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MORPHOLOGICAL STUDIES OF VOMERONASAL ORGAN IN THE WILD JUVENILE RED- FLANKED DUIKER *Cephalophus rufilatus* (GRAY 1864)

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ABSTRACT

The vomeronasal organ (VNO) of the juvenile Red-flanked duiker (Cephalophus rufilatus) weighing between 0.8-1.4 kg was studied by gross dissection and light microscopy. The organ was found to be present at the base of the nasal septum completely housed by the vomeronasal cartilage, but the various soft tissue components of the organ were not remarkably present as in most adult mammals. The average palatal length of the organ was 1.9 cm, while the transverse diameter of the lumen of the duct measured 0.5 cm. The average thickness of the vomeronasal sensory epithelium on the medial wall was 50.05 µm, while that of the 'non sensory' respiratory epithelium on the lateral wall was 40.05 µm. Our findings suggest that the VNO of the juvenile duiker is rudimentary at this stage and may not be able to support vomeronasal functions. Further development of the various components is required to achieve its functional capacity.

Keywords: Red-flanked duiker, *Cephalophus rufilatus,* Vomeronasal organ, Anatomy, Histology

INTRODUCTION

In several mammalian species, olfactory sensory perception is mediated by two anatomically and functionally distinct organs, the main olfactory and vomeronasal organ(VNO) (Dulac and Axel, 1998).The VNO is a highly variable structures located bilaterally in the mucosa of the base of the nasal septum (Bhatnagar and Smith, 2003). It is typically encased within a cartilaginous or bony capsule (Salazar *et al.,* 1995). The VNO plays important role in chemosensory-mediated phenomenal effects on endocrine regulation, social and sexual behaviour (Halpern and Martinez-Marcos, 2003). It contains the peripheral chemoreceptors necessary for detection of pheromones (Wysocki *et al.,* 1991).

The VNO is also thought to function as an organ to determine the flavour of food in the mouth by olfaction (Dursun, 1994). Some researchers (Kumar *et al.*, 1981; Soler and Suburo, 1998; Doving and Trotier, 1998) suggested that the VNO may be related to "frehmen behaviour" (lip curl) displayed especially by felids and ungulates. The forest duikers *Cephalophus* spp are small little-known group of 15 species of African bovids which is ~~wi~~dely distributed throughout sub-Saharan Africa (Ansel, 1971). Forest duikers are considered primitive antelopes, which diverged early in bovid evolution and thus thought to have retained numerous primitive characteristics ((Estes, 1974; Kranz and Lumpkin, 1982). Moreover the group is relatively homogenous. All *Cephalophus spp* are small (4 – 64 kg) with build, gait and short slanted horns seem well adapted to movement through thick vegetation of the forest habitats. All duikers are browsers but individual species may be exclusively frugivorous, or frugivorous and herbivorous (Gautier-Hion *et al.,* 1980). They are true ruminants. Red-flanked duiker (*Cephalophus rufilatus*) is rare specie of forest duikers found throughout Central and Western Africa. They are among the few duiker species found outside equatorial rain forests (Estes, 991). Red-flanked duikers have the largest preorbita (maxillary) glands of all duiker species (Kingdon, 1984). These glands exude a scent used in territorial marking. Duikers *Cephalophus spp* are important source of food and income throughout forest regions of Central and West Africa. Local inhabitants kill duikers for food by capturing them in live traps or with nets. In West Africa, it is one of the most common meats sold in both rural and urban markets.

There is scant literature on the morphological and behavioral differences between wild and domesticated African bovids. In addition, some questions regarding the breed-related differences in the topographical location in a given species-large and small ruminants, goat, swine, sheep, cats as well as the boundaries of the location

of the sensory and non sensory epithelium of the vomeronasal organ in animals remain unclear. To date, there has been no conservation projects aimed at protecting populations of this species in the wild (Fischer and Linsenmair, 2001). Knowledge on the ecology and reproductive behaviour is still very limited (Newing, 2001). Moreover, information on the morphology of the vomeronasal organ in the Red-duiker (*C. rufilatus)* is apparently lacking. This study is therefore designed to shed light on the morphological aspect of the VNO in this species which hitherto is lacking.

MATERIALS AND METHODS

Six wild juvenile *C. rufilatus* (4 males and 2 females) weighing between 0.8 kg-1.4 kg purchased at intervals from farmers engaged in kill-trapping in the forests around Ogurugu/Opanda, in Nsukka area of South Eastern, Nigeria, were used for this study. Following decapitation, the heads were washed with normal saline and their vomeronasal organs were dissected out along with the nasal septum and hard palate. This was examined grossly using a dissecting microscope. The palatine and vomer bones were trimmed and the VNO dissected out from the tissues by sawing with small hand saw. These blocks of tissue containing the VNO was fixed in 10% neutral buffered formalin, decalcified using formic acid-sodium citrate solution according to Bhatnagar and Kallen (1974) and Smith et al., (1997). The tissues were dehydrated in graded series of ethanol, cleared in xylene and embedded in paraffin wax. The blocks were sectioned in transverse plane at 6 µm thickness using a rotary microtome. Every tenth section was mounted on glass slides and stained with Haematoxylin and Eosin. The middle sections of the organ were studied with a Hund Wetzlar 600H light microscope with Moticam 1000 digital camera attachment and images captured into a computer. Ocular micrometer, calibrated with a stage micrometer was used to measure the thickness of the sensory and nonsensory epithelium.

RESULTS

Gross Anatomy: The VNO was observed to be paired and oval shaped and located on the ventral part of the nasal cavity, closely associated with the vomer, maxillary and incisive bones (Figures 1, 2 and 3). The rostral and middle segments of the organ were observed to be completely encapsulated by the vomeronasal cartilage, while the caudal extremity of the organ was partially surrounded by a coma-shaped vomeronasal cartilage. The VNO extended from the incisive ducts of the oral cavity to the 1st and sometimes the 2nd premolar tooth. The duct of the VNO was found to be oblong-shaped, though the size and internal contour of the duct varied along its longitudinal axis. The mean palatal length of the VNO was 1.9 cm, while the mean lumen diameter of the duct was 0.5 cm.

Histological Features: The vomeronasal ducts of the middle segment of the VNO were bounded medially and laterally by cartilaginous walls. The medial and lateral walls were observed to be concave and convex respectively. The epithelium lining the medial wall was thicker (50.05 µm) than the lateral wall (40.05 µm).The mean diameter of the lumen of the vomeronasal duct was 530.05 µm and 260.05 µm for the long and short axis of the duct respectively. The medial wall of the vomeronasal duct was lined with olfactory epithelium (vomeronasal sensory epithelium) (Figure 4)**.** This epithelium is comprised of three cell types, namely supporting cells, olfactory cells and basal cells. The supporting cells were elliptical in shape and apico-peripheral in location. The olfactory cells were observed to be bipolar neurons with microvillous apical surface projections. The basal cells were round in shape and located close to the poorly differentiated basement membrane. The lamina propria of the medial wall was very prominent and contained few nerve bundles. Sparse vascularisation and few glandular ducts were observed near the boundary with the lateral wall. The vomeronasal nonsensory epithelium on the lateral wall was lined with ciliated pseudostratified columnar cells with goblet cells and basal cells. Blood vessels and lamina propria were sparsely distributed in the lamina propria (Figure 5).

DISCUSSION

This study describes the existence of a VNO in the juvenile *C. rufilatus*, a model of the primitive bovid ancestors*.* Our results in the juvenile duiker showed that the VNO is a rudimentary structure compared to that of juvenile blind mole rats (Zuri *et al.,* 1998), other rodents (Garrosa *et al.,* 1986; Sangari *et al.,* 2002), neonatal and adult goat (Besoluk *et al.,* 2001; Igbokwe, 2006). There were no apparent morphological and morphometric differences between the male and female animals studied. In the *C. rufilatus* studied, the average palatal length of the VNO was 1.4 cm, while the average transverse diameter of the vomeronasal duct was 0.5 cm and the VNO terminated caudally between the first and second developing premolar teeth. In adult goats, the VNO terminated at the level of the third premolar

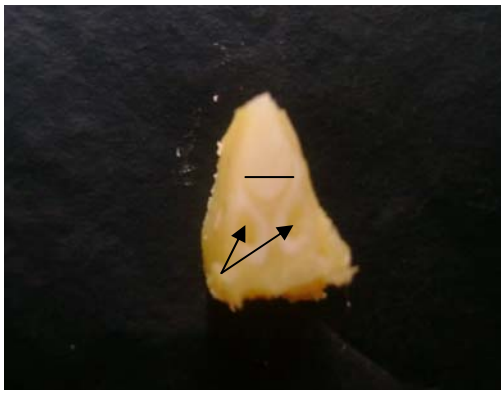

Figure 1: Gross dissections, showing the paired VNO (arrows) and its lumen and nasal septum (bar). H & E ×100

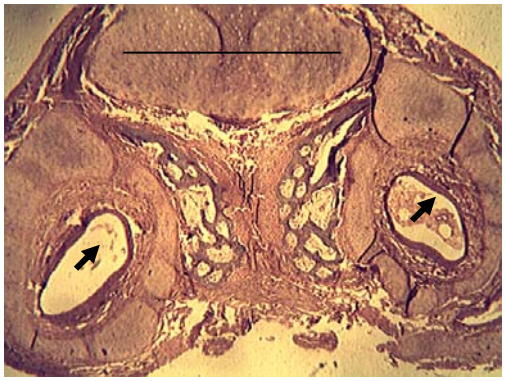

Figure 2: Histological section of the middle segment showing the paired VNO, and surrounding skeletal bones, nasal septum (bar). H & E ×100

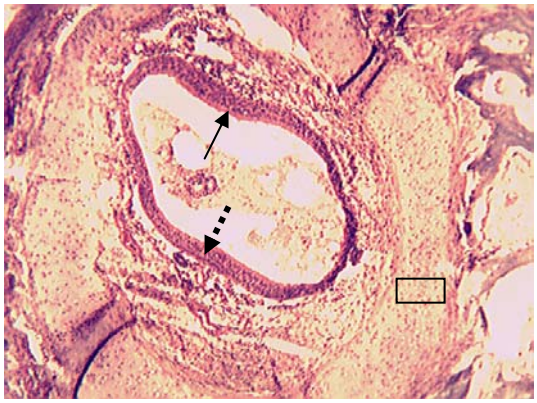

Figure 3: VNO housed by hyaline cartilage (box), vomeronasal sensory epithelium on medial wall (unbroken arrow), 'non sensory' respiratory epithelium on lateral wall (broken arrow): No marked differences in thickness of both epithelia H & E×200

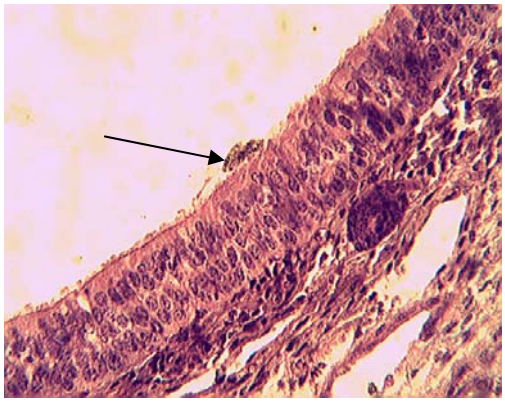

Figure 4: vomeronasal sensory epithelium (pseudostratified columnar) comprising microvillary surfaces(dark arrow), surporting cells (a), bipolar sensory neurons (b), basal cells(c), nerve bundle(n), lamina propria (L). H & E × 400

(Besoluk *et al.,* 2001). The vertical diameter in goats in its central part is 5 mm (Takigami *et al.,* 2000). In adult sheep, the caudal part ends at the first premolar or second premolars (Kratzing, 1971). The vertical diameter of the VNO lumen has a width of 1 cm in its central part (May, 1964). In swine, the VNO length is up to 4 cm; it ends blindly and reaches the second premolar level (Salazar *et al.,* 1997). In cattle, the caudal part of the VNO ends at the level of the first and second premolar (Kumar et al., 1981). The lumen of the ventral part of VNO is not covered with cartilage that constitutes the organ (Kostov, 2007). Jacobs et al., (1981) recorded that the ventral part of the vomeronasal duct in cattle was not covered with the vomeronasal cartilage. However, we observed that the rostral and middle part of the VNO in the duiker was completely enveloped by the vomeronasal cartilage except at its caudal part. Besoluk et al. (2001) reported that only the dorsal part was lacking the vomeronasal cartilage in Angora goats (*Capra hircus*), while, Adams and Wiekamp (1984) reported lack of vomeronasal cartilage in the dorsolateral part of the vomeronasal organ in dog.

