concluded that prolonged aluminium sulphate intake accelerates features of senescence in the adult mice liver (Alessandra *et al*., 2008). Recent research has shown that omega-3 fatty acids can help support heart, brain, joint, and skin health. They are a natural ingredient your body needs to stay healthy.

As a result, omega-3 supplements have become a popular option for people looking to improve and maintain their health. Omega-3 oil are vital fatty acids that come only through food or supplements. They work in a couple of ways. First, omega-3 oil allows cell walls to take in nutrients and get rid of waste. Second, they make it easier for your cells to function properly by aiding the communication and connection between them. Omega-3 also helps improve joint health by maintaining a healthy chemical balance (Calder, 2017). This study was aimed at evaluating the possible effects that aluminium chloride could have on the histology of the skin of adult Wistar rats.

2 . MATERIALS AND METHODS

Chemicals

Aluminum chloride and all reagents were purchased from a reliable chemical supplier. In this study, 100mg/kg body weight of aluminum chloride solution was freshly prepared by dissolving it in water.

Animals

Forty adult Wistar rats (180- 220 g) were obtained for used in the course of the study. The rats were kept in rat cages in well ventilated house, temperature of 25 ± 2°C, 12h natural light and 12h darkness, with free access to tap water and dry rat pellet. They were allowed to acclimatize for 7 days prior to the experiment. All the animals received humane care in compliance with the institution's guideline and criteria for humane care as outlined in the National Institute of Health Guidelines for the Care and Use of Laboratory Animals.

2. RESEARCH DESIGN

The forty adult rats were divided into four groups (n=10).
Group I: control group received distilled water.
Group II: received 100mg/kg body weight of aluminum chloride, intraperitoneally.
Group III: received 200mg/kg of omega-3 oil orally.
Group IV: received 200mg/kg of omega-3 oil and 100mg/kg of aluminum chloride.
Administration was done for 28 days. The rats were weighed (initial and final body weight, and percentage weight gain/loss) and sacrificed. The skin was dissected out and fixed in 10% Neutral Buffered Saline for histological evaluation.

Tissue processing for histological studies

The fixed rat skin from all groups was processed employing routine paraffin embedding and stained with Haematoxylin and Eosin for histological evaluation. The slides were examined and evaluated under a 500-pixel Leica digital binocular microscope and the following were evaluated in the skin:

Statistical analyses

Data were obtained and expressed as mean ± S.D. and further analyzed employing one-way ANOVA, followed by Dunnet's post-test for multiple comparisons using GraphPad Prism California, USA, version 9.0 for Windows, and the level of statistical significance set at $p< 0.05$.

