

## The Biochemical Effects of Microwave Radiation on the Skin of Wistar Rats (AWR)

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### Abstract

This research work investigated the effect of Microwave (MW) radiation on the skin and some biochemical parameters using Albino Wistar Rat (AWR). 14 wistar rats of about 16-18 weeks old weighing between 170-230g were used for this study. Two of the wistar rats were used for preliminary test to check that animals were healthy and for proper understanding of parameters after which they were randomly divided into two groups of six each; group C (controlled) and group E (exposed). Group E were fed with microwaved food and water microwaved for 10 minutes in the microwave oven while group C were fed with non-microwaved food and water for 60 days terminated into four sessions at 20 days interval; 1st, 20th, 40th, and 60th day after which the blood samples and skin were taken to National Veterinary Research Institute (NVRI), for proper analysis. The results of the biochemical tests showed an increase in Alkaline Phosphatase (ALP), Aspartate Amino Transferase (AST), Alanine Amino Transferase (ALT) in the exposed group compared to the controlled group with time and increased ingestion of microwaved food. Increase in serum ALP activity observed in the exposed group indicates hepatocellular injury, liver cancer, gallstones or blockage in bile duct. Increase ALT levels are most commonly associated to viral hepatitis, ischemic hepatitis or liver injury. Increase AST level indicates liver damage if associated with ALT and ALP elevation. The skin of the rats exposed to MW radiation showed increase thickening in the stratum corneum and proliferation of hair follicles which indicates hyperkeratosis of the skin. The value of SAR calculated (0.03 mW/Kg) for the skin was observed to be much less than the standard value of 0.08 W/Kg and much less than the recommended level of exposure to MW radiation (2 W/Kg). The results from this research indicate that exposure to MW radiation affects skin and biochemical parameters (AST, ALP, ALT) even at calculated SAR and with long exposure may lead to health hazards.

**Key words:** Microwave radiation (MW), non-ionizing radiation, skin, Aspartate Amino Transferase (AST), Alanine Amino Transferase (ALT), Alkaline Phosphatase (ALP).

### 1. Introduction

Over the years, with increasing use of technological systems and appliances that operate at millimeter range, there have been considerable concern and discussion about the possible hazards of microwave radiation (non-ionizing radiation) and safety [1] due to the suspected health hazards associated with exposures.

Non-ionizing radiations are those radiations within the electromagnetic spectrum with wavelength range of  $10^{-6}$  m to  $10^2$  m having an energy range of  $10^{-1}$  eV to  $10^{-7}$  eV. Non-ionizing radiation include the spectrum of ultraviolet (UV), visible light, infrared, microwave, radiofrequency and extremely low frequency radiation. When electromagnetic (EM)

fields pass from one medium to another, they are reflected, refracted, transmitted or absorbed, depending on the complex conductivity of the exposed body and the frequency of the source. The depth to which microwaves can penetrate tissues is primarily a function of electric and magnetic properties of the tissues and of the microwave frequency. In general, at a given frequency, the lower the water content of the tissues, the deeper the waves can penetrate. Also, at the frequencies of interest, the lower the frequency, the deeper the penetration into the tissue with given water content [2]. Microwave absorption effect is much more significant by the body parts, which contain more fluid (water, blood, etc) like the brain that consists of about 90% of water. Effects is more pronounced where the movement of the fluid

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is less, for example: eyes, brain, abdomen, heart [3]. Effects of this radiation accumulate over time and become pronounced after 8 to 10 years of exposure [4].

Microwave radiation can affect the skin, eye, ear, blood cells, and brain of human and animal health. The exposure to microwave radiation is known to have biological effect on human and animal which include; heating effect of the skin, whole body hyperthermia, local hyperthermia, carcinogenic effects, cardiovascular effect, haematological effect, effect on eyes and auditory effect. These effects are either caused by thermal or non-thermal radiation of the microwave radiation [5]. A microwave oven changes the molecular structure of food by the process of radiation with the use of a magnetron which converts electrical energy to microwave radiation. The microwave travels through a waveguide and is distributed into a metal cavity where food is cooked. Microwaving causes adverse effect in food which includes the destruction of nutrients. The alternating microwave electric current generated by magnetron of every microwave oven forces the food molecules to rotate at frequency of 1-100 billion times per second. The friction from this violent trashing motion tears at the food, vitamin and enzymes molecules, destroying for instances their cell walls while heating them savagely and changing their shapes. Microwaved foods contain deformed molecules not present in food cooked conventionally [6]. Naturally occurring amino acids have been observed to undergo isomeric changes as well as transformation into toxic forms under the impact of microwaves produced in the ovens. Ingestion of microwaved food causes abnormal changes in the blood and physiology of humans [6].

