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IJPBS |Volume 2| Issue 4 |OCT-DEC |2012|266-276

Research Article
Biological Sciences

EFFECTS OF ALUMINIUM CHLORIDE EXPOSURE ON THE HISTOLOGY OF THE STOMACH OF WISTAR RATS

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ABSTRACT

Aluminium is one of the trace elements with moderate toxic effect on living organism. Traditionally, aluminium has been considered as nontoxic to humans. However, in recent years, increased attention is being focussed on possible adverse effects of aluminium on human health. The stomach is a hollow muscular organ located on the left side of the upper abdomen, under the ribs. It is part of the digestive system that receives food from the esophagus. The stomach secretes acid and enzymes that digest food.The purpose of this study was to evaluate the possible effects that aluminium chloride exposure could have on the histology of the stomach of wistar rats. Twenty wistar rats were used for this study. The wistar rats were divided into five groups as follows: group I was the control that received distil water only, group II received 475mg kg^{-1}, group III received 950mgkg^{-1}, group IV received 1,425mg kg^{-1} and group V received 1,900mg kg^{-1} via oral intubation for duration of eight weeks. The stomach was fixed, processed, stained in H&E and the slides were viewed under light microscope fitted to digital camera and laptop. Our results revealed that there were no significant negative effects of aluminium chloride on the histology of the stomach. Based on our observations, we therefore conclude that aluminium chloride exposure had no deleterious effects on the histology of the stomach of wistar rats

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KEYWORDS

Effects, Aluminium Chloride, Exposure, Histology, Stomach and Wistar Rats.

1. INTRODUCTION

Aluminum is a trivalent cation found in its ionic form in most kinds of animal and plant tissues and in natural waters everywhere [1]. It is the third most prevalent element and the most abundant metal in the earth's crust, representing approximately 8% of total mineral components [2]. It is one of the trace elements with moderate toxic effect on living organism.

Due to its reactivity, aluminum in nature is found only in combination with other elements such as sulphate, chloride etc. Dietary aluminum is ubiquitous but in such small quantities that it is not a significant source of concern in persons with normal elimination capacity. Urban water supplies may contain a greater concentration because water is usually treated with aluminum before becoming part of the supply. Subsequent purification processes that remove organic compounds take away many of the same compounds that bind the element in its free state, further increasing aluminum concentration[3].

Traditionally, aluminium has been considered as nontoxic to humans. However, in recent years, increased attention is being focussed on possible adverse effects of aluminium on human health. Human exposure to aluminium is from its natural

occurrence in the environment i.e. through food, water and air, as well as, from aluminium deliberately introduced into the environment by man. The main food sources of aluminium are: hard cheese, grain products (flour), herbs and tea leaves. Chronic exposition to this trace element can cause alterations in skeletal, nervous, hematopoietic and respiratory systems [4,5,6,7].

Aluminium is also thought to be a causal agent in some cases of encephalopathy and osteomalacia observed in patients with chronic renal failure caused by long-term hemodialysis [8.] Aluminium toxicity in humans has been implicated in many neurodegenerative diseases such as Alzheimer's disease, amyotrophic lateral sclerosis, and parkinsonism-dementia [9, 10, 11]. The mechanism of aluminium-inducted neurotoxicity and identification of effective treatment for such impairments is, therefore, an important public and occupational health priority for industrial and developing nations. Aluminium contributes to a variety of cognitive impairments in mice, rabbits, and rat pups [12, 13, 14, 15].

Aluminium is a possible contributing factor in Alzheimer's disease [5]. Evidence for the contribution of Aluminium to Alzheimer's Disease (AD) remains contradictory [16,17]. However, 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 [18,19,20].

The stomach is a muscular organ located on the left side of the upper abdomen. It is a hollow organ in the upper abdomen, under the ribs. It is part of the digestive system.The stomach receives food from the esophagus. As food reaches the end of the esophagus, it enters the stomach through a muscular valve called the lower esophageal sphincter.

The stomach secretes acid and enzymes that digest food. Ridges of muscle tissue called rugae line the stomach. The stomach muscles contract periodically, churning food to enhance digestion. The pyloric sphincter is a muscular valve that opens to allow food to pass from the stomach to the small intestine.

