SUB-THEME: ANIMAL PHYSIOLOGY AND BIOTECHNOLOGY

EFFECTS OF ELECTROMAGNETIC RADIATION FROM GSM MASKS ON PHYSIOLOGICAL PARAMETERS OF WEST AFRICAN DWARF BUCKS.

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ABSTRACT
Environmental electromagnetic fields arise from different sources, such as cell phones, household current and appliances, wireless technology, cordless phones and base stations, and have contributed to heightened public awareness over their potential metabolic syndrome. This study investigated the impact of the base station mask (≈1800MHz; 66.6W) on animal health using the West African Dwarf (WAD) bucks. Twenty bucks aged 3-6 years were randomly selected based on the proximity to the masks station for this study. The animals were randomly selected into five (5) groups, Group I (0-100m), Group II (150 -200m), Group III (250-300m), Group IV (350-400m) and Group V >2000m with four (4) bucks per group. Each buck was examined for behavioural manifestation, physiological and sperm analysis using standard procedure. The results revealed that animals in the I, II and III had more effect ($p<0.05$) on behavioral, physiological and reproductive parameters while group IV and V produced lesser effect ($p>0.05$). In conclusion the electromagnetic radiation (EMR) from base station may posed adverse effect on West African Dwarf (WAD) Bucks welfare. The findings of this study support the suggestion that a residential building be kept away from the base station masks.
Key words: Electromagnetic radiation (EMR), base station masks, behavioural, physiological, WAD bucks

INTRODUCTION
Electromagnetic radiation (EMR) or radiofrequency (RF) fields shows a significant marked effect on biological processes by raising free radicals, which tend primarily to improve lipid peroxidation, and thus modify the antioxidant protection systems in human tissues, contributing to oxidative stress (Ozguner et al. 2005, Azab and Ebrahim 2017). In recent times, number of EMRs in our society has grown due to the large-scale extension of communication networks such as mobile phones, base stations, WLAN, Wi-Fi, Wi-MAX, etc. In comparison to man-made sources, radiation from natural sources such as the sun and the planet is routinely released (Zhang et al. 1995, Ebrahim et al. 2016).
Due to the global concern for the potential health hazard induced by electromagnetic radiation (EMR), a considerable amount of research has focused on the modulation of normal physiological function especially the brain (Narayanan et al. 2009, Fragopoulou et al. 2010, Ammari et al. 2008 and Nittby et al. 2008), effects on living tissue by radiation involves modification of the cell structure and damage to DNA, the extent of damage depends on the form of radiation (EPA, 2012). Heat production and activation of the inductible process of nitric oxide (NO) synthase may be the cause of the biological effects of EMF exposure (Paredi et al. 2001). As a result, exposure to electromagnetic radiation (EMR) has increased the production of reactive oxygen species (ROS), including superoxide anion, hydrogen peroxide and hydroxyl radicals (Aweda et al. 2003).
Increasing use of cell phones and number of related base stations are becoming a widespread source of non-ionizing electromagnetic radiation, thereby any biological consequences are expected to arise in low-level EM fields. Increasingly, data shows that oxidative stress can be associated with the adverse effects of radiofrequency (RF) radiation on the brain. It has significantly contributed to the exponentially growing EMF smog, an unprecedented source of ambient radiation pollution that has driven scientists to explore human effects. The mechanism underlying these effects is yet unknown but the consensus is that extremely low frequency field (ELF) and EMF interact with biological systems through electric fields, either applied or induced by time varying magnetic fields (Liburdy 1995, Sani et al. 2018). Therefore, there is need to ascertain the effect of base station or masks on some physiological parameters using WAD Bucks. However, nothing has been done to determine the harm sustained to goats that are constantly exposed toEMFr present in the area.Further study on the

long-term effect of RF-EMR from telecommunications using unrestrained WAD bucks in Nigeria is therefore needed.

MATERIALS AND METHODS

Experimental Design

Twenty (20) healthy West African Dwarf. (WAD) bucks aged 3-6 years with the same genetic background and within their home range were used for this study at Ijan-Ekiti ($7^{o}37^{1}$N $5^{o}24^{1}$E), Ekiti State, Nigeria. They were randomly selected based on their proximity to the masks station. The bucks were sample into five (5) groups, Group I (negative control) (0 - 100m), Group II (150 -200m), Group III (250-300m), Group IV (350-400m) and Group V (positive control) (>2000m) comprising four (4) bucks per group.