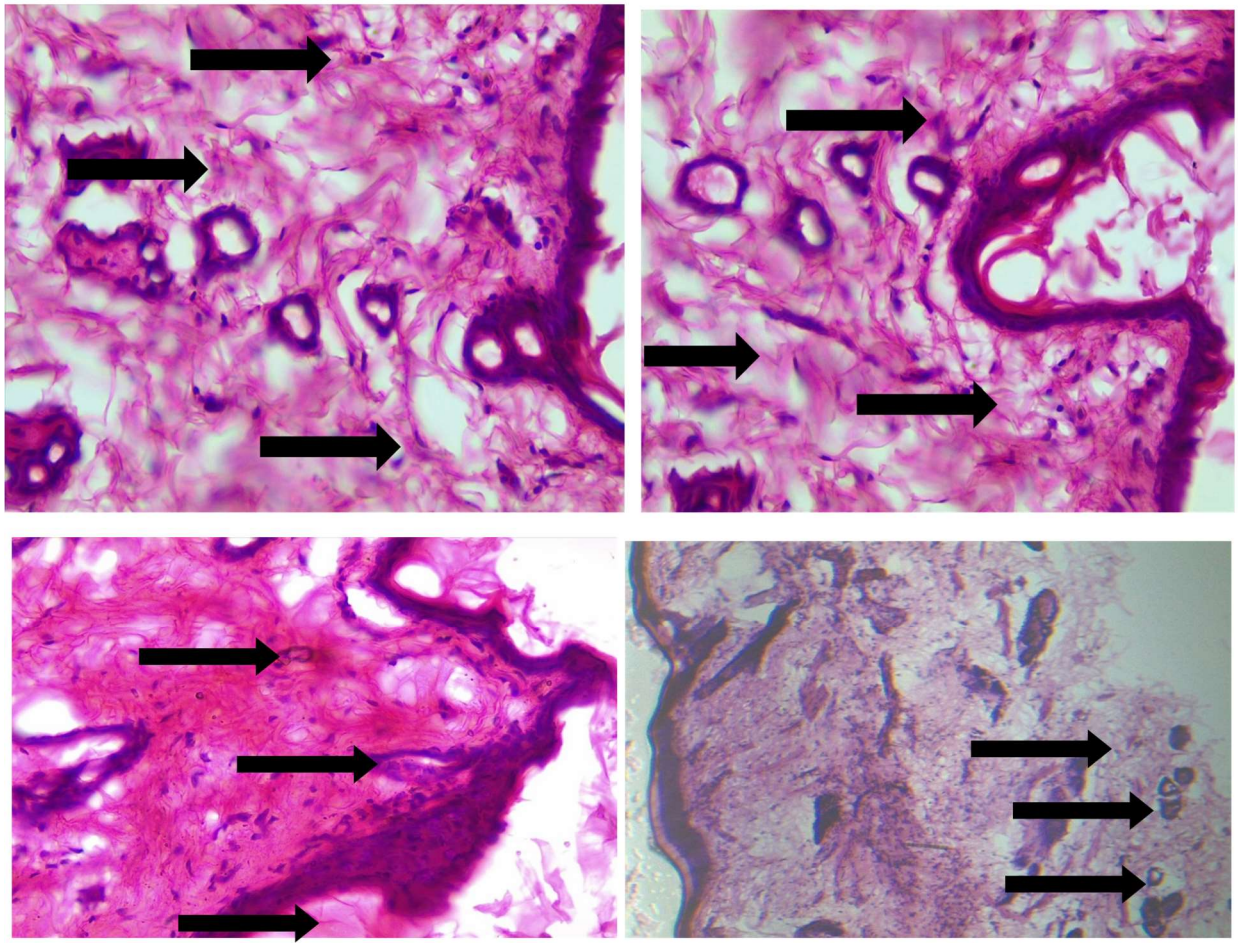
3. RESULTS

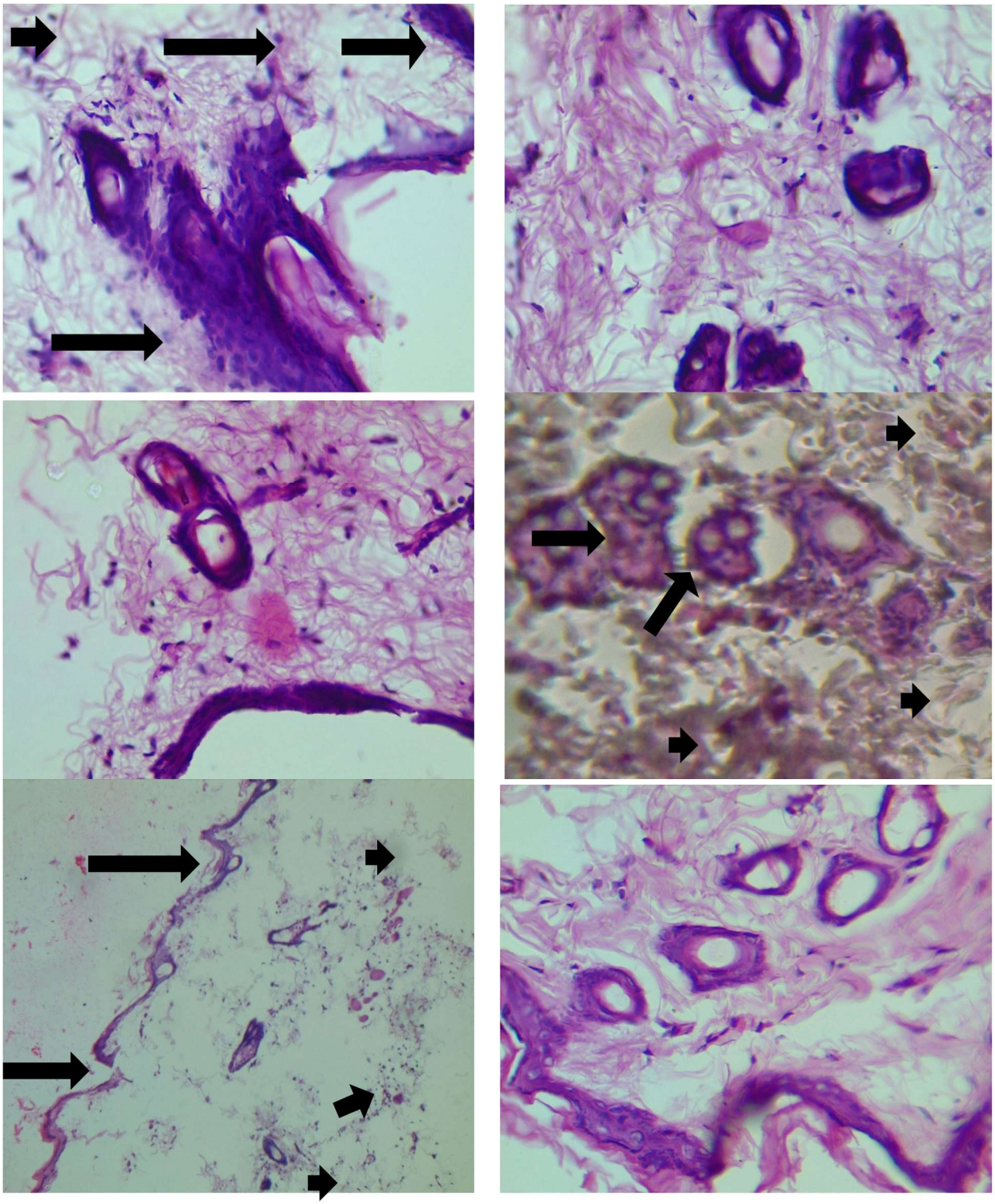
Body weight

Table 1: Mean body weight in grams of the control and treated groups

Group	Initial weight (g)	Final weight (g)	Weight gain/loss (g)	% Weight gain/loss
Control	153.9±12.6	163.30±13.8	9.38±10.0	2.95±3.2
$AlCl_3$	165.8±10.8	163.6±13.6	2.20±11.1^{+}	-0.73±3.4^{+}
Omega-3 oil	165.1±9.4	185.8±12.9^{a}	20.70±15.7^{a}	5.86±43^{a}
$AlCl_3$+omega-3 oil	158.0±10.6	168.9±17.1*	15.56±20.3*	5.47±5.3*

Values (n=10) are expressed in grams as Mean±SD at P<0.05. $^{+}$ $AlCl_3$ vs control, ^{a}Omega-3 oil vs $AlCl_3$ group and *Omega-3 oil+ $AlCl_3$ vs $AlCl_3$ group, I – Control group, $AlCl_3$– Aluminium chloride.