There is a wide agreement that the vomeronasal duct is lined by 2 types of epithelium, respiratory and sensory in several mammalian species (Wysocki and Meredith, 1987; Salazar *et al.,* 1995; Doving and Trotier, 1998; Evans, 2003)). This has been demonstrated by several methods (Banister and Dodson, 1992). The vomeronasal organ of the red-flanked duiker is no exception to this rule and our results confirm these findings. We measured the thickness of the vomeronasal sensory epithelium of the medial wall to be 50.05 µm, that of the 'non sensory' respiratory epithelium on the lateral was 40.05 µm. Vaccarezza *et al.* (1981) reported that the vomeronasal sensory epithelium and 'non sensory' epithelium were 140 µm and 30 µm respectively in rats, being a macrosomatic animal. In the dog, Adams and Wiekamp (1984) found that the sensory and 'non sensory' epithelium were 55 – 121 µm and 34 – 72 µm thick respectively.

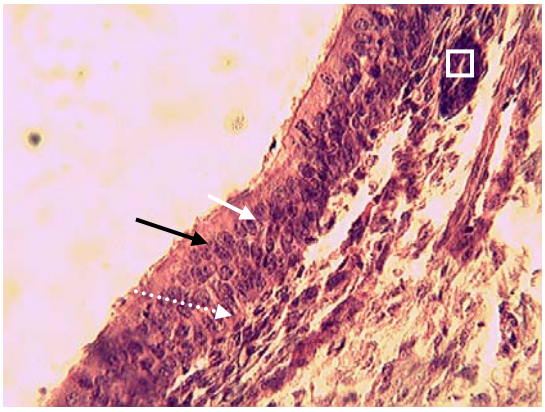

Figure 5: Non sensory respiratory epithelium comprising surporting cells (dark arrow), ciliated columnar cells (white arrow), basal cells (white arrow), glandular ducts (box), H & E× 400

The vomeronasal sensory epithelium of the medial wall is thin, approximately the thickness of the VNO of a 13 day rat embryo (Yoshida *et al.*, 1993) and that of adult male ferret (Weiler *et al.,* 1999). Only about 1-2 rows of sensory bipolar neurons were seen. This was also observed in the rudimentary VNO of ferret. We did not observe intruding capillaries in the sensory epithelium as described for other mammals (Yoshida *et al.,* 1993; Sangari *et al.,* 2002). Intruding capillaries usually reflect a high metabolic activity (Vaccarezza *et al.,* 1981).Their absence suggests low metabolism and is described in species with a thin epithelium in which the VNO seems not to play important role in behaviour. In species with functionally important VNO, capillaries intrude prenatally when VNO has reached certain developmental stage (Breiphol *et al.,* 1981). Taniguchi *et al.* (1992) stated that there are no venous sinuses in the VNO. These have been observed in neonatal goats (Igbokwe, 2006) and by Salazar *et al.* (1997) in adult pigs, cows and horses. Our findings in the Red-flanked duiker did not reveal groups of vessels which can be called venous sinuses. Numerous glandular ducts open at the junction of the lateral and medial walls in the rat (Vaccarezza et al., 1981) and goat (Igbokwe, 2006).This feature was not observed in the juvenile duiker. Duikers are known to exhibit 'flehmen' behaviour (Estes, 1991). Soluble substances may enter the VNO via the incisive duct through either the nasal vestibule or the oral cavity.

C .rufilatus reaches sexual maturity at 9 – 15 months (Kingdon, 1984). It is probable that the full development and functionality of the VNO takes place several months after birth. The VNO may play more important role in territorial marking than reproductive functions. *C. rufilatus* posses the largest preorbital gland of all duiker species used in scent marking between conspecifics.

In conclusion, we hope that this study revealing macroscopically and microscopically the structure and function of the vomeronasal organ in the juvenile Red-flanked duiker (*C. rufilatus*) will shed light on future studies on the reproductive biology and ecology of this endangered specie suitable as microlivestock.

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DIAGNOSIS OF NASAL MYIASIS IN THE WEST AFRICAN DWARF (WAD) SHEEP AT UMUDIKE, ABIA STATE, SOUTH-EASTERN NIGERIA

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ABSTRACT

A West African Dwarf (WAD) sheep with typical symptoms of nasal myiasis was procured on 9th December, 2008 by the Department of Microbiology and Parasitology at the College of Veterinary Medicine (CVM), Michael Okpara University of Agriculture Umudike (MOUAU) in Abia State, south-eastern Nigeria for the purpose of teaching the subject, 'nasal myiasis', to para-clinical students of veterinary entomology. A sagittal section of the head of the suspected sheep was carried out for post mortem examination, whereupon two mature maggots, identified as the third stage larvae of the sheep nostril fly Oestrus ovis, were observed in the ventral meatus. The preserved specimens will help to expand the students' knowledge of the key identification features of the larva of Oestrus ovis, as well as the relative positions of the anatomical organs that may be affected by the developing larvae leading to pathological conditions which manifest as clinical symptoms of nasal myiasis in the sheep.

Keywords: Sheep bot fly, *Oestrus ovis*, Nasal myiasis, Diagnosis

INTRODUCTION

The family Oestridae consists of several genera of large dipterous flies whose larvae are obligatory parasites of animals and man. Myiasis is the infection by these larvae (Roberts and Janovy, 2000) which are highly host specific and spend considerable time feeding and developing in their preferred hosts (Urquhart e*t al*., 2003). An example is the larvae of the nasal bot fly *Oestrus ovis*. The adult female fly, which does not lay eggs, is world-wide in distribution. Its larvae develop inside it and are deposited in the nostrils of sheep. The presence of the fly makes the sheep to bunch together with their heads lowered, with their nostrils close to the ground (Lapage, 1968) or protected between the bodies of other sheep. When the female fly darts at a sheep, causing it to raise its head, the fly immediately squirts a jet of liquid containing up to 25 larvae (Urquhart *et al.,* 2003) at the upturned nostril of the sheep. There are three developmental stages of the larva; the first stage larva is small, flat and white, but has a strong, sharply pointed horn-like mouth-hooks and long cephalo-pharyngeal skeleton. The second larva is long and cylindrical with a broad posterior end, and it attaches itself to the nasal mucosa with the strong mouth-hooks. The third stage is the matured larva which resembles the second, but is longer with brown bands on the dorsal aspect of the segments. Its dorsal surface is convex while the ventral side is flat and the larva tapers anteriorly while the posterior end is squared off. This implies that sheep may at any time contain larvae in different stages of development in various sections of the nasal passages before they either crawl out or sneezed out of the sheep's nostrils to pupate on the ground. The dark brown pupa is found in the soil or under stones and tufts of foliage and lasts between 3 – 8 weeks before the adult emerges. The female adult fly survives for only two weeks, during which it can deposit up to 500 larvae in the nasal passages of the sheep (Urquhart *et al.,* 2003).

WAD sheep are commonly kept semi-intensively in Nigeria and are sometimes left to stray on public grounds constituting nuisance and danger to public health (Ikpeze, 2005). Adult fly causes annoyance which makes the sheep restless, interrupting their feeding which may lead to loss of condition (Thomton and Gracey, 1976). The larvae of *Oestrus ovis*, which is deposited on the nostril of the sheep, attach to the mucus membranes of the nasal passages where they cause irritation and inflammatory reactions resulting in the development of sticky muco-purulent nasal exudates. The irritation causes the affected sheep to frequently sneeze and shake their heads. Affected sheep may grate their teeth, rub their nose on fixed objects, move in circles with unsteady gait, and cease to eat properly. The larvae, by their activities, may also erode the bones of the skull to enter the brain (Lapage, 1968) where they may die in the sinuses causing secondary bacterial infection. Urquhart *et al.* (2003) observed that man could be occasionally infected if *Oestrus ovis* deposits larvae near the eyes, leading to

catarrhal conjunctivitis, but such larvae will never fully develop.

Diagnosis of nasal myiasis in sheep is often based on clinical signs and when the animal is observed to sneeze out the larva. Looking for larvae in the nasal and cranial cavity of the sheep is regarded as a post-mortem (PM) curiosity, but finding the active larvae in the nasal passages of the sheep is the confirmatory diagnosis of nasal myiasis. PM examination of the head of suspected sheep is not usually conducted because clients preferred to sell the affected animals or slaughter them for meat consumption. This situation will not afford para-clinical students of Veterinary Medicine the opportunity to carry out or witness the PM procedure for the examination of the head of sheep for the larvae of *Oestrus ovis*. This paper aims at doing this by using a typical case of 'Nasal Myiasis' to conduct PM, where the sagittal section of the head of the affected sheep was used to show the active larvae of *Oestrus ovis*. This paper will also help to expand the students' knowledge of the anatomical organs that may be affected by the migration of the developing larvae in the cranial cavity, leading to the pathological conditions that manifest as clinical symptoms of nasal myiasis in the sheep.

MATERIALS AND METHODS

Source of Animal: The WAD sheep with a typical symptoms of nasal myiasis, with a history of restless, muco-purulent nasal discharge, frequent head shaking, unsteady gait and improper feeding behaviour was procured on 9th December 2008, from a local market at Umuahia, for the purpose of Teaching and Research by the Department of Microbiology and Parasitology at the College of Veterinary Medicine (CVM), Michael Okpara University of Agriculture Umudike (MOUAU), Abia State, south-eastern Nigeria, where the present researcher was serving as an Adjunct Lecturer in Veterinary Entomology.

Physical Examination: The sheep was inspected visually. There was evidence of purulent mucoid nasal discharge, emaciation, diarrhoea, head shaking, and walking in circles with unsteady gait. The muco-purulent nasal discharges were cleaned. Ectoparasites, recognized as hard ticks (Acarina: Ixodidae), were observed on the various body regions of the sheep. Based on the history and the symptoms manifested by the sheep, a tentative diagnosis of nasal myiasis was made.