Behavioural responses

The manifestations of behavioural activity were observed as described by Sofowora (1984) and behavioural observations were measured and recorded using categorical scale (Reis and Judd 2000).

Physiological parameters

Physiological parameters of the WAD-bucks were taken as reported by Fatoba and Ajigbogun (2015) in which clinical thermometer was used for the rectal temperature and stethoscope for pulse rate, heart rate and the respiratory rate.

Semen collection and analysis

Semen was collected through the electro-ejaculator into collecting tube while semen evaluation was done according to Karagiannidis et al (2000) and Oyeyemi et al (2001) procedures. The color of the semen was determined by visual evaluation. Mass activity was determined within one minute of collection by a drop of concentrated semen without a slip under low magnification (x4). The semen was placed in a buffer solution for further analysis.

Statistical Analysis

Data generated were analyzed using One-way analysis of variance (ANOVA). Significatly different means were separated by the Duncan ‘s Multiple Range Test using SPSS version 23.

RESULT AND DISCUSSION

The behavioural responses were presented in Table 1. The animals showed decreased restlessness ($p<0.05$) but increased alertness, activeness ($p>0.05$), grooming, aggression, and mating activity ($p<0.05$) in the bucks across the groups. The result could be traced to non-thermal effects that have shown variations in cell metabolism by both resonance absorption and induced EMFs (Aweda et al. 2003).

The results from the responses could be linked to the exposure of human to the EMR which had been linked to melatonin impairment (Wilson et al. 1990, Wood et al.1998) which caused a delay and reduces sleep, disorientation, confusion and depression (Abelin et al. 1999), thereby inhibits pineal gland development of melatonin (N-acetyl-5-methoxy-tryptamine), which has been considered a powerful antioxidant, much more potent than vitamin E, which in several pathophysiological states detoxifies a range of reactive oxygen species (ROS).The findings of this study indicate that long-term exposure to low-intensity (pulsed) electromagnetic radiation from GSM base stations can have major effects on the actions of WAD bucks causing restlessness reported in both humans and laboratory animals and demonstrated distance variations in response to the EMR source (Akinyemi et al. 2014).

Table 1: Behavioural Activity in WAD –Bucks following exposure to Electromagnetic radiation

Parameters	GROUPS					
(%)	I	II	III	IV	V	S.E
Activeness	25.00	25.00	50.00	75.00	100.00	0.7013
Alertness	25.00	25.00	50.00	75.00	100.00	0.7013
Grooming	0.00^{b}	25.00^{b}	50.00^{ab}	75.00^{ab}	100.00^{a}	0.9682
Restlessness	100.0^{a}	100.00^{a}	75.00^{a}	25.00^{b}	25.00^{b}	0.9682
Aggression	0.00^{c}	0.00^{c}	25.00^{bc}	50.00^{ab}	100.00^{a}	1.2245
Mating activity	0.00^{c}	0.00^{c}	25.00^{bc}	50.00^{ab}	100.00^{a}	1.2245

a,b,c,values along the same row with different superscripts are significantly different ($p<0.05$), S.E = Standard error

Some physiological parameters of the bucks were shown in Table 2. The heart, respiratory, rumination rates and rectal temperature values were decreased ($p<0.05$) across the groups. The animals in group I had the highest values of rectal temperature, heart, respiratory and rumination rates and lowest in the group V. Rectal temperature was highest in I and lowest in Group V and the values follow trend of I > II > III > IV >V and were significantly differed ($p<0.05$). However, rectal temperature shows no significant different ($p>0.05$) between IV and V which signifies that the EMR did not produces harmful effect on the parameter tested. The results obtained on rectal temperature has been linked to the brain's blood circulation which is able to reduce the excess heat by increasing local flow and may be due to this thermal effect (Thomee et al. 2007). As a matter of fact, preliminary studies have already reported that EMR affect brain functioning and behaviours (Fernie and Reynolds 2005, Hamblin and Wood 2002).