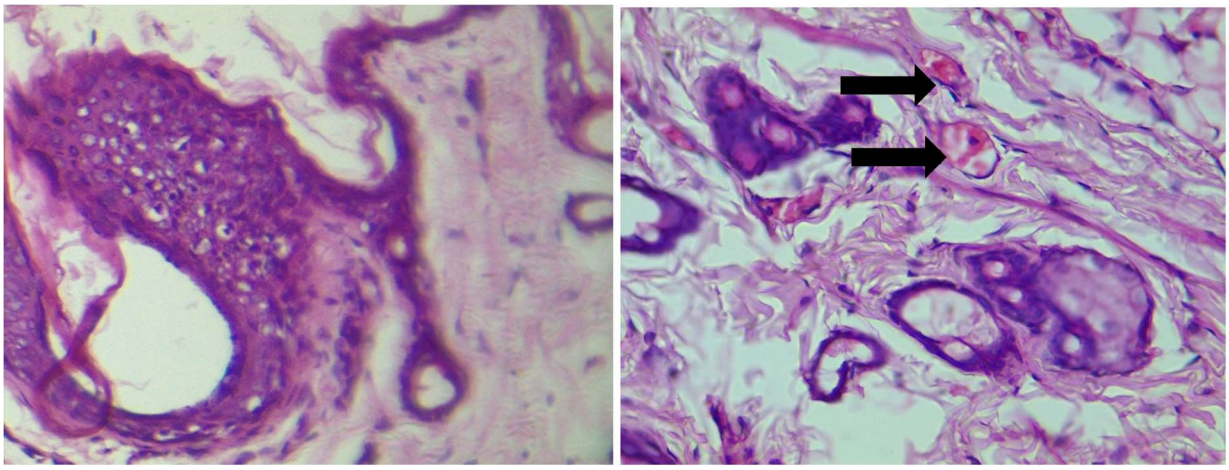


Plate 1a: No visible lesions seen, Dermal collagen is prominent (arrows) Plate
Plate 1b: No visible lesions seen, Dermal collagen prominent
Plate 1c: No visible lesions seen, Dermal collagen is prominent (arrows)
Plate 2a: No visible lesions seen. The sweat glands appear distorted (arrows)
Plate 2b: Collagen portion of the dermis is reduced (arrows).
Plate 2c: No visible lesions seen.
Plate 3a: No visible lesions seen,
Plate 3b: Sebaceous glands are very prominent (arrows) The dermal collagen are clumped together (arrowheads).
Plate 3c: The epidermis is very thin (arrows), the dermal collagen is very scanty (arrowheads)
Plate 4a: No visible lesions seen.
Plate 4b: No visible lesions seen.
Plate 4c: There is a mild congestion of the dermal capillaries (arrows).

4. DISCUSSION

In this study, there was normal histology of the skin with the existing cutaneous layers listed above and shown plate 1. There were distorted skin structures (see Plates 2-5) congested collagen fibres (Plates 3and 4) of the skin of the aluminium chloride-treated rats.

This was contrary to a report that stated that aluminium given in pharmacologic doses is absorbed but does not accumulate in the liver (Klein *et al*., 1989). Prolonged aluminium exposure accelerates ageing changes in the adult rat brain (Delonale *et al*., 2001) and enhanced aluminium deposition in the brain is a shared characteristic of progressive neurological diseases that are common in aged populations (Miu *et al*., 2004). The deposition of aluminium in non-nervous organs and its subsequent effects are less known. It was previously described that the effects of aluminium in the rat kidney and liver, where it induces lysosomal activation, increases iron deposition (Stacchiotti *et al*., 2006) and hence the liver was involved in aluminum absorption and excretion through biliary flux (Gonzales et al, 2007).

The aluminium chloride-treated Wistar rats showed slight distortion of the arrangement of dermal collagen, prominent sebaceous glands and relatively thin epidermis when compared with the control.

Conclusion: Based on our histological observations, we therefore conclude that aluminium chloride exposure was not severely detrimental to the skin of adult Wistar rats but caution should be taken in its usage.