The stomach, like the small intestine is a mixed exocrine-endocrine organ that digests food and secretes hormones. It is a dilated segment of the digestive tract whose main functions are to continue the digestion of carbohydrates initiated in the mouth, add an acidic fluid to the ingested food, transform it by muscular activity into a viscous mass (chyme), and promote the initial digestion of proteins with the enzyme pepsin.

The wall of the stomach has five layers:

- **Inner layer or lining (mucosa)**: Juices made by glands in the inner layer help digest food. Most stomach cancers begin in this layer.
- **Submucosa**: This is the support tissue for the inner layer.
- **Muscle layer (Muscularis)**: Muscles in this layer contract to mix and mash the food.
- **Subserosa**: This is the support tissue for the outer layer.
- **Outer layer (serosa)**: The outer layer covers the stomach. It holds the stomach in place.

The mucosa and sub-mucosa of the un-distended stomach lie in the longitudinally directed folds known as rugae. When the stomach is filled with food, these folds flatten out [21]. The objective of this study was to evaluate the possible effects that aluminium chloride exposure could have on the histology of the stomach.

2. MATERIALS AND METHODS

This study was conducted in the Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Samaru, Zaria, Nigeria. The rules and regulations governing animal handling were strictly adhered to.

2.1. Experimental Animals

Twenty wistar rats were used for this experiment. The wistar rats were housed in steel cages in the animal house of Department of Human Anatomy, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria; they were given sufficient food, water and kept under good ventilation. The wistar rats were kept for two weeks before commencement of aluminium chloride administration. This was to enable the wistar rats acclimatized to the environment.

2.2. Experimental Design

The wistar rats were divided into five groups; group I was the control that received distil water only, group II received 475mg Kg^{-1}, group III received 950mg kg^{-1}, group IV received 1,425mg kg^{-1} and group V received 1,900mg kg^{-1} via oral intubation for duration of eight weeks.

2.3. Tissue processing and staining

The wistar rats were humanely sacrificed by anesthetizing them in a suffocating chamber using chloroform, after the end of eight weeks of administrations of various concentrations of aluminium chloride except the control group I that received distil water only. The abdominal region was dissected and the stomach was removed, and immediately fixed in 10% formalin. After fixation, the tissues were transferred into an automatic processor where they went through a process of dehydration in ascending grades of alcohol (ethanol) 70%, 80%, 95% and absolute alcohol for 2 changes each. The tissues were then cleared in xylene and embedded in paraffin wax. Serial sections of 5 micron thick were obtained using a rotary microtome. The tissue sections were deparaffinised, hydrated and stained using the routine haematoxylin and eosin staining method (H&E). The stained sections were examined under the light microscope fitted to a digital camera and lap top.