Post-Mortem (PM) Examination of the Head of the Sheep and Identification of Larvae: A PM sagittal section of the head of the sheep was carried out (Sisson and Grossman, 1953) whereupon two mature active larvae, identified as the third stage larvae of the sheep nostril fly *Oestrus ovis*, were observed in the ventral meatus. Species identification was based on the location of the larvae, and comparison with the key identification features in the illustrations of Uquhart *et al.* (2003), Roberts and Janovy (2000) and Lapage (1967). Details of external structures used in successful species identification are presented in the results section of this paper. One of the recovered larvae was fixed and preserved in 70 % alcohol to which drops of 10 % glycerol was added to prevent drying out of the specimen if the alcohol evaporates. This, and the sagittal section of the sheep's head containing the other larva which was preserved in formalin, were deposited as voucher specimens in the Entomology Laboratory at MOUAU.

RESULTS AND DISCUSSION

Result of PM examination of the sagittal section of the head of the sheep revealed two 3rd stage larvae of *Oestrus ovis* in the ventral meatus adjacent to the ventral turbinate (Figure 1 A). In these locations the larvae have produced catarrhal inflammation of nasal mucus membranes and the adjoining turbinate bones and meatuses (Figure 1 B). The external features of the third stage larvae in the sagittal section have been elaborated to show the key identification features of the species (Figure 2 A and B). The paper clearly shows that about twelve vital anatomical structures and organs in the naso-cranial cavity of the sheep (Figure 3) could be affected by the presence of the migrating and developing larvae of *Oestrus ovis*.

Confirmatory diagnosis of naso-pharyngeal myiasis in sheep, by looking for and finding active larvae of *Oestrus ovis* in the nasal cavity, is a PM curiosity which is however very useful in expanding the knowledge of the subject, allowing for proper species identification as has been demonstrated in this paper. Key identification features of the third larvae of *Oestrus ovis* are quite evident on the dorsal and ventral surfaces of the larvae (Figure 2 A and B). Rows of brownish spines visible on the ventral surface and the sharply pointed mandibular sclerites used by the larvae for attachment and feeding are responsible for much of the pathology seen in nasal myiasis. These actions cause irritation of the delicate mucus membranes of the nasal passages leading to inflammatory reactions and the associated symptoms

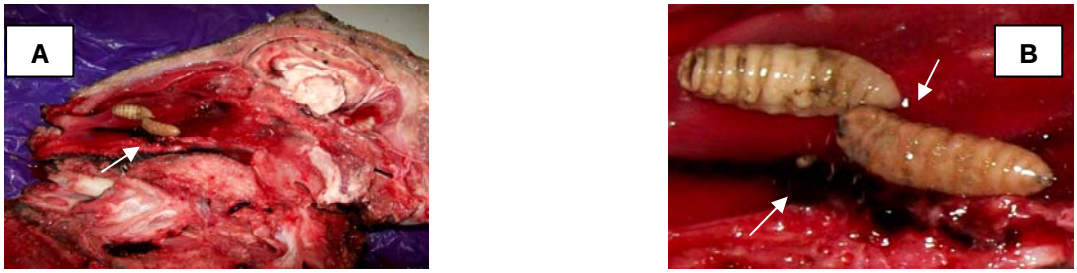

Figure 1: Sagittal section of the head of sheep. A, Larvae of *Oestrus ovis* in the ventral meatus; **B**, Larvae producing catarrhal inflammation of nasal mucus membranes and the adjoining turbinate bones and meatuses.

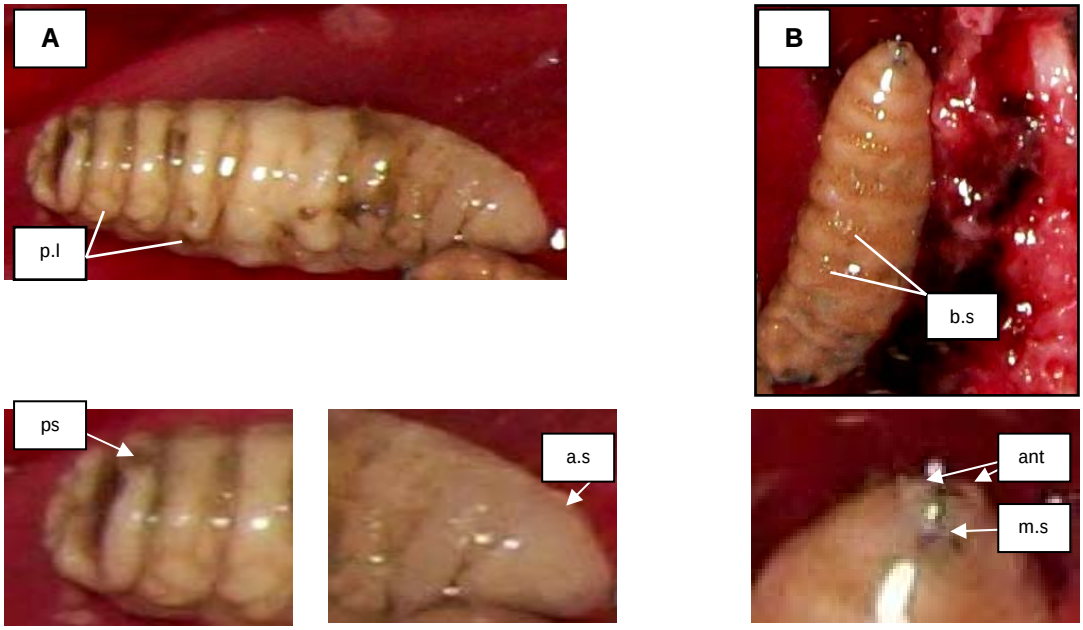

Figure 2: ***Oestrus ovis*** (Third stage larvae). **A:** Dorso-ventral view, **B:** Ventral view. Showing the eight segments and the prolegs (p.l). Length of larva, 22mm, width, 7mm. The dorsal side is arched, the ventral side flat. Dorsal surface has no spines, but its ventral surface has several rows of brownish spines (b.s). There are fleshy lumps on the sides of the segments, especially on the posterior ones. Note, in A, the anterior spiracle (a.s) and the posterior spiracles (p.s); and, in B, two stumpy antennae (ant.), and the mandibular sclerites (m.s) which are sharply pointed and horn-like.

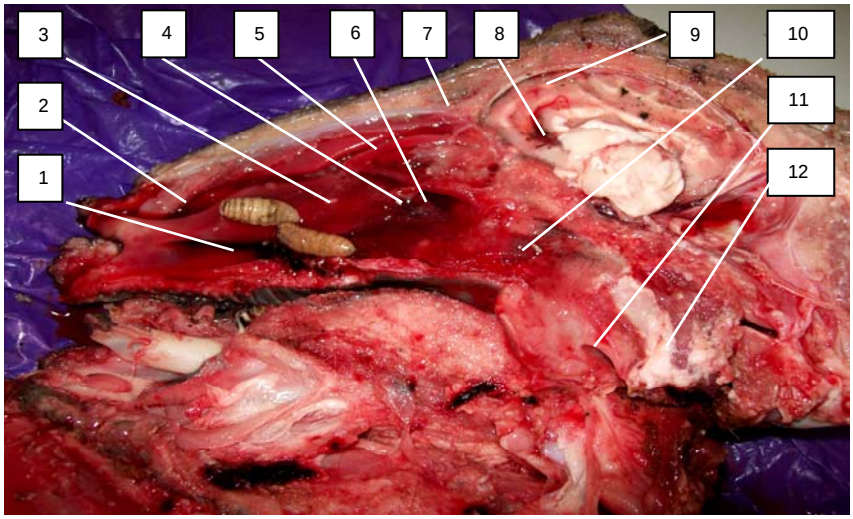

Figure 3: Sagittal section of the head of sheep. Showing anatomical structures likely to be affected by the presence of the developing larvae of *Oestrus ovis.* 1, Ventral meatus; 2, dorsal meatus; 3, ventral turbinate; 4, pre-sphenoid; 5, ethmo-turbinate; 6, Eustachian opening; 7, frontal sinus; 8, lateral ventricle; 9, cerebral hemisphere; 10, pharynx; 11, trachea; 12, oesophagus.

of muco-purulent nasal discharge, frequent sneezing, head shaking, walking with unsteady gait and improper feeding.

Figure 3 is very informative as nasal myiasis could affect not less than twelve anatomical structures and organs in the nasal and cranial cavities of the affected sheep. Smith *et al.* (1972) pointed out that growth and migration of larvae in these sites could result in serious damage to the tissues and can cause death. The sagittal section revealed that erosion of the ventral turbinate had taken place leading to haemorrhages observed in the ventral meatus. Haemorrhages observed between the cerebral hemisphere and the lateral ventricles of the brain suggested that damage had been done to brain tissue, and this may be responsible for cerebral involvement that manifested as symptoms of unsteady gait and walking in circles observed in the sheep. Other vulnerable organs include the openings of the Eustachian tubes, pharynx and trachea. Nevertheless, the successful larvae will eventually drop to the ground where they pupate before the adult flies emerge. In such circumstance, the affected sheep may recover spontaneously if there is no complication due to secondary bacterial infection or other pathological conditions like erosion of the turbinate bones and migration of larvae into the brain tissues.

Uitpeuloog or Bulging Eye Disease had been described as an oculo-vascular myiasis of domestic animals in South Africa (West, 1977), but other myiasis fly could as well be responsible for it. In man, especially shepherds, occasional infection will result if the bot fly *Oestrus ovis* deposits larvae near the eyes (Urquhart *et al*., 2003) leading to catarrhal conjunctivitis, but with no further development of the larvae.

ACKNOWLEDGMENTS

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SURVEY OF KETOSIS AND HYPOPROTEINAEMIA IN SLAUGHTERED CATTLE IN THE SAHEL REGION OF NIGERIA

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ABSTRACT

Serum ketone and total protein concentrations of 966 cattle slaughtered at the metropolitan abattoir, Maiduguri, Nigeria, were estimated during the dry and rainy months of the year. None of the sera had a titrable ketone concentration. Serum total protein (STP) concentration of <60.0 g/L, considered as hypoproteinaemia, was more frequent in the dry than rainy period. The prevalence rates of hypoproteinaemia in the dry and rainy periods were 91.1 and 1.7 percents respectively. The mean STP concentration for all the cattle was 59.9 ± 28.9 g/L. Thus, the poor quality of herbage in the dry season may be responsible for undernutrition among the cattle population, reflected by hypoproteinaemia without ketosis.

Keywords: Nigeria, Sahel region, Cattle, Serum ketones, Serum total protein, Undernutrition

INTRODUCTION

In the sahel region of Nigeria, pasture is limited and of low quality during drought lasting for 7 – 9 months every year. Nomadic herdsmen with their livestock are engaged in transhumance to areas in the sub-humid zone with abundant pasture. The cattle supplied to the Maiduguri abattoir (Borno State, Nigeria) for slaughter come from the semi-arid localities and, sometimes, from the bordering countries of Niger, Chad and Cameroun, which are in similar climatic belt. Over 20 thousand herds of cattle are slaughtered annually in this abattoir (Igbokwe *et al.,* 2001) and some of them are in poor body conditions because of under-nutrition. Thin, emaciated and unthrifty animals are common in their population, especially during the dry season. Ketosis and hypoproteinaemia occur in cattle feeding on poor quality feedstuff deficient in propionate and protein (Radostits *et al.,* 1994).In the present study, serum ketone bodies and total proteins of slaughtered cattle in the Maiduguri abattoir were estimated to assess the adequacy of nutrition.