## 2. Materials and Methods

### 2.1 Materials

The materials used are; microwave oven, wistar rats, centrifuge tube, electromagnetic radiation tester, plastic containers, plexi cage.

### 2.2 Method

14 matured wistar rats of about 16-18 weeks old weighing between 170-230g obtained from the ani-

mal house department, faculty of pharmaceutical sciences, University of Jos was used for this study. Two of the wistar rats were used for preliminary studies for proper understanding of parameters standard. The animals were randomly divided into two groups of six each; group C (control) and group E (exposed), which were housed in standard plexi cage under controlled light. Group E (exposed) were fed and given water which was exposed to microwave radiation (internal irradiance) from microwave oven for 10 minutes. Group C were fed with non-microwaved food and water. The same quantity and type of food and water was given to both group respectively. The research procedure was carried out repeatedly for 60 days divided into four sessions at 20 days interval; 1<sup>st</sup>, 20<sup>th</sup>, 40<sup>th</sup> and 60<sup>th</sup> day after which the skin and blood samples were taken to National Veterinary Research Institute (NVRI), Vom, Plateau state for analysis.

### Laboratory Analysis

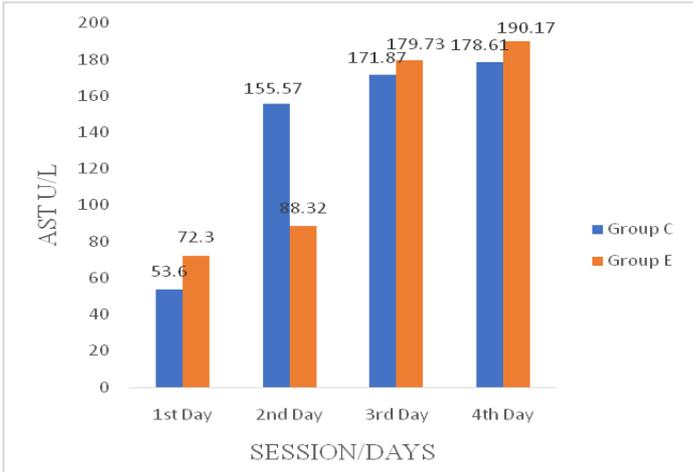
Skin tissue was collected in plastic container fixed in 10% buffered formalin before histological examinations. The blood sample was collected by simple incising of the jugular vein and evacuating the blood into centrifuge tubes before the analysis. Aspartate Amino Transferase (AST), Alanine Amino Transferase (ALT), Alkaline Phosphate (ALP) were analyzed using spectrophotometer; Jenway 6310 (with power 50VA, frequency 50/60Hz, voltage 230/115V and serial number; 1514).