3. RESULTS AND DISCUSSION

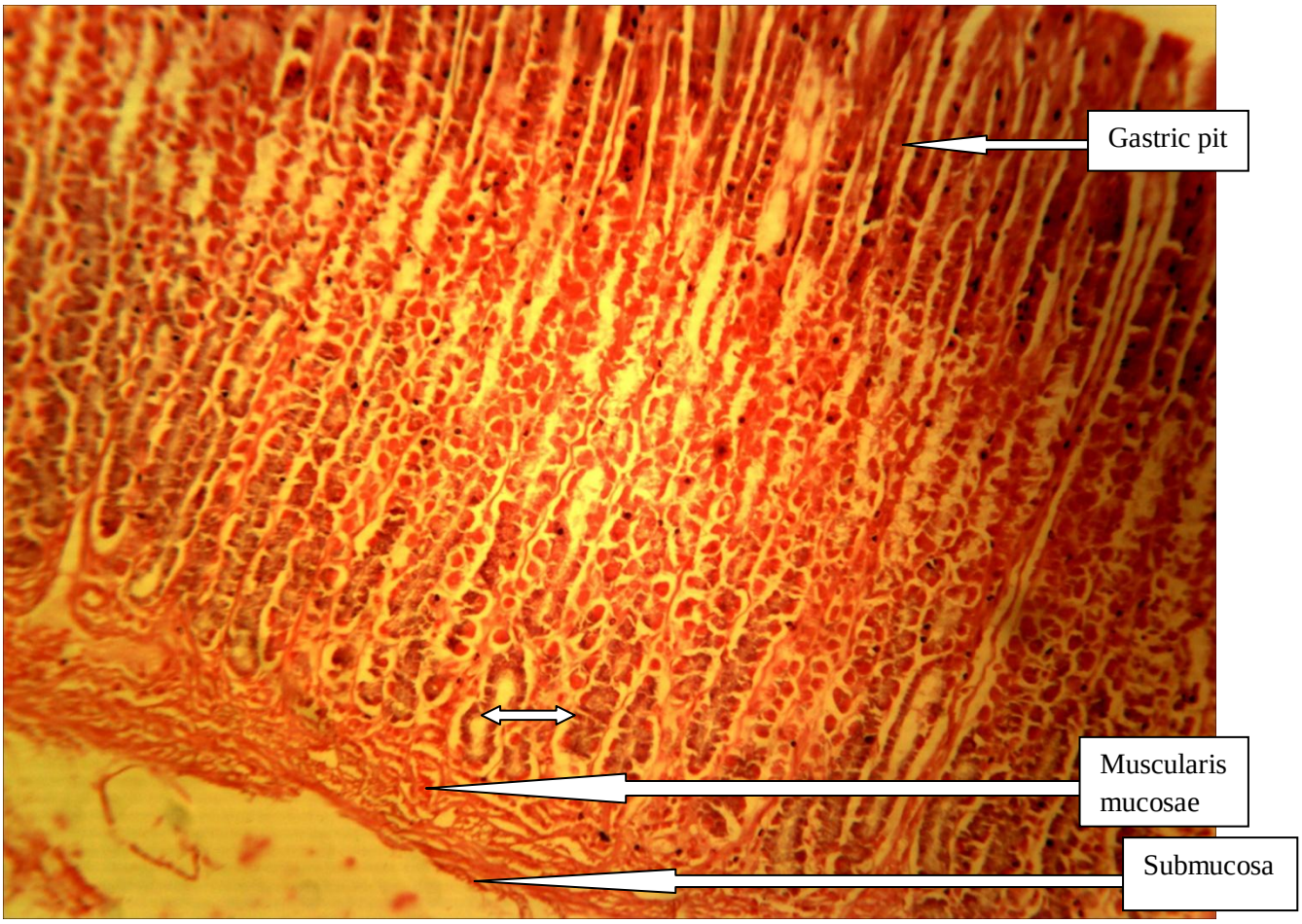

Plate I: Photomicrograph of Stomach of group I showing Normal submucosa, muscularis mucosae, pyloric glands (double arrow) and gastric pit. X100 H&E