MATERIALS AND METHODS

The blood samples (10 ml) of randomly selected equal numbers of adult male and female cattle slaughtered in the Maiduguri abattoir (Borno State, Nigeria) from February to August 1999 were collected from the jugular veins into containers without anticoagulant. Each sample was allowed to clot and after centrifugation at 2000g for 5 minutes, serum was harvested. Serum ketone concentration was estimated by the Rothera's test (Dumm and Shipley, 1946). Serum total proteins (STP) concentration was estimated by the Biuret colorimetric method (Silverman *et al.,* 1986). The data were summarized as means ± standard deviations and comparisons between monthly means were assessed by a one-way analysis of variance (Chatfield, 1983). The bar charts of the frequency distributions of the data were plotted.

RESULTS

Nine hundred and sixty six serum samples (120 – 130 samples per month) had no titrable ketone concentration during a period of 7 months. Thus, there was a zero incidence of ketosis among the cattle.

The mean STP concentrations of cattle during the period was 59.9 ± 28.9 (17.0 - 121.5) g/L. There were significant ($P<0.05$) variations among the monthly mean STP concentrations, with the higher values in the rainy season than dry season (Table 1).

Table 1: Serum total protein concentrations of cattle slaughtered in Maiduguri abattoir

Month	Number of Samples	Total Proteins, g/l
February	10	28.6±10.1[b]
March	32	48.4±18.6[a]
April	10	26.1±6.4[b]
May	40	41.3±7.6[a]
June	20	46.8±4.8[a]
Dry Season	112	41.8±13.6[a]
July	20	93.8±11.1[c]
August	38	95.4±16.9[c]
Rainy Season	58	94.9±15.0[c]
Total	170	59.9±28.9

Key: [a, b, c] *Means with different superscripts are significantly different (P < 0.05)*

The frequency distributions of STP concentrations of the cattle (Figure 1) were unimodal and incompletely symmetrical during the rainy and dry seasons. The mean value in each season was close to the modal class. The lowest STP concentrations were 31.0 g/L and 17.0 g/L in the rainy and dry seasons, respectively. The overlap in frequencies of STP concentrations in both seasons occurred at 60-79 g/L intervals.

The STP concentrations of ≥80 g/L observed in the rainy season were not recorded in the dry season. The highest values were 121.5g/L and 77.2g/L in the rainy and dry seasons, respectively. The percentage of cattle having STP concentrations ≥60 g/L were 8.9% and 98.3% during the dry and rainy seasons, respectively. Conversely hypoproteinaemia at STP of <60.0 g/L occurred in 91.1% of the cattle during the dry season.

DISCUSSION

Ketosis is biochemically diagnosed by evaluating ketonaemia and ketonuria. Serum ketone levels in bovine ketosis are elevated from the normal values of <10 mg/dl to 10 – 100 mg/dl (Radostits *et al.,* 1994). The Rothera's test detects serum ketone levels of ≥10 mg/dl (Dumm and Shipley, 1946). Lack of titrable ketone concentrations in all the serum samples indicated zero incidence of ketosis among the slaughtered cattle.

Ketosis usually occurs when the plasma glucose level is below 2.2 mmol/L in cattle fed on poor quality feedstuff deficient in propionate and protein (Radostits *et al., 1*994). However, undernourished cattle may be able to maintain blood glucose levels through gluconeogenesis using rumen-derived propionate and amino acids, and catabolism of muscle proteins (Radostits *et al.,* 1994; McDonald *et al.,* 1995). Absence of ketosis in starved cattle may be due to rapid metabolism of ketone bodies for energy in some tissues of the body, which prevents accumulation of ketones in the blood circulation.

Poor nutrition of the slaughtered cattle was suggested by low STP concentrations. This was more frequently encountered in the dry than the rainy season. The STP values ranged from 17.0 - 121.5 g/L as compared to 68.0-80.0 g/L of plasma total proteins reported as normal values for temperate cattle breeds (Schalm *et al.,* 1975). The mean plasma total protein concentrations reported in intensively managed ruminant flocks in Maiduguri were 68.0 ± 7.8 g/L (Igbokwe and Ajuzieogu, 1991) and 72.9 ± 5.3 g/L (Igbokwe et al., 2003) in sheep and 67.4 ± 6.3 to 75.0 ± 9.2 g/L (Mohammed *et al.,* 1993) in goats.

Majority (98.3%) of the cattle slaughtered in the rainy season had high serum total proteins. Only one of them (1.7%) was hypoproteinaemic with STP value of 31.0 g/L which was an outlier. The lowest class interval for STP in the rainy season was 60 – 64 g/L. The high STP was presumed to be due to adequate nutrition with high quality pasture in the rainy season. Highly digestible immature herbage with high contents of crude proteins, non-protein nitrogen, soluble carbohydrates and metabolizable energy (McDonald *et al.,* 1995) is the hallmark of early rainy season (July – August).

Hypoproteinaemia (STP of <60.0 g/L) was commonly encountered in the dry season (91.1% of 112 cattle) and STP value as low as 17.0 g/L was observed. Because of low colloidal osmotic pressure of blood of hypoproteinaemic animals, oedematous areas may occur in parts of the body and such occurrence is frequent in emaciated animals (Thornton and Gracey, 1974). Therefore, watery poor quality beef may be one of the outcomes of drought periods when the lower quantities of pastures available to the grazing animals have high fibre and low nutritive contents. The meat of emaciated animals has more water and less protein contents, and increased water-to-protein ratio than the lean meat of healthy animals (Thornton and Gracey, 1974).

In the late dry season, pasture plants are usually tall, spindly and sparsely distributed (McDonald *et al.,* 1995), and grazing cattle trek long distances to reach limited dead pasture. Moreover, voluntary feed intake of the animals is likely to be often depressed by high environmental temperatures from March or April to June (39 – 43 ^{0}C), inadequate water supply for drinking (Igbokwe, 1997) and untreated chronic infections often diagnosed at

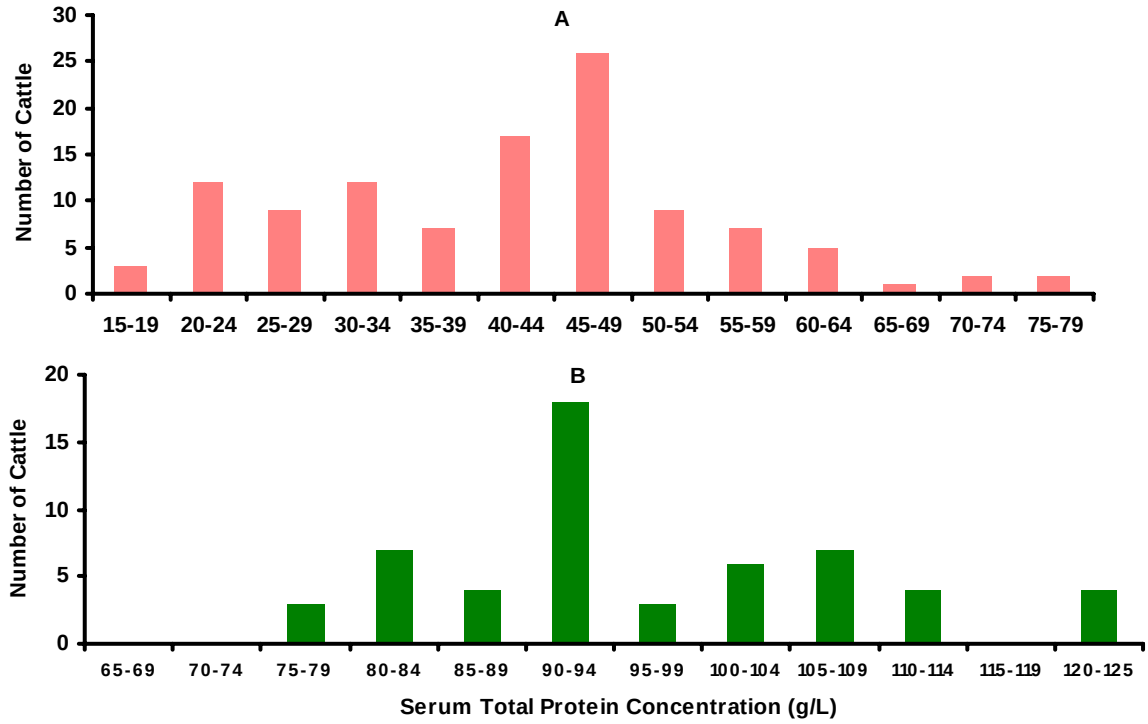

Figure 1: Frequency distribution of the serum total protein concentrations of cattle in Maiduguri, Nigeria, in dry (A) and rainy (B) seasons

slaughter such as tuberculosis, contagious bovine pleuropneumonia, fascioliasis and helminthiasis (Nwosu and Srivastava, 1993; Ameh *et al.,* 1998; Igbokwe *et al.,* 2001).

In conclusion, the survey had revealed that ketosis was not epidemiologically important, but frequent occurrence of hypoproteinaemia among the cattle was a notable indication of poor quality feeding of our cattle during the dry season.

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RETROSPECTIVE ANALYSIS OF DISEASE CONDITIONS AMONG REPRODUCTIVE DOMESTIC RUMINANTS IN SOKOTO, NIGERIA

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ABSTRACT

A fifteen-year (1991 – 2005) study of reproductive cases in animals presented to the Usmanu Danfodio University Veterinary Teaching Hospital, Sokoto, were analyzed based on species, disease condition and sex using clinical case files of Sheep, goat and cattle. Within the study period a total of 88 reproductive cases were handled out of which 53 (57.95 %) occurred in sheep, 32(36.36 %) goat and 5(5.68 %) cattle. Dystocia 23(26.13 %), Pregnancy toxaemia 11(12.50 %), mastitis 9(10.23 %), castration 5(5.68 %) and orchitis 3(3.41 %) were the diseases recorded. Reproductive cases were higher in females 77(87.5 %) than in males 11(12.5 %). From the study, reproductive cases were most prevalent in sheep than in goats and cattle.

Keywords: Livestock reproduction, Sheep, Goat, Cattle, Dystocia, Pregnancy toxaemia, Mastitis

INTRODUCTION

The production of livestock is dependant greatly on their well being particularly their reproductive performances. Disease conditions always impair livestock production (Akerejola *et al.*, 1979; Lamorde, 1996). Apart from this, several other factors such as environment and nutrition, especially inadequate protein intake (Kumidiake e*t al.,* 1981; Smith and Somade, 1994) decrease reproductive performance.

The knowledge of diseases prevalence give useful information on disease pattern and thus can be used in preventing diseases as well as formulating policies for future management of prevalent diseases. Although analysis of some common disease have been conducted in different parts of Nigeria (Esuruoso, 1972; Ugochukwu and Ephraim, 1985; Cadmus *et al.*, 2001), Ebbo *et al.* (2003) reported that there was little information on the prevalence of different livestock disease in Sokoto. However, only Wosu and Anene (1990) in Nsukka and Waziri *et al.* (2006) in Maiduguri have analyzed reproductive disease condition among ruminants.

This study is therefore aimed at determining the pattern of reproductive diseases encountered at the Usmanu Danfodio University Veterinary Teaching Hospital, Sokoto, within a fifteen-year period.

MATERIALS AND METHODS

The data obtained are from clinical case files of sheep, goat and cattle presented to the Usmanu Danfodio University Veterinary Teaching Hospital Sokoto, Nigeria from January 1991 – December 2005 (fifteen-year period). The data were analyzed based on species, disease condition and sex using percentage distribution in a tabular form.