REFERENCES

1. Alessandra S, Antonio L, Matteo F, Giorgio S, Rossella B, Rita R, Luigi FR, Effects of aluminium sulphate in the mouse liver: Similarities to the aging process. Experimental Gerontology; 2008, Vol.43, Issue 4; Pp330-338.
2. Berthon G, Chemical speciation studies in relation to aluminum Metabolism and toxicity. Coord Chem Rev; 1996, 149:241–280.
3. Bolognia, J. L., Jorizzo, J.L., Rapini, R.P. Dermatology. 2nd ed St Louis, MO: Mosby Elsevier; 2008
4. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Effects of oral administration of aluminium chloride on the histology of the hippocampus of wistar rats. Curr. Res. J. Biol. Sci.; 2011a, 3: 509-515.
5. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Behavioural endpoints of adult wistar rats, following aluminium chloride exposure. Br. J. Pharmacol. Toxicol ; 2011b, 2: 273-276. ISSN: 2044-2467.
6. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Effects of Aluminium Chloride on Anxiety-Related Behaviour. American Journal of Neuroscience, Science Publication; 2011c, 2(2): 65-69, ISSN 1948-9900.
7. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Effects of Aluminium Chloride Exposure on the Histology of the Cerebral Cortex of Adult Wistar Rats. Journal of Biology and Life Science@Macrothink Institute; 2012a, Vol.3, No.1. ISSN 2157-6076. DOI: 10.5296/jbls.v3i1.1421.
8. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Histological Study of the Effects of Aluminium Chloride Exposure on the Testis of Wistar Rats. American International Journal of Contemporary Research; 2012b, Vol. 2, No. 5.
9. Buraimoh AA, Ojo SA, Hambolu JO, Adebisi SS, Effects of Aluminium Chloride Exposure on the Sperm Count of Adult MaleWistar Rats. Asian J. Biol. Sci; 2012c, Vol.3 (2): 435-438.
10. Candura SM, Manzo L, Costa LG, Role of occupational neurotoxicants in psychiatric and neurodegenerative disorders.In: Costa LG, Manzo L (eds) Occupational neurotoxicology. CRC Press,Boca Raton; 1998, pp 131-167.
11.]. Deloncle R, Huguet F, Fernandez B, Quellard N, Babin P, Guillard O, Ultrastructural study of rat hippocampus after chronic administration of aluminuml-glutamate:an acceleration of the aging process.Exp. Gerontol, 36; 2001, pp. 231–244.
12. Exley C, The aluminium-amyloid cascade hypothesis and Alzheimer's disease aluminium and β-amyloid. Alzheimer's Disease; 2005, 38:225-234. DOI: 10.1007/0-387-23226511.
13. Flaten T, Aluminium as a risk factor in Alzheimer's disease, with emphasis on drinking water. Brain Res. Bull, 55; 2001, pp. 187–196.

14. Gonzales M, Alvarez Mdel L, Pisani G, Bernal C, Roma M, Carrillo M, Involvement of oxidative stress in the impairment in biliary secretory function induced by intraperitoneal administration of aluminium to rats. Biol. Trace Elem. Res., 116; 2007, pp. 329–342.
15. Gupta VB, Anitha G, Hegda ML, Zecca L, Garruto RM, Ravid R, Shankar SK, Stein R, Hanmugavelu P, Jagannatha Rao KS, Aluminium in Alzheimer's disease: are we still at a crossroad? Cell. Mol. Life Sc; 2005, 62: 143-158.
16.]. Klein GL, Lee TC, Mann PA, Miller NL, Alfrey AC, Effects of Aluminum on the Liver Following HighDose Enteral Administration to Rats. Journal of Pediatric Gastroenterology & Nutrition; 1989, Volume 9, issue1.
17.]. Miu AC, Olteanu A, Miclea M, A behavioural and ultrastructural dissection of the interference of aluminium with aging. J. Alzheimers Dis., 6 ; 2004, pp. 315–328.
18.]. Schmidt ML, Zhukavera V, Perl DP, Sheridan SK, Schuck T, Spinal cord neurofibrillary pathology in alzheimer disease and guam parkinsonism-dementia complex. J. Neuropathol. Exp. Neurol.; 2001, 60: 10751086.
19. Slominski, A.T., Zmijewski, M.A., Skobowiat, C., Zbytek, B., Slominski, R.M., Steketee, J.D. (2012). Sensing the environment: regulation of local and global homeostasis by the skin's neuroendocrine system. Adv Anat Embryol Cell Biol. 2012; 212: v, vii, 1–115
20. Stacchiotti A, Rodella LF, Ricci F, Rezzani R, Lavazza A, Bianchi R, Stress proteins expression in rat kidney and liver chronically exposed to aluminium sulphate. Histol. Histopathol., 21; 2006, pp. 131–140
21. Williams RJP, Aluminium and biological systems: an introduction. Coord Chem Rev; 1996, 149:1–
22. Yokel RA, The toxicology of Aluminium in brain:review, Neurotoxicology; 2000, 21 (5): 813-828.
23. Zhang K, Zhou Q,Toxic effects of Al-based coagulants on Brassica chinensis and Raphanus sativus growing in acid and neutral conditions. Environ Toxico; 2005, l 20:179–187.