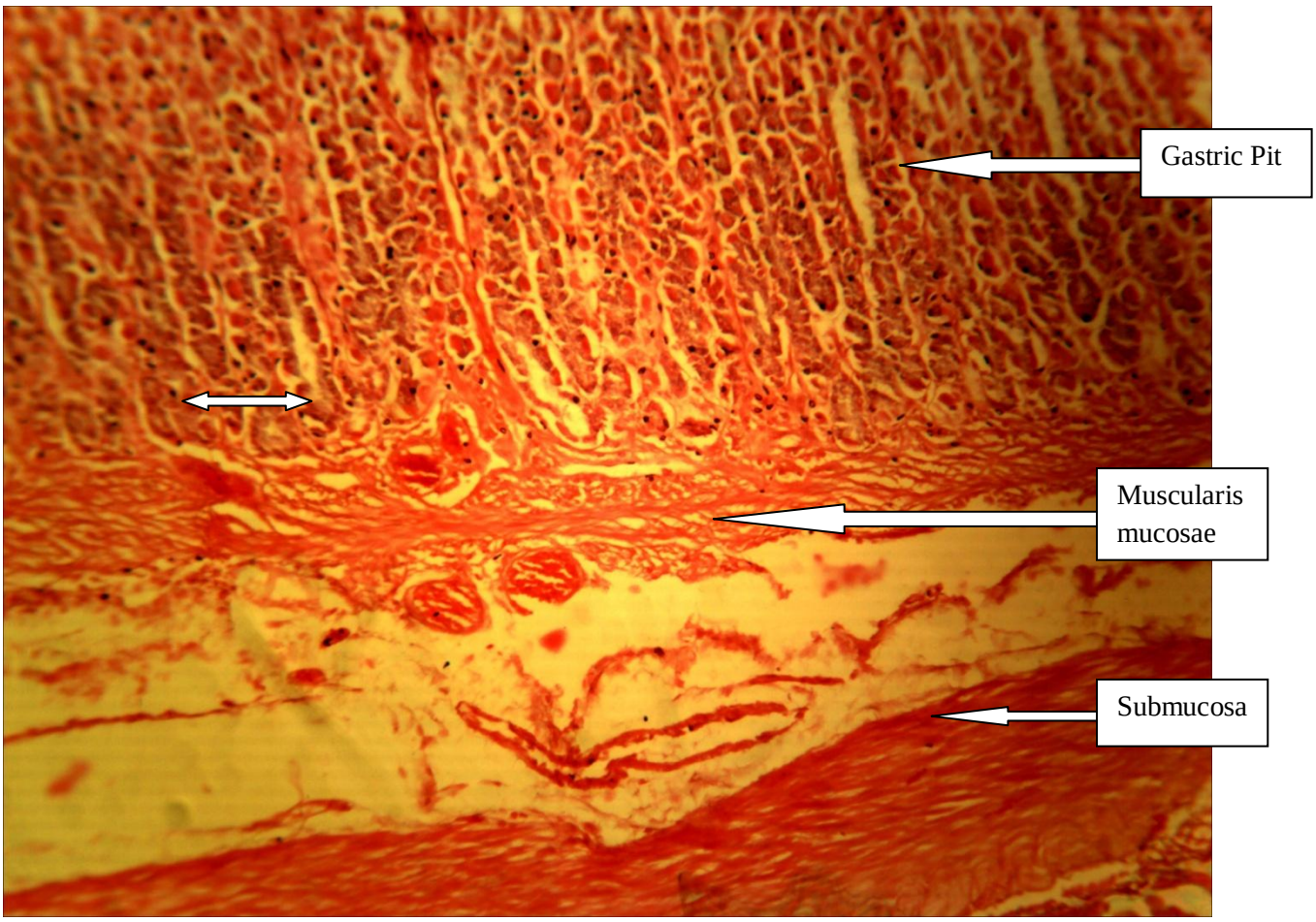

Plate II: Photomicrograph of Stomach of group II showing Normal submucosa, muscularis mucosae, pyloric glands (double arrow) and gastric pit. X100 H&E