RESULTS

The analysis of various reproductive disease conditions in different sex is presented according to specie in Table I. A total of eighty-eight (88) reproductive cases were handled in domestic ruminants within the study period. Sheep had the highest prevalence of 51(57.95 %), followed by goats 32(36.36 %) then cattle 5(5.68 %). Dystocia 23(26.13 %) was the most prevalent reproductive condition, this is followed by Pregnancy toxaemia 11(12.50 %), then Retained placenta 10(11.36 %), Mastitis 9(10.23 %); Paturient paresis 7(7.95%); Abortion 6(6.82 %); Castration 5(5.68 %); Vaginal prolapsed 4(4.55%); Stillbirth 4(4.55%); Orchitis 3(3.41 %); Uterine prolapse 3(3.41 %); Balanopostitis 2(2.27 %); and Phimosis 1(1.14 %).

Table 1: Distribution of reproductive diseases according to species and sex

Disease condition	Cattle	Goat	Sheep	Total	Prevalence rate (%)
Dystocia	1	9	13	23	26.13
Preg. Toxaemia	-	1	10	11	12.50
Parturient Paresis	-	3	4	7	7.95
Retained placenta	1	4	5	10	11.36
Abortion	1	3	2	6	6.82
Stillbirth	-	1	3	4	4.55
Uterine	-	-	3	3	3.41
Vaginal Prolapse	-	1	3	4	4.55
Mastitis	1	3	5	9	10.23
Orchitis	-	2	1	3	3.41*
Balanopostitis	-	-	2	2	2.27*
Castration	-	5	-	5	5.68*
Phimosis	1	-	-	1	1.14*
Total	5 (5.68%)	32 (36.36%)	51 (57.98)	88	100

** Prevalence of Male reproductive disease which sum-up to 12.5%.*

Reproductive cases in females 77(87.5 %) were more prevalent than males 11(12.5 %).

DISCUSSION

Higher prevalence of reproductive disease conditions in small ruminants (sheep and goat) over cattle has been recorded. The high number in the animal species of small ruminants is as a result of high number of cases handled in the hospital coupled with the low cost of rearing. This is consistent with the reports of Mohammed *et al.* (1994-95) and Waziri *et al.* (2006) but contradicts that of Wosu *et al*. (1990). The religious and socio-economic importance of sheep in Northern Nigeria may explain why most inhabitants of Sokoto keep them as it is used during festive periods such as *eld-el kabir*, wedding and naming ceremonies. The number of cattle cases handled within the study period was low despite the report of Williams *et al.* (2000) that Sokoto state is the second largest cattle producing state in Nigeria. The low numbers of cattle cases handled may probably be due to high cost of rearing cattle in the metropolis as well as the high cost of transporting disease cattle from the rural parts of the state to the Veterinary Teaching Hospital, Sokoto.

Dystocia was the most prevalent reproductive condition. This is consistent with the reports of Wosu and Anene (1990) in Nsukka and Waziri *et al.* (2006) in Maiduguri. Dystocia is caused by twinning, poor feeding and management (Arthur *et al.,* 1998). Free roaming of animals is a common scenario in Sokoto metropolis. Na-Allah *et al*. (2003) reported that most ruminant livestock kept by inhabitants of Sokoto are reared under semi-extensive system of production in which they are allowed to roam freely; this probably explains the high occurrence of dystocia and pregnancy toxaemia. Castration was the most frequent reproductive condition recorded in male goats. Castration is known to improve growth and thus meat quality in castrated ruminants.

Reproductive disease condition were more in females probably due to their unique position as essential reproductive vessels and the fact that females are reared for a longer periods than males. This was consistent with the report of Waziri *et al*. (2006) in Maiduguri.

Conclusion: The study showed that reproductive disease conditions were more frequent in sheep and female sexes were more vulnerable, with dystocia being the most prevalent reproductive condition encountered within the period.

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DISTRIBUTION AND SEASONAL ABUNDANCE OF ANOPHELINE MOSQUITO SPECIES IN NGURU, YOBE STATE, NORTH-EASTERN NIGERIA

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ABSTRACT

The essence of this study was to identify Anopheles mosquito species in Nguru, Yobe State and to determine their distribution and relative abundance in the months of the year. Insecticide and aspirator were used to collect mosquitoes in human dwellings and preserved in 2% formalin for identification using dissecting microscope. Anopheles gambiae (1145); Anopheles funestus (1220) and Anopheles arabiensis (827) were the major anopheline species prevalent in the town. The results obtained showed that An. gambiae were mostly abundant in wet months, followed by Anopheles funestus at the end of the rainy season, and Anopheles arabiensis in drier months. Based on the observation of Anopheles monthly distribution and supported data on malaria prevalence, the three species seem to complement one another and sustain the endemicity of malaria in the town. The study demonstrates the occurrence of malaria vectors all year round due to the favourable environmental conditions associated with Nigerian arid zone.

Keywords: Malaria, Mosquito species, Distribution, Prevalence, Seasons, Arid savanna zone, Nigeria

INTRODUCTION

Malaria has been described as the most devastating parasitic disease bedeviling mankind, especially in tropical and sub tropical regions. Factors that determine the occurrence of malaria are those that influence the three components of malaria life cycle viz: *Anopheles* mosquitoes presence, contact with human and ability to complete the invertebrate half of their life cycle (Service, 1980). The degree of endemicity in any region is determined by species of indigenous anopheline mosquitoes, relative abundance, feeding, resting behaviour and their individual suitability as hosts for *Plasmodium*, among others. (Martin, 1976).

Malaria parasites are transmitted by the bite of infected female *Anopheles* mosquito. (Service, 1980). In many endemic areas the disease is becoming increasingly difficult to control because of the resistance to anti-malarial drug and poor vector control measures. The ecological balance between man and his environment is easily upset by parasites, pests, vectors and their likes there by making their effects more pronounced (Anthony and Mike, 1983). The arthropod vectors often find the warm and humid tropics most favourable for rapid breeding and development (Anthony and Mike, 1980).

The distribution of malaria in the World is determined by the distribution of the various species of anopheline mosquitoes in which the malaria parasite *(Plasmodium*) undergo the phase of sexual reproduction (Clegg and Clegg, 1980). The genus *Anopheles* contains about 380 species. The most important of which in Africa south of the Sahara are An. *gambiae*; *An. arabiensis* and *An*. *funestus*. Others of minor importance are *An. nili; An. moucheti*; An*. hargreavesis and An. hankcoki. Anopheles gambiae* being anthropophilic and endophagic species have more frequent contacts with humans and thus an extremely effective vector of malaria, especially in tropical Africa (Service, 1980).

The World Health Organization (WHO, 1996) estimates that malaria affects some 300 – 500 million people killing 1.5 - 2.5 million every year. The Federal Ministry of Health, Abuja admits that Nigeria has lost over ₦132 billion to the treatment of malaria, which contribute to childhood and maternal death (Joel, 2007).

A number of studies have been carried out on anopheline mosquito species. Examples are studies of Wanji *et al.* (2003) on mount Cameroon and Okafor (1991) in human dwellings in the Obafemi Awolowo University, Ile-Ife, South West Nigeria. Okafor (1991), found *An. gambiae An. funestus* and *An. nili* present in the campus and the neighbouring villages. This present study in Nguru, North-Eastern Nigeria is aimed at identifying anopheline species and their monthly distribution. This will serve as a reference source for more research work and contribution to the vector control strategy for effective malaria control in North-eastern Nigeria.

Table 1: Monthly distribution and abundance of mosquito species in Nguru, North -eastern Nigeria

Month (2006)	Total catch	Number and percentage catch of different mosquito species		
		Anopheles	***Culex***	***Aedes***
January	328	112(34.1)	106(33.5)	110(33.5)
February	289	109(37.7)	89(30.8)	91(31.5)
March	489	177(36.2)	160(32.7)	152(31.1)
April	750	299(39.8)	230(30.7)	221(29.5)
May	700	280(40.0)	216(30.8)	204(29.2)
June	726	296(40.8)	168(23.1)	272(37.6)
July	1126	450(40.0)	360(32.0)	316(28.1)
August	1284	512(39.9)	425(33.1)	347(27.0)
September	1178	472(40.0)	364(30.9)	342(29.0)
October	375	128(34.1)	150(40.0)	97(25.9)
November	528	165(31.2)	214(40.5)	149(28.2)
December	483	192(39.7)	152(31.5)	139(28.8)
Total	8256	3192(38.6)[a]	2634(31.9)[b]	2440(29.5)[c]

[a, b and c] *significantly different abundance of anopheles mosquito species (P= 0.05)*

Table 2: Monthly distribution and abundance of *Anopheles* mosquitoes in Nguru, North-eastern Nigeria

Month (2006)	Total catch	Number and percentage catch of different mosquito species		
		An. gambiae	***An. funestus***	***An. arabiensis***
January	261	73 (28.0)	80 (30.6)	108 (41.4)
February	241	67 (27.8)	77 (31.9)	97 (40.3)
March	228	70 (30.7)	68 (29.8)	90 (39.5)
April	221	73 (33.0)	70 (31.7)	78 (35.3)
May	271	99 (36.5)	106 (39.1)	66 (24.4)
June	250	107(42.8)	103(41.2)	40(16.0)
July	236	118(50.0)	90 (38.1)	28(11.9)
August	293	178 (60.7)	87 (29.7)	28 (9.6)
September	294	108 (36.7)	158 (53.7)	28 (9.5)
October	315	96 (30.5)	171 (54.3)	48 (15.2)
November	294	80(27.2)	107(36.4)	107(36.4)
December	288	76 (26.4)	103 (35.8)	109 (37.9)
Total	3192	1145(35.9)[a]	1220 (38.2)[b]	827(25.9)[c]

[a, b and c] *significantly different abundance of anopheles mosquito species (P= 0.05)*

MATERIALS AND METHODS

Study Area: The research work was carried out in Nguru, an ancient town in the North-Eastern Nigeria. Nguru is located on latitude 12.58^{o} of equator and longitude 10.28^{o} of Greenwich Meridian. The town being in the semi-arid, Sahel savanna zone has very marked dry (October-May) and rainy (June-September) seasons. Annual rainfall ranges between 250 mm and 550 mm. Mean day temperature vary from 38 ^{o}C to 42 ^{o}C during the hottest months of March, April and May. It also varies from 17 ^{o}C to 22 ^{o}C during the coldest months of December and January.

The relative humidity is about 17 % during the hot dry weather and can reach or even exceed 70 % during the peak of wet season in August.

The study was conducted in three selected communities (areas) of the town: Hausari, Bulabulin and Sabon-Gari Kanuri. Ten homes were visited in each sample areas. The abundance and monthly distribution of *Anopheles* mosquito species was studied from January 2006 to December 2006 using cross-sectional samples.

Method of Collecting and Identification of Mosquitoes: All corners, hidden places and walls of human dwellings in the selected area were sprayed with Mobil insecticide to kill or weaken the mosquitoes. Knock down mosquitoes were picked into sampling bottle containing 2% formalin as preservatives. Mosquitoes were collected alive in the night and morning hours using aspirator and preserved in specimen bottles containing 2% formalin.