## 3. Results

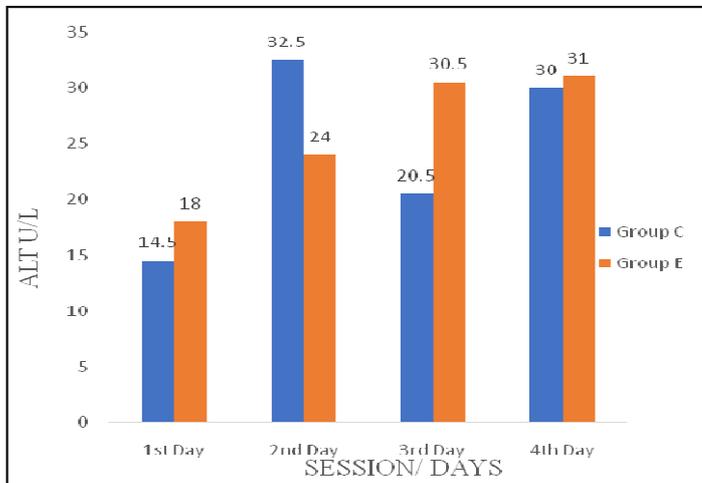
### 3.1 Biochemical Parameters Results

**Table 1: Mean Values of the Biochemical parameters.**

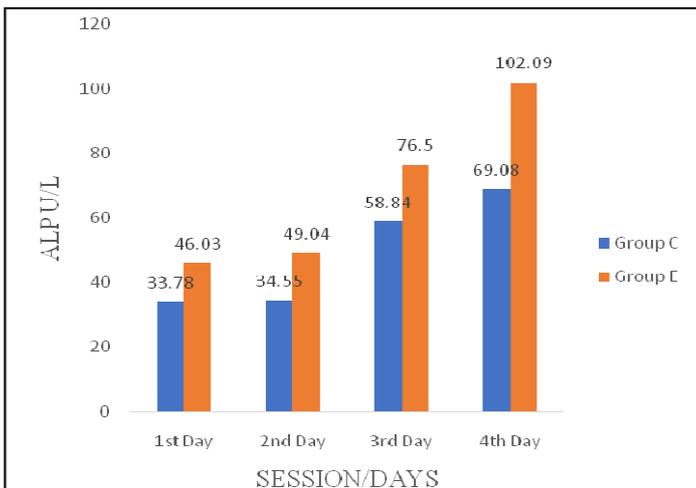
S/ N	SESSION	GROUPS	AST u/l	ALT u/l	ALP u/l
1.	1 <sup>st</sup> Day	Control	53.60	14.50	33.78
		Exposed	72.30	18.00	46.03
2.	20 <sup>th</sup> Day	Control	155.57	32.50	34.55
		Exposed	88.32	24.00	49.04
3.	40 <sup>th</sup> Day	Control	171.87	20.50	58.84
		Exposed	179.73	30.50	76.50
4.	60 <sup>th</sup> Day	Control	178.61	30.00	69.08
		Exposed	190.17	31.00	102.09



**Fig 1: Biochemical Test (AST) Vs. Session/Days of Irradiation**

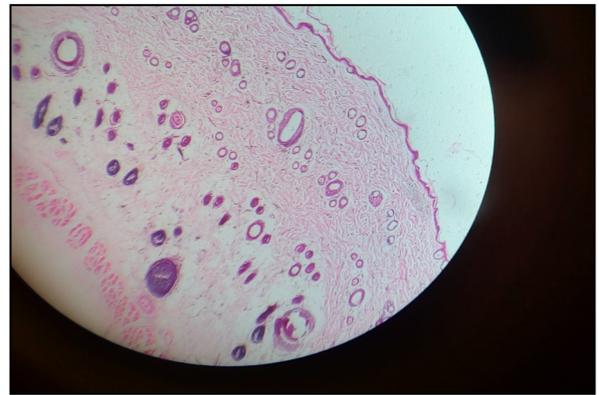


**Fig 2: Biochemical Test (ALT) Vs. Session/Days of Irradiation**



**Fig 3: Biochemical Test (ALP) Vs. Session/Days of Irradiation**

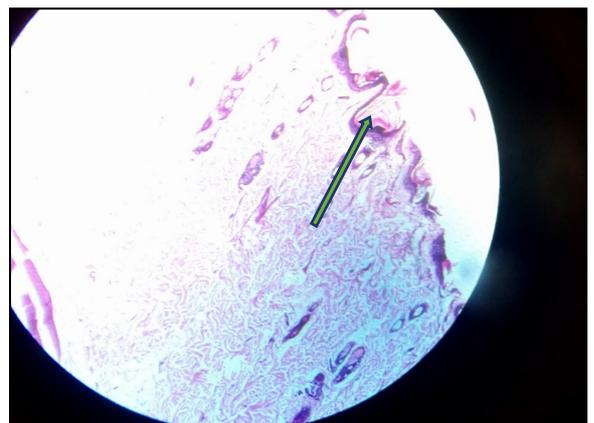
### 3.2 Histology Results (Skin)



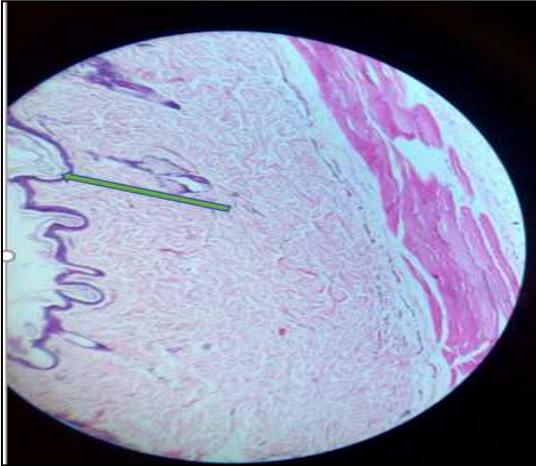
**Plate 1: Pictomicrograph of skin of rat showing normal histology of skin epidermis layer.**



**Plate 2: Pictomicrograph of the skin of rat exposed to microwave radiation for 20 days showing severe hyperkeratosis and proliferation of hair follicles**



**Plate 3; Pictomicrograph of skin of rat exposed to microwaved radiation after 40 days showing slightly severe orthokeratotic hyperkeratosis.**



**Plate 4: Pictomicrograph of the skin of rat exposed to microwave radiation after 60days showing severe orthokeratotic hyperkeratosis.**