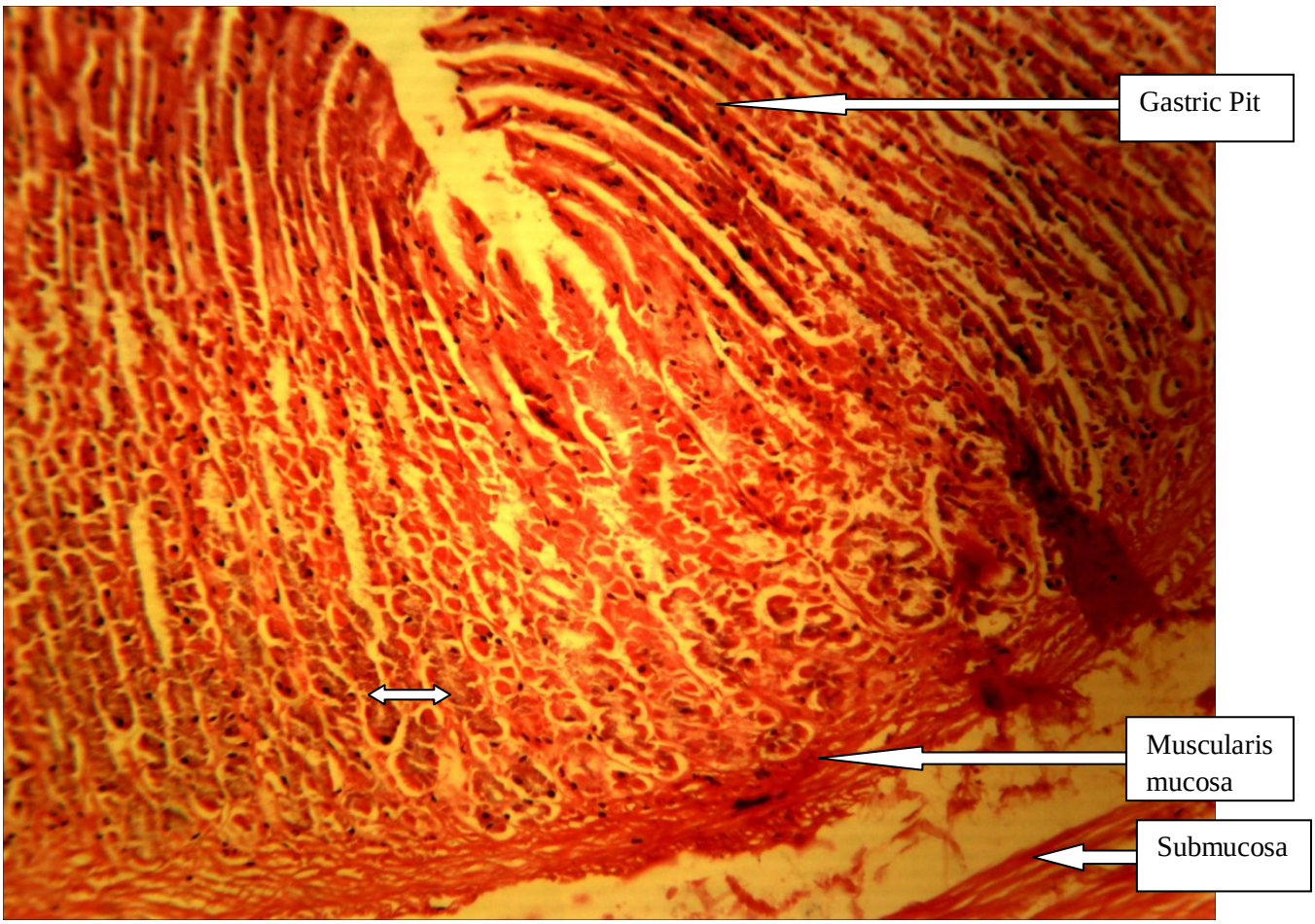

Plate III: Photomicrograph of Stomach of group III showing Normal submucosa, muscularis mucosae, pyloric glands(double arrow) and gastric pit. X100 H&E