Rectal temperature is usually known to be a reasonable index of deep body temperature, even though there is significant variance at various periods of the day, the higher magnitude of the rise in rectal temperature of the WAD goats during the season (heat stress) implies that these animals can store body heat during the heat stress period and can promote the loss of water and increased use of energy correlated with increased respiratory rate.

Table 2: Physiological parameters of WAD Bucks upon chronic exposure to Electromagnetic radiation

Parameters	GROUPS					
	I	II	III	IV	V	S.E
Heart rate (beats /min)	122.00^{a}	120.00^{a}	116.00^{a}	100.00^{b}	91.50^{b}	1.4080
Respiratory rate (beats /min)	45.00^{a}	40.00^{ab}	39.50^{b}	30.00^{c}	29.00^{c}	1.4514
Rumination rate (beats /min)	36.50^{a}	34.00^{ab}	30.50^{ab}	29.00^{bc}	28.00^{c}	2.1065
Rectal temperature (^{o}C)	39.50^{a}	39.25^{a}	38.25^{b}	37.50^{bc}	37.00^{c}	1.2384
Scrotal Temp.	36.50	36.45	36.03	36.08	35.94	0.3122

a,b,c, values along the same row with different superscripts are significant ($p<0.05$)
S.E = Standard error

The reproductive parameter is shown on Table 3. The semen colour was milky with increased ($p<0.05$). mass activity, motility and sperm concentration but decreased abnormality across the tested groups. The abnormality was significantly higher ($p<0.05$) following EMR exposure. The observation in the study indicated that electromagnetic fields (EMF) increase free radical activity in cells (Lai and Singh 1997, Simko et al. 2007), through Fenton reaction (Lai and Singh 2004). The use of mobile phones by men is associated with reduced semen content, sperm count, motility, viability and normal morphology and is related to the period of cell phone use (Agarwal et al. 2006). However, the level of harm is likely to increase with the exposure time (Forgacs et al. 2006).

Table 3: Effect of Electromagnetic radiation on Spermiogramic parameters of WAD-Bucks

	TREATMENTS					
Parameter	I	II	III	IV	V	S.E
Colour	Milky	Milky	Milky	Milky	milky	-
Mass activity	2.0^{b}	2.0^{b}	2.0^{b}	2.5^{ab}	3.0^{a}	1.7326
Mass motility	40^{c}	43^{c}	45^{c}	58^{b}	75^{a}	3.0045
Sperm conc. (x 10^{7})	5.45^{a}	572^{ab}	$6,18^{b}$	7.21^{c}	7.34^{c}	0.8765
Sperm abnormality	70^{a}	65^{ab}	53^{b}	28^{c}	20^{c}	2.9649

a,b,c,d, values along the same row with different superscripts are significant ($p< 0.05$) S.E = Standard error

Hales et al (2005) documented oxidative stress at the level of the testes that is capable of disrupting the steroidogenic genocity of the leydig cells and the ability of germinal epithelium to differentiate normal spermatozoa (Naughton et al. 2001), result shows that the semen features were compromised by the EMR. The result obtained from this work explains the restlessness observed in the treated groups which in line with interference of mobile phone with the brain modulation associated with the continuous use of the phone (Eberhardt et al. 2008). The increase in spermatozoa abnormalities in this

study indicates that the EMR caused a high destruction of the spermatozoa and inhibited maturation of sperm cells. The findings of this study indicate that long-term exposure to low-intensity (pulsed) electromagnetic radiation from GSM base stations can have major effects on populations of WAD bucks as reported for wild birds (Fernie and Reynolds 2005).

CONCLUSION

The present research found that the effects of electromagnetic field exposure on WAD bucks depend on distance and time. This finding suggests that the animal's body fuel may be affected by the electromagnetic fields (EMF) following heat and activation of the inductible form of nitric oxide (NO) synthase could be the source of the biological effects of EMF exposure found in this research. The study showed that the reproductive organs of WAD bucks were significantly disrupted and may have a similar impact on higher mammals. It is proposed that more research be performed on the long-term impact of telecommunications RF-EMR on other animal species.

Conflict of interest

The author declares no Conflict of interest

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