The collected mosquitoes were mounted on glass slides and viewed under simple Olympus (dissecting) microscope for identification using relevant taxonomic keys (Service, 1980; Huang, 2001). *Anopheles* mosquitoes were identified by the palp which is as long as the proboscis and pointed and by the number, the length, arrangement of the

dark and pale scales in small blockson the veins of the wings (Service, 1980; Huang, 2001).

Male and female *Anopheles* mosquitoes were identified by examination of antennae, in which those with feathery (plumose) appearance are males and those with only short and inconspicuous antennal hairs (pilose) are females (Service, 1980). Other mosquito species identified were *Culex* and *Aedes* (Huang, 2001)

Data Analysis: Relative frequencies (percentages) were used for the presentation of data in tables. Analysis of Variance (ANOVA) was used to assess the significance of difference in the proportions.

RESULTS AND DISCUSSION

Monthly Distribution of Mosquito Species: Mosquito species found in Nguru are *Anopheles, Culex and Aedes*. *Anopheles* mosquitoes were dominant in January, February, March, June, July, August, September and December. Total number of mosquitoes collected were 8,256, out of which 3,192 (38.6%) were *Anopheles*; 2634 (31.9%) were *Culex* and 2440 (29.5%) were Aedes. The number of *Anopheles* mosquito was the highest in the months of July, August and September and it fell drastically in the month of October (Table 1). The abundance of *Anopheles* mosquito in July to September was as a result of high rainfall, that contributed to increase in number of breeding sites (tin cans, blocked gutters, stagnant waters), as *Anopheles* species need bright water with adequate oxygen and sunlight for their breeding (Goma, 1966; Service, 1980)**.** Since there is fluctuation in the abundance of *Anopheles* mosquito in the months and seasons, this might be the reason behind the instability of malaria infection in the ancient town (Lamidi, 2008).

Monthly Distribution and Abundance of Anopheline Mosquitoes: Morphological examinations of *Anopheles* mosquitoes show that Nguru is under the influence of three major anopheline species: *An. gambiae*, *An. funestus* and *An. Arabiensis*. The total numbers of anopheline species collected were 3,192. *An. funestus* was the overall most populous species with 1220 (38.2%) followed by *An. gambiae* with 1145 (35.9%) and *An. arabiensis* with 827 (25.9%) (Table 2).

The abundance of *An. gambiae* peaked in August and fell progressively from September through May. *An. funestus* was relatively low in number in rainy months. Its peak abundance occurred in October. *Anopheles arabiensis* had lowest abundance in wet months. Its peak abundance was in December/January (Table 2). The difference observed in the distribution and abundance of anopheline species in different months was statistically significant (P= 0.05).

Different findings have shown that *An. gambiae*; *An. arabiensis* and *An. funestus* are the principal vectors of malaria in African and are widely distributed from South of the Sahara desert to Northern South Africa (Cohuet *et al.* 2004). The common *Anopheles* species found in different ecological zones of Africa are *An. gambiae* and *An. funestus*. Other species are *An. moucheti; An. marshalli*, *An. hankocki; An. nili, and An. arabiensis* (Okafor, 1991; Wanji *et al.,* 2003; Christopher *et al.,* 2005).

The identification of *An. arabiensis* in Kenya (Hong *et al*. 2006) and in Senegal (Cohuet *et al* 2004) together with the two commonest *Anopheles* species in Africa (*An. gambiae* and *An. funestus) was* in line with the present study. This is due to the fact that *An. arabiensis* prefer drier Savanna ecological zone (Service, 1980) and this might be the reason why *An. arabiensis* was more in the Sahelian town (Table 2).

Conclusion: Vector control is one of the approaches to prevention of malaria. The environment must be kept clean and clear of stagnant water. Where stagnant water is present, it is suggested that kerosene or liquid oil should be sprayed on the water to kill the various developing stages of mosquito (Anthony, and Mike, 1983). Adult mosquitoes can be killed with insecticides. The use of mosquito nets which reduce the chances of being bitten by mosquitoes has been found to be effective malaria control strategy (Snow *et al.,* 1988).

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MORPHOLOGICAL FEATURES OF FETAL AND ADULT ADRENAL GLANDS IN KANO BROWN GOATS (*Capra hircus*)

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ABSTRACT

Gross and histomorphological features of fetal and adult adrenals obtained from slaughtered Kano brown goats at Obollo Afor and Nsukka abattoirs were studied. The specimens were divided into groups A – D for gestation day (GD) 86-102, 103-124, 125 – 146 and adults respectively. The mass of the adrenals increased significantly with age. Microscopically, GD 86 – 102 adrenals comprised outer capsule, definitive zone (DZ), fetal zone (FZ) and medulla. By GD 103 – 124 they exhibited transitional zone with less dense packed cells when compared with outer definitive zone. Full term adrenals had definitive cortex with zona granulosa at the early formative stage. The adult adrenals exhibited structures with typical zonation of the cortex. The width of DC increased while that of FZ decreased significantly (P < 0.01) with increasing age of the fetuses. These results suggest that the adrenals of Kano brown goats undergo morphological developmental changes similar to those of other animals.

Keywords: Adrenal gland, Adults, Fetuses, goats, *Capra hircus,* Morphology

INTRODUCTION

The adrenal gland is called the suprarenal gland because of its anatomical position above the kidney. They are often two in number, the right and left adrenal glands. It regulates many physiological functions both in fetal and postnatal life (Mecenas *et al*., 1996; Smith *et al*., 1998; Hill, 2007). In ruminants, the right adrenal gland is pyramidal and usually lies against the medial margin of the cranial extremity of the corresponding kidney while the left adrenal gland is less regular in shape and less constant in position (Dyce *et al*., 2002).

The adrenal gland has two distinct functional units which are of different embryological origins; a mesodermal cortex and a neural crest ectoderm-derived medulla. A connective tissue capsule surrounds each gland**.** Comparative anatomical records reveal that the nephric origin of adrenocortical cells is a general feature of all vertebrates (Wrobel and Suss, 1999).

In fetuses of higher animals, the fetal cortex consists of three distinct layers viz the definitive zone (DZ), fetal zone (FZ) and transitional zone (TZ) (Lanmann, 1953). The DZ is a thin layer of tightly parked cells surrounding the FZ. The FZ accounts for 80 - 90% of the cortex and is the primary site of growth and steroidogenesis. During the second and third trimesters, a striking enlargement of the FZ contributes to the growth of the adrenal cortex in humans (Mesiano and Jaffe 1997a, b). The TZ has irregularly distributed group of cells with reduced volume of cytoplasm. These small cells constitute a broad band lying between the glomerulosa and the outer FZ in full term *Macaca mulatta* fetuses (McNulty *et al.,* 1981). Projections of cords extending from DZ into the FZ indicate centripetal migration of DZ cells. The fetal adrenal cortex which later forms the adult adrenal cortex grows by cellular hypertrophy, hyperplasia, apoptosis and migration (Mesiano and Jaffe, 1997a; Spencer *et al*., 1999).

The histology of adrenal gland varies with stage of development and the age of the fetuses. The development and histomorphology of adrenal glands have been studied in *Mus musculus* (Waring, 1935), *Tammar wallaby* (Call *et al*., 1980), *Macaca mulatta* (McNulty *et al*., 1981), *Sus scrofa* (Bielanska – Osuchowska, 1989), *Ovis aries* (Naaman and Durand, 1997), *Bos taurus* (Wrobel and Suss, 1999), *Papio species* (Leavitt *et al.,* 1999) and *Homo sapiens* (Spencer *et al.,* 1999; Sirianni *et al.,* 2005). There is dearth of information on the development of adrenal glands in *Capra hircus.*

This work was designed to study the gross and histomorphological features of adrenal glands in fetal and adult Capra hircus (Kano brown goats).

MATERIALS AND METHODS

Twenty-one fetal and twenty-one adult adrenal glands used for this study were collected from slaughtered Kano brown goats in Nsukka and Obollo–Affor abattoirs. The age of the fetuses was determined by crown-rump length method (Nwaogu and Ezeasor, 2008). The age of the adult goats was estimated using dentition (Chibuzo, 2006). The adrenal glands were dissected out immediately after slaughter. The samples were weighed and divided into four groups using specific age intervals viz: Groups A – C for gestation days (GD) 86-102, 103-124, 125-146 respectively and Group D – 1 to 2 year adults.

The glands were fixed in Bouin's fluid for 24 hrs. The fixed tissues were then dehydrated in a series of ascending ethanol concentration (70 %. 80 %, 90 % and 100 %), cleared in xylene, impregnated in liquid paraffin wax and embedded in paraffin blocks. Sections of 6µm thickness were cut using rotary microtome, dewaxed in xylene, hydrated in series of descending ethanol concentration, stained with haematoxylin and eosin and mounted on glass slides (Drury *et al.,* 1976). The slides were studied, photomicrographs prepared with digital camera (moticam 1000 1.3m pixel USB 2.0) attached to a microscope (Hund Wetzlar model) and images captured into a computer.

The width of the cortex, fetal and definitive zones was measured with stage and ocular micrometer gauge at x100 magnification. The data were analyzed statistically by ANOVA and Duncan's New multiple Range Test using SPSS for Windows version 12.0 (SPSS Inc. USA).

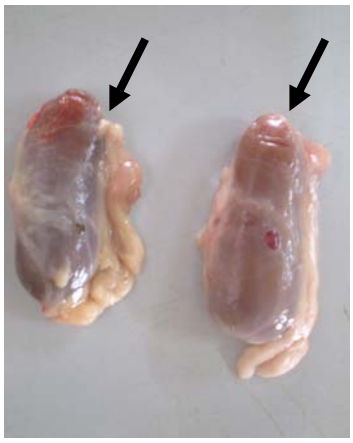

Figure 1: Gross photograph of adult adrenal glands (arrows)

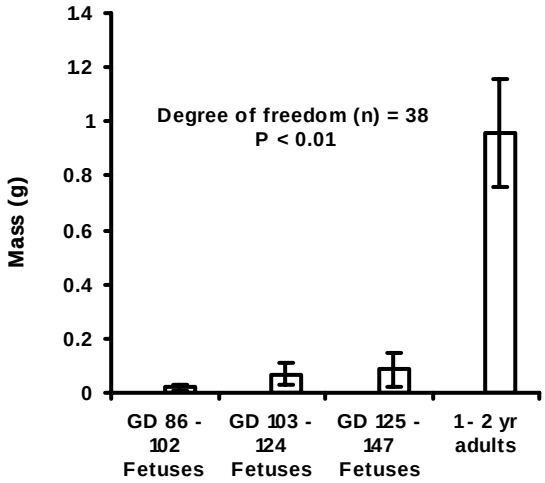

Figure 2: Comparison between adrenal gland mass of different age groups

RESULTS

Gross Features: The adrenal glands were situated on the cranial pole of the kidneys in fetuses while in the adult goats they were located cranio-laterally to the kidneys. The adrenal gland was oval shaped in both fetuses and adults. The color varied from cream to red in fetuses but reddish-brown in the adults (Figure 1). There was a significant difference ($P < 0.01$) between the adult mean adrenal mass (0.88 ± 0.20g) and those of the fetuses (Figure 2). The mean adrenal mass of the full term fetuses (0.10 ± 0.06g) was significantly higher ($P < 0.01$) than those of GD 86 -102 (0.02 ± 0.01g) and GD 103 – 124 (0.08 ± 0.04g) fetuses.