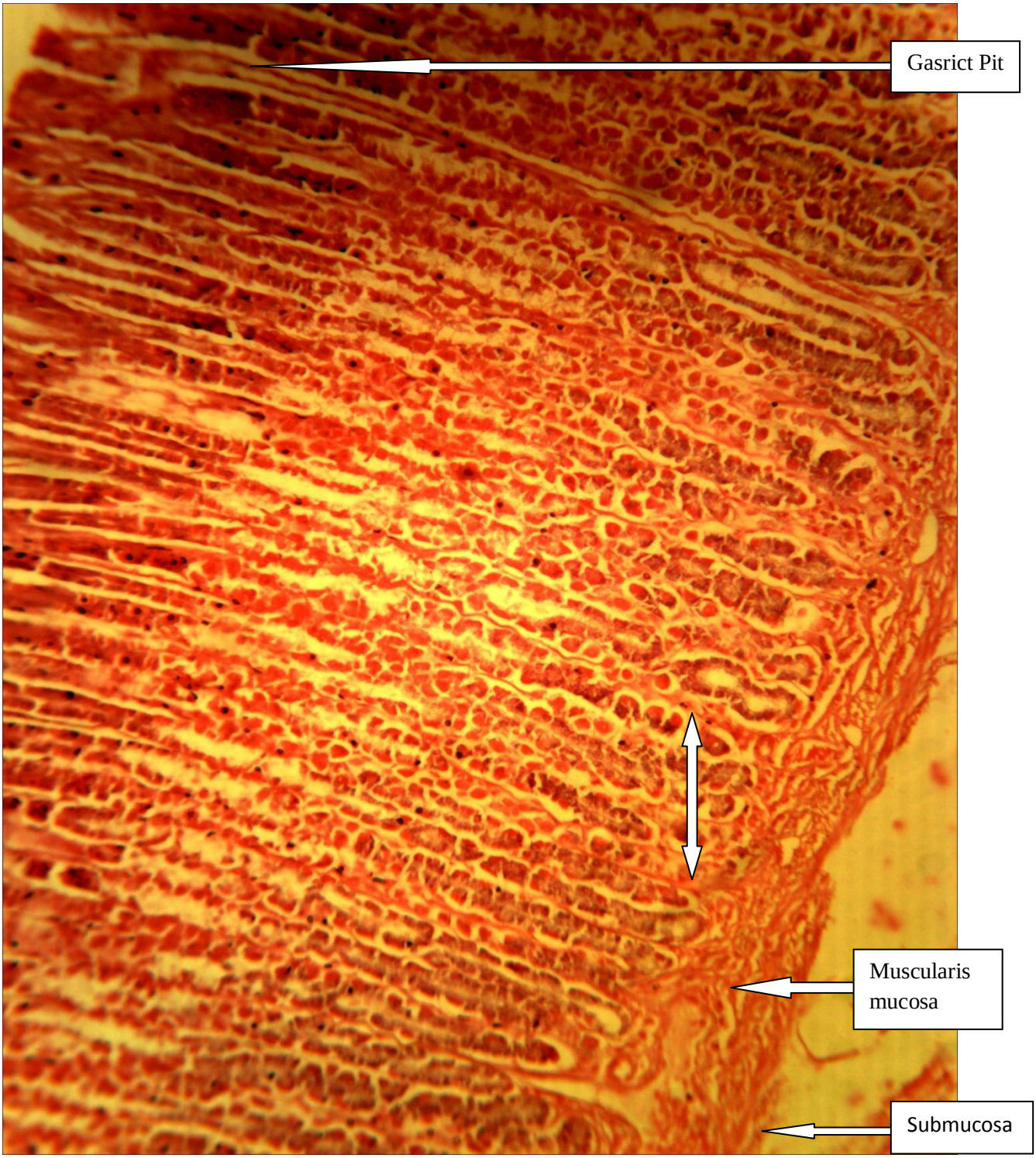

Plate IV: Photomicrograph of Stomach of group IV showing Normal submucosa, muscularis mucosae, pyloric glands (double arrow) and gastric pit. X100 H&E