### 3.3 Specific Absorption Rate (SAR)

The radiation dose emitted by the microwave oven was measured using an electromagnetic radiation tester. The average and peak value of the magnetic field are; 15.46 $\mu$ T in each case while the average and peak value of the electric field are 0V/m and 2V/m respectively. This electromagnetic radiation dose is harmful.

$$SAR = \frac{\sigma E^2}{\rho_m} \text{ (W/Kg)} \quad \text{----- (1)}$$

At peak (rms) value;  $E = 2 \text{ V/m}$

Conductivity of skin tissue,  $\sigma = 0.170 \Omega\text{m}$

Mass density of skin tissue,  $\rho_m = 1109 \text{ Kg/m}^3$  [7]

$$\text{Therefore, } SAR = \frac{0.170 \times 2}{1109} = 0.000306 \text{ W/Kg}$$

## 4. Discussion

In this research work, observations showed an increase in ALP, ALT and AST levels in the exposed group (Group E) which is irradiated by microwave radiation emitted by the microwave oven through ingestion of microwaved food for 60 days. ALT is one of such enzymes which is elevated in hepatitis and from other acute liver damage [8]. The damage which occurs in hepatocytes of the liver after feeding

on micro wave heated food can release enzymes into the blood stream as indicator [9]. The increase in ALP concentration is associated with chemical conditions as diabetes [10]. The elevation of serum (ALT) activity in blood is widely used as a surrogate marker for tissue damage after irradiation by electromagnetic waves [11]. Aspartate amino transferase (ALT) is a cellular enzyme which is found in higher concentration in the cells of liver, red blood cells [8].

There was a significant increase in ALP levels. The increase in serum ALP activity observed in the exposed group (Group E) indicates hepatocellular injury, Cirrhosis, liver cancer, gallstones or blockage in bile duct. ALP level increases with time and increase ingestion of the microwaved food. Elevated levels of ALP in the blood are mostly caused by liver disease or bone disorders. A significant increase was also recorded in ALT in the exposed group after exposure of the wistar rats to electromagnetic field (microwave) radiation for 60 days. This agrees with [12] who also recorded that the activities of AST were significantly increased after exposure. ALT are primarily located in hepatocytes, but also found in the skeletal muscles, heart and kidneys. Increase in ALT levels are most commonly associated with viral hepatitis, ischemic hepatitis or liver injury due to toxin.

There was also an increase in the level of the AST in blood serum of the irradiated wistar rats which is a marker of hepatocyte injury and liver fat accumulation. AST elevation generally indicates liver damage if ALT, bilirubin and ALP are also elevated [13]; measurement of some liver marker enzymes concentration in the blood in a simple manner to detect organ dysfunction as well as damage which occurred in the liver hepatocytes.

The skin of rats in the control group (Group C) showed a normal histology of the skin (1<sup>st</sup> day) showing the stratum corneum, stratum granulosum, stratum spinosum and stratum basale as shown in plate 1 above. The skin of the rats exposed to electromagnetic radiation (microwave radiation) for 20 days shows slightly thickened stratum corneum and proliferation of hair follicles. This is shown in plate 2 above. The skin of rats exposed to micro-

wave radiation after 40 days shows severe thickened stratum corneum and proliferation of hair follicles. This is shown in the pictomicrograph (plate 3) above. After 60 days, the skin of rats exposed to microwaved radiation shows severely thickened stratum corneum, the stratum granulosum faintly visible as if it is overshadowed by the stratum spinosum. This is shown in plate 4 above.

Hyperkeratosis is the thickening of the stratum corneum (the outermost layer of the epidermis), often associated with the presence of abnormal quantity of keratin and usually accompanied by an increase in the granular layer. It can be caused by vitamin A deficiency or chronic exposure to arsenic [14].

## 5. Conclusion

In this research work aimed at investigating the effect of microwave radiation on the skin and biochemical parameters; can conclude therefore that on increasing ingestion of microwave radiation (internal irradiance) through feed can cause hepatitis, acute liver damage, liver cancer and hepatocellular injury (observed from increase in the biochemical parameter of study). Thus, indicating that long time exposure might pose detrimental effects of blood components, liver and their function [15].

Exposure to microwave radiation can also cause hyperkeratosis on increasing ingestion of this radiation through microwaved feed. The value of SAR calculated ( $3.1 \times 10^{-4}$  W/Kg) for the skin (base on radiation emitted by the microwave oven) was observed to be much less compared to the standard value of 0.08 W/Kg and even much less than the recommended level of exposure, which is 2 W/Kg for normal use [16] but still has a biological effect.

Results from this research work agrees with [12] the fact that blood parameters and serum activities (ALT, AST, ALP) of albino rats was affected by exposure to electromagnetic field but showed signs of improvement with vitamin C and E treatments compared to electromagnetic field exposure alone.

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