Histological Features: The fetal adrenal glands comprised cortex and medulla. The cortex possessed two zones namely DZ near the capsule and inner FZ. The DZ comprised tightly packed basophilic cells while the FZ contained eosinophillic cells arranged as cords running towards the medulla at GD 124 (Figure 3). The DZ exhibited a glomerular pattern of cellular arrangement in full term fetuses. There were projections of DZ into the FZ (Figure 4). The TZ was also observed in the full term fetal adrenals.

The adult adrenal cortex comprised of three zones with the zona fasciculata as the largest zone. The zona glomerulosa cells were arranged in oval clusters while cells of the zona fasciculata were arranged in a cord-like pattern running towards the medulla (Figures 5 and 6). The cells of the zona reticularis were arranged in oval clusters (arrow head) and also as irregular network of cords (arrow) (Figure 7). The mean width of the adult definitive cortex (1500.0 ± 100.0µm) was significantly ($P < 0.01$) higher than those of the fetuses (40.0 ±

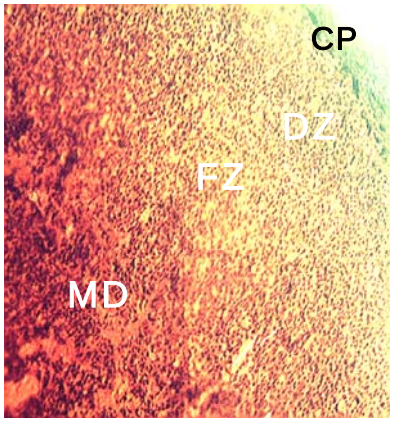

Figure 3: Section of GD 124 fetal adrenal gland showing capsule (CP), definitive zone (DZ), fetal zone (FZ) and medulla (MD). H & E. X200

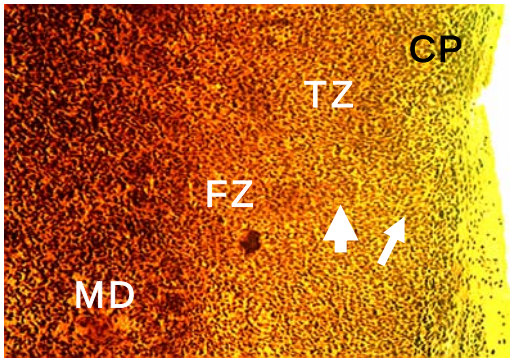

Figure 4: Section of full term adrenal gland showing capsule (CP), zona glomerulosa at formative stage (long arrow), transitional zone (TZ), projection of DZ (short arrow), into fetal zone (FZ) and medulla (MD). H and E. X 200

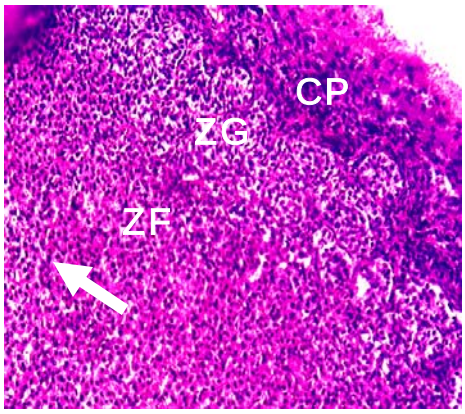

Figure 5: Section of adult adrenal cortex showing the capsule (CP), zona glomerulosa (ZG) and fasciculate (ZF) with cord – like arrangement of cells (arrow). H & E. X250

10.0µm, 80.0 ± 15.4µm, 90.0 ± 21.0µm). The FZ decreased significantly with fetal age (Figure 8).

DISCUSSION

This work provides baseline information on morphological features of adrenal glands in fetal and adult Kano brown goats. The results of the present study indicate that the adrenal glands migrated away from the kidneys with age in Kano brown goats. The change in color from cream to red in fetuses and reddish brown in adults suggests increased blood supply to the organ. This is in agreement with the report that the adrenals are highly vascularized (Banks, 1993; Dyce *et al.,* 2002). The increase in adrenal mass from mid gestation to late gestation indicates growth. This agrees with the reports in *Macaca mulatta* (McNulty *et al.,* 1981) and man (Carr and Casey, 1982). However it is at variance with the report that fetal adrenals showed a decrease in growth rate over the final 20 days of gestation in baboon (Tame *et al.,* 1998). The changes in the adrenal mass could not be followed through neonatal period hence the neonatal adrenals were not studied.

The width of the definitive zone increased significantly with age while that of the fetal zone decreased with age. Similar observation has been reported in baboon (Leavitt *et al.,* 1999). The definitive zone in near term fetuses showed early formation of a glomerular pattern. This is supported by the report that at gestation day 130, bovine fetal adrenal gland exhibited zona glomerulo-fasciculata (Wrobel and Suss, 1999). The transitional zone observed in the adrenals of full term fetuses suggests that adrenal cortical zonation begins before birth in Kano brown goats. This corroborates with what was described as dense band in full term *M. mulatta* fetuses (McNulty *et al.,* 1981). The transitional zone according to Leavitt *et al.* (1995) is the developing zona fasciculata.

The projections of the definitive zone into the fetal zone as observed in this study are supported by the migration theory of the adrenal gland development (Mesiano and Jaffe, 1997a). This may explain why measurements of the width of the definitive and fetal zones taken at different cortical points gave different values. The combined width of the definitive cortex and the fetal zone is less than that of the adult adrenal cortex. This suggests that in addition to the migration theory of growth, this growth may also involve cellular hyperplasia.

The result of this study showed that the fetal zone was still present in full term fetal adrenal glands. Similar observations have been reported in *M. mulatta* (McNulty *et al*., 1981) and baboon (Leavitt *et al,* 1999). The maximum growth of the FZ might have occurred before gestation day 86 which is late second trimester in goats. It is the lowest age used in this work. This observation is supported by the report that human fetal adrenal cortex grows rapidly during the second and third trimesters (Spencer *et al.,* 1999).

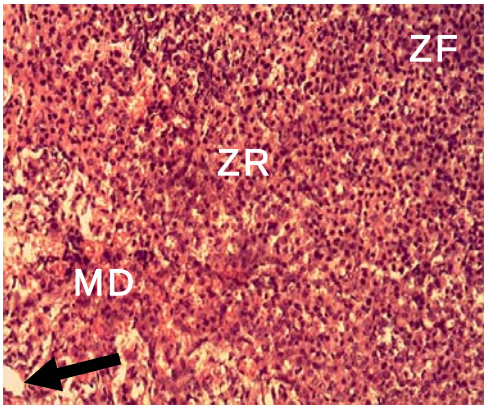

Figure 6: Section of adult adrenal gland showing part of zona fasciculata (ZF), zona reticularis (ZR), medulla (MD) and blood vessel (arrow). H & E. X250

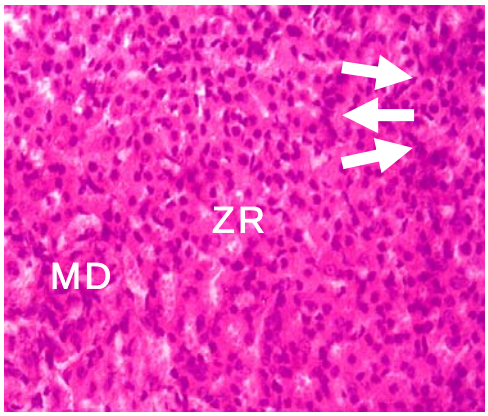

Figure 7: Section of adult adrenal gland showing zona reticularis (ZR) with cells arranged in oval clusters (short arrows), cords (long arrow) and medulla (MD) H & E X400

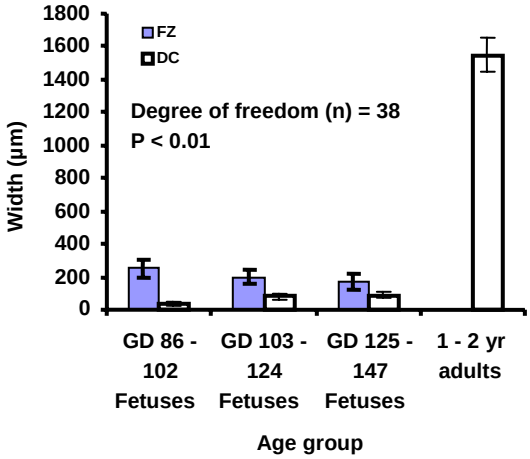

Figure 8: Comparison between width of fetal and definitive cortical zones of the age groups

The fetal zone was not observed in adult adrenal glands. The fetal zone existed through out gestation and the time for its disappearance was not identified. Probably it disappears during the neonatal period in this species. The adult adrenal cortex comprised three zones viz, zona glomerulosa, zona fasciculata and zona reticularis. The zona glomerulosa contained clusters of cells. This is a characteristic morphological feature of adrenals in ruminants and man (Banks, 1993).

Conclusion: GD 86 – 102 adrenals comprised outer capsule, definitive zone (DZ), fetal zone (FZ) and medulla in Kano brown goats. By GD 103 – 124 they exhibited transitional zone. Full term adrenals had definitive cortex with zona granulosa at the formative stage. The adult adrenals exhibited structures with typical zonation of the cortex and medulla. The fetal adrenal mass and width of DZ increased significantly while FZ decreased with fetal age.

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NUTRIENT COMPOSITION OF CEREAL BASED ORAL REHYDRATION SOLUTIONS FOR MANAGEMENT OF DIARRHOEA IN INFANTS

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ABSTRACT

This study evaluated the nutrient composition of two cereal, millet and sorghum, based oral rehydration solutions. The test solutions were made from 50g of millet and sorghum each. The nutrient composition of the solution was determined using proximate analysis. The result showed that the mothers were aware of the salt sugar oral rehydration solution. However 57.7% did not know the proportion of the sugar and salt used in the preparation. These mothers had very little knowledge of any other substitute used in diarrhoea treatment. Most of the respondents (75.3%) consumed millet or sorghum. Sixty five percent gave millet or sorghum to their children as either a drink or porridge. The result of the sensory evaluation showed that the sorghum oral rehydration solution was more acceptable than the millet solution. The proximate analysis showed that the millet oral rehydration solution provided 170.2kcal of energy and 8.76% protein per litre, 0.8mg potassium per 100g and 22mg of sodium per 100g. The sorghum oral rehydration solution provided 170.2kcal of energy and 8.76% protein per litre, sodium 32mg/100g and potassium 1.4mg/100g.

Keywords: Cereal, Oral rehydration solution, Nutrient content, Acceptability

INTRODUCTION

Diarrhoea is one of the major causes of infants and young children mortality and morbidity in developing countries (WHO, 1998). About 4 million cases of diarrhoea are recorded every year with 2.2 million of the deaths mostly among children under the age of five in the developing countries and a significant cause of malnutrition in children (WHO/UNICEF, 2000). The effects and result from acute diarrheoa disease often depend on the nutritional status of the individual and the diet adopted during the illness (WHO, 2004).

Diarrhoea has been found to worsen the nutritional status of the individual due to vomiting, restricted diet and reduced food intake (Tomkins, 1981; WHO, 2004). World wide interest in the proper management of diarrhoeal disease in infants has led to the provision of the WHO/UNICEF glucose based oral rehydration solution. This has helped to reduce the number of deaths in 1970s from 5 million children world wide each year to just over 1 million by the beginning of the 21st century (WHO, 2004). However, this solution is only available in hospitals and health centers which are sparsely located in most rural areas of the developing countries. The alternative which is sugar salt oral rehydration therapy (ORT) has considerably reduced the morbidity and mortality of diarrhoeal diseases. However diarrhoea continues to have a devastating effect on children in the developing countries (WHO, 2004). This home based sugar salt solution, has been found to be inconsistent as it does not provide the necessary glucose and electrolytes for optimum absorption. Furthermore, this therapy is not readily available in many rural homes in Nigeria due to the high cost of sugar.

There is therefore a need for an available, cheap, effective and acceptable oral rehydration solution (ORS) for diarrhoeal management in the rural communities. The alternative is the cereal based oral rehydration solution, which has been shown to be effective in replacing lost fluid, contribute to the nutrient intake of the patients, easily available, cheap, familiar and more acceptable (Molla *et al.,* 1989; Kenya *et al.,* 1989). Several authors have used different cereals in the preparation of cereal-based oral rehydration solution. These include rice (Ramadas *et al.,* 1985; Chowdury *et al.,* 1991) maize, mash potatoes and rice (Molla *et al.,* 1989). These author indicated that the sugar derived from starch hydrolysis tend to draw less fluid out of the body into the gut compared with a similar amount of simple sugar. Ramadas *et al.* (1985) indicated that the hydrolysis of starch releases glucose gradually which is absorbed rapidly and cereal ORS can be advantageously used in relatively large amounts without the risk of inducing osomotic diarrhoea. Cereal based ORS is more of food with some quantity

of salt (1 teaspoonful) and water (1 litre) component as that of the glucose-based ORS, while 20 g and 30 g of glucose and sucrose is replaced with 50 g of cereal flour. In addition, cereal-based ORS is available, cheap, effective, palatable and acceptable to patients.

The objective of this study was to assess the nutrient content, knowledge, acceptability and accessibility of cereal-based ORS for children with diarrhoea who are 6 – 24 months old.

MATERIALS AND METHODS

Procurement and Processing of the Raw Materials: The study involved the preparation of cereal-based ORS using sorghum and millet grains. Millet and sorghum grains were purchased from local market in Nsukka, Enugu State, Nigeria. The grains were handpicked by removing the stones and foreign materials. They were soaked for 6 hours, degermed and dehulled and soaked for further 6 hours, dried, milled and sieved to produce fine flour.

Preparation of the Cereal Based Oral Rehydration Solution: 50 g each of millet and sorghum flour were boiled separately in a litre of water with 3 g of salt added to each solution. The solutions were allowed to boil for 10 minutes, cooled and scooped into bowls for sensory evaluation and chemical analysis.

Chemical Analysis: Samples of millet and sorghum flour were analysed for moisture content, fat, crude fibre, crude protein, ash and energy value. Millet and sorghum salt solutions were analyzed for minerals, iron, calcium, potassium, phosphorus, magnesium and zinc using standards analytical methods. The moisture content of the sample was determined using the hot air oven method (AOAC, 1995) The ash content, fat was done by extraction method using soxhlet extractor; crude protein was determined using semi-micro kjehdahl procedure (AOAC, 1995). Crude fibre and energy were determined using standard methods.

Sampling Size and Population: A total of 150 mothers were purposively selected from Nsukka metropolis, Enugu State, to determine the accessibility and use of these cereals in their homes. A 20-men panel, which consisting of mothers, were used for sensory evaluation, which include colour, flavour, taste and overall acceptability.

RESULTS

The nutrient composition of the two cereal based ORS revealed that sorghum-ORS was more energy dense (170.20 kcal) than the millet- ORS (162.14 kcal) (Table 1).

The distribution and consumption of cereals by the respondents indicated that rice was the most consumed cereal (74 %) and millet was the least (0.7 %) (Table 2). However, 35.3 % of the families consume one type of cereal three times per week.

The frequency and percentage of consumption of sorghum and millet per week and the form it is being consumed revealed that 75.3 % of the families consumed millet/sorghum daily (21.2 %). Porridge (57.5 %) was the preferred form of consumption of these cereals. Other form of consumptions was as drink (45.1%). Sorghum-ORS was more acceptable than the millet-ORS (Table 4). However, the colour of millet-ORS was preferred.

Table1: Nutrient composition of 1 litre of the millet-ORS and sorghum-ORS

Nutrient composition	Millet-ORS	Sorghum-ORS
Energy (kcal)	162.14	170.20
Proximate composition (%)		
Moisture	11.20	11.41
Protein	7.88	8.76
Fat	2.0	2.0
Carbohydrate	76.12	74.33
Crude fibre	1.80	2.0
Ash	1.0	1.5
Minerals (mg/100g)		
Sodium	22	32
Calcium	11.43	12.86
Potassium	0.8	1.4
Magnesium	29.85	33.58
Zinc	2.75	2.46
Iron	3.42	4.65
Copper	0.60	0.28

Table 2: Frequency and percentage consumption of cereal products per week by families in Nsukka metropolis

Most consumed cereal	Frequency	Percentage
Rice	111	74
Maize	28	18.7
Wheat	3	2
Millet	1	0.7
Sorghum	7	4.6
Total	**150**	**100**
Frequency of consumption		
Once	-	-
Twice	48	32
Thrice	53	35.3
4-6 times	19	12.7
Daily	30	20
Total	**150**	**100**

Table 3: Frequency and percentage of consumption of sorghum / millet per week and form consumed by families in Nsukka metropolis

Consumption of millet / sorghum	Frequency	Percentage
Yes	113	75.3
No	37	24.7
Total	**150**	**100**
Frequency of consumption		
Once	40	35.4
Twice	25	22.1
Thrice	23	20.4
4 - 6 times	1	0.9
Daily	24	21.2
Total	**113**	**100**
Form of consumption		
Porridge	62	54.9
Drink	51	45.1
Total	113	100
Fed to children		
Yes	65	57.5
No	51	42.5
Total	**113**	**100**

Table 4: Organoleptic attributes and general acceptability of millet-ORS and sorghum-ORS by families in Nsukka metropolis

Types of ORS	Organoleptic attributes			General Acceptability
	Colour	Flavour	Taste	
Millet-ORS	3.72±0.31	2.93±0.22	2.47±0.31	2.73±o.25
Sorghum-ORS	2.4±0.25	3.25±0.23	2.87±0.31	3.25±0.35

DISCUSSION

New interest has developed in the use of home based cereal oral rehydration solution (ORS) in the management of diarrhoeal diseases. The WHO / UNCEF glucose based ORS has a constant composition and provides the necessary glucose and electrolytes for optimum absorption, however, these are imported and unavailable. The sugar-salt ORS has inconsistent proportion and do not provide optimum glucose and electrolyte absorption (Ramadas *et al*., 1985).

The nutrient composition of the cereal based-ORS showed that sorghum-ORS was more nutrient dense than millet-ORS expect in zinc and copper. The energy and the protein content of millet-ORS (162.14; 7.88 %) and sorghum-ORS (170.20 kcal; 8.76 %) contribute 5.1 % and 6.6 % of recommended energy allowance respectively of infants. Analysis of the cereal based ORS showed that they contain several minerals and electrolytes. These contribute to the improvement of children nutritional status as most of the nutrients are lost during diarrhoea episode. Studies with children have shown that cereal based ORS resulted in substantial reduction in stool output in the first 24 hours compared to the standard ORS (Molla *et al.,* 1990). Study by Murtaza *et al.* (1987) revealed that diarrhoea infants who were treated with rice-ORS had significant reduction in fluid losses and more rapid weight gain than infants who received glucose-ORS. Ramadas *et al.* (1985) showed in his study that cereal-ORS reduced vomiting, stool output and duration of the diarrhea. Kenya *et al.* (1989) showed in their study that infants who were treated with maize-ORS were successfully rehydrated within 24 hours compared to those who received glucose-ORS. Chowdury *et al.* (1991) compared the acceptability of rice-ORS to glucose-ORS and revealed that the mothers unanimously agreed that rice-ORS stopped the diarrhoea more quickly than glucose-ORS. These mothers, the authors indicated can prepare and use cereal-ORS quite easily to treat dehydration and this method will increase the utilization of oral rehydration therapy in rural homes.

The result of this work also showed that the mothers consumed these cereals either as a drink or porridge and the babies were fed with it. This would be easier for the mothers as they are familiar with the cereals and they can easily use it as a rehydrating solution. These cereals are accessible, easy to make and affordable. The organoleptic study showed that the sorghum was more acceptable by mothers than the millet-ORS. However most of the mothers consumed either millet or sorghum and were fed to their babies.

In conclusion the result of the study showed that the cereal-based ORS prepared from millet and sorghum flours contributed varying degrees of nutrients to patients' nutrient intake. There is a possibility that this will improve the nutritional status of patients with diarrhoea. The cereal-based ORS is easily available and accessible to the mothers. They are easy to prepare compared to the sugar salt solution that requires the knowledge of the right amount of salt and sugar to be added. Furthermore, there is the problem of available clean water to use in the preparation of the sugar salt solution, which may further complicate the problem of diarrhoea in these infants. The sorghum-ORS was more acceptable by the mothers than the millet-ORS. However, both cereals were used by the mothers in their homes and are given to the infants in the form of drinks and gruels. This may be an alternative to the sugar/salt solution or the glucose solution.

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COMPARATIVE STUDY OF BREAKFAST INTAKE AMONG SCHOOL CHILDREN IN URBAN AND RURAL AREAS OF NSUKKA

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ABSTRACT

A comparative study of the breakfast intake of school children between the ages of 10-12yeras in Nsukka urban and rural areas was investigated. Sixty urban and thirty rural school children were randomly selected from three primary schools. Data was collected using a structured; pre tested and validated questionnaire which was analysed using statistical package for social science (SPSS) and descriptive statistics (frequency distribution and percentages). Chi-square analysis was also used to compare the breakfast intake of these school children in the urban and rural areas. The result of the study showed a higher breakfast consumption of children in the rural than the urban areas though the result was not statistically significant. The percentage distribution showed that 90% of the rural children took breakfast compared to the 78.3% of the urban school children while 10% and 21.7% of the rural and urban children respectively did not consume breakfast. The factors that contributed to the rural children not taking breakfast include unavailability of food, and not being hungry. In the urban area the factors that affect breakfast intake include lack of time, not being hungry and unavailability of food. However, there was a significant difference (P<0.05) in the availability of food in rural homes and the quantity of food purchased in the market compared to the urban dwellers. The rural dwellers had more food in their homes and purchased less food in the market. Poverty was implicated as the major cause of low breakfast intake. Other factors that affected breakfast intake were family size, occupation of the head of the house hold and educational level.

Keywords: Breakfast intake, Rural, Urban, School Children, Factors

INTRODUCTION

Breakfast is considered the most important meal of the day (Marika, 2003), it is described as the first meal of the day that breaks the fast that had been on for over twelve to fourteen hours (Wayon *et al.,* 1997). Without a breakfast meal there is the possibility of low blood glucose levels (hypoglycaemia) and low metabolic rate, irritability and fatigue (Marika, 2003). The quality of the breakfast is important as the nutritional status of a child can be affected as well as the physical and mental growth, health and general well being of the child.

Breakfast is important in the health of children as the body is low in energy reserve and there is a need for the breakfast meal to provide the energy needed for the day. Breakfast provide 25% of the daily nutrient requirement in children (Gibson and O'Sullivan, 1995). Consumption of breakfast enables children to achieve in school work as it is high in carbohydrate provides glucose which is