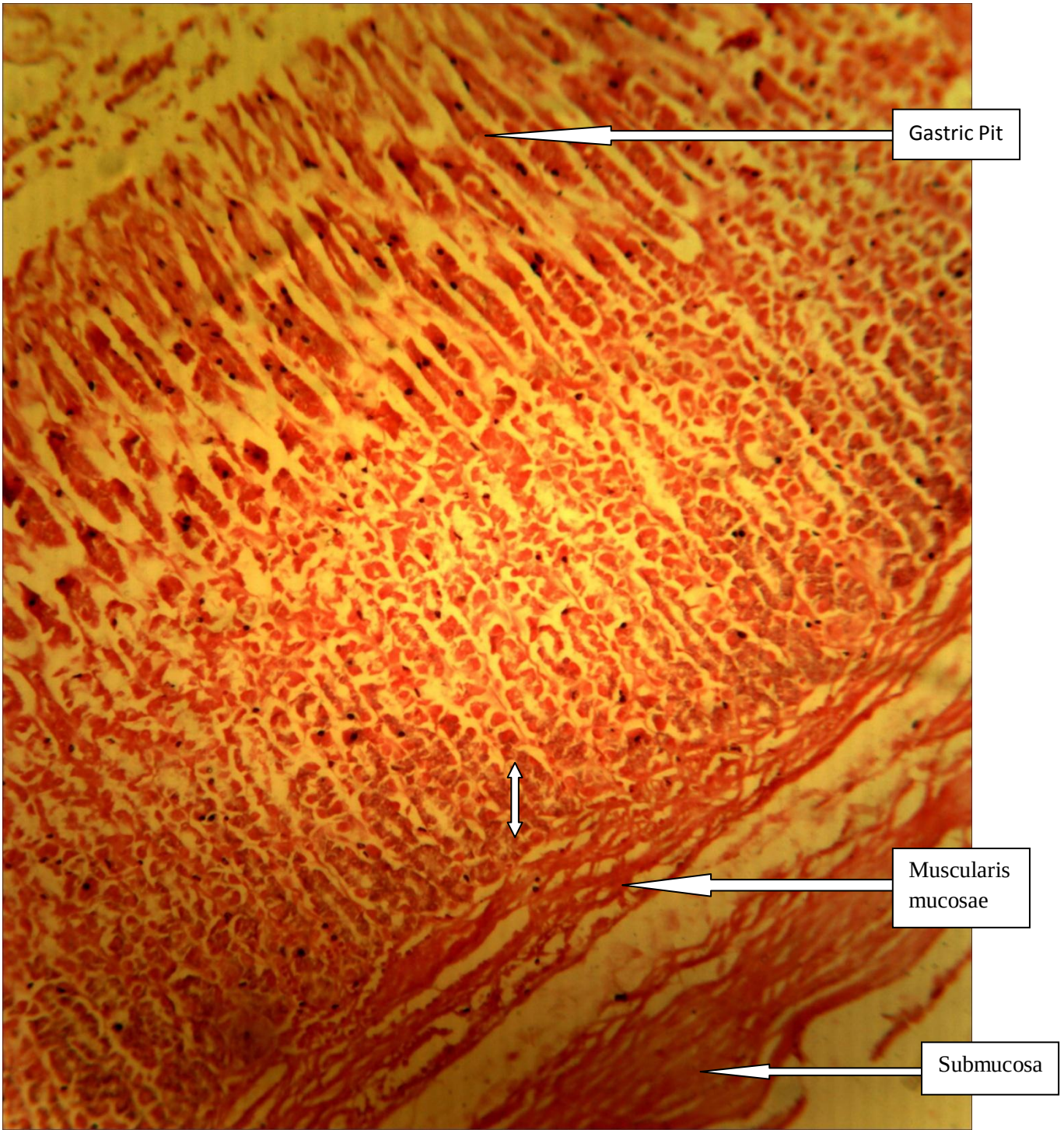

Plate V: Photomicrograph of Stomach of group V showing Normal submucosa, muscularis mucosae, pyloric glands(double arrow) and gastric pit. X100 H&E

Humans are uniformly exposed to aluminium that is present in the soil, food and drinking water [16]. Aluminium is potentially neurotoxic although its biological effects are not yet well known [22]. There are several data linking elevated Al^{3+} levels to neurological pathologies such as multiple sclerosis, Guam Parkinson dementia, Parkinson's disease and Alzheimer's disease [23].

Aluminium Chloride was implicated to have negative effects on behavioural endpoints of wistar rats (i.e. alters behaviour), have negative effects on anxiety-related behaviour of wistar rats as it increased the rate of anxiety in aluminium treated rats and was also said to have neurodegenerative effects on the histology of cerebral cortex of adult wistar rats especially at higher dose[24, 25,26]. It was stated that aluminium chloride exposure could be detrimental to the integrity of the testes of wistar rats [27]. These were in contrast with our present findings where aluminium chloride exposure had no deleterious effects on the histology of the stomach of wistar rats (**Plates I-V**).

However, another findings indicated that although, aluminium chloride decreased the level of sperm count, but it did not result into infertility; this they reported could be as a result of the fact that the wistar rats that received the highest dose of aluminium chloride (1,900 mg kg^{-1}) had an average sperm count of 19.75 million (10^6) which was close to 20 million sperm count required for fertility while the other treated groups had sperm count above 20 million per milliliters [28].

Other reports on occupational Aluminium exposure and neurological impairments demonstrate mixed findings[29]. Despite strong experimental and clinical evidence for Aluminum neurotoxicity, the mechanism of Aluminium effects on the nervous system is still not completely clear. It was reported that Aluminium chloride exposure has neurodegenerative effects on the histology of cerebral cortex of adult wistar rats especially at higher dose as evident in aluminium treated groups which showed extensive neuronal vacuolation and necrosis (neuro-degeneration) of the cerebral cortex of wistar rats [26]. It was also estimated that there was graded increased in brain Aluminium uptake of wistar rats across the groups as the group that received the highest dose had highest brain aluminium uptake which was dose dependent[30]. Aluminium Chloride Exposure was also said to have no effects on the histology of the epididymis and hence storage of sperm cells (spermatozoa) by the epididymis could be safe [31]. This was in concord with our findings in this present study where we observed that aluminium chloride had no deleterious effects on the histology of the stomach of wistar rats (See **Plates I-V**).

In our present study, the submucosa, muscularis mucosae, pyloric glands and gastric pit were intact in all groups; the histological structures/features of the somach of both the control (Plate I) and the aluminium treated groups (Plates II-V) present normal histological features.

4. CONCLUSION

Our results revealed that there were no significant negative effects of aluminium chloride on the histology of the stomach (**Plates I-V**). Based on our observations, we therefore conclude that aluminium chloride exposure had no deleterious effects on the histology of the stomach of wistar rats, as eminent in the normal histological structures of both the control group and the aluminium treated groups.

ACKNOWLEDGEMENT

The authors wish to thank and acknowledge the financial support of the Vice Chancellor of Ahmadu Bello University Zaria and also acknowledge the management of Ahmadu Bello University for supporting this research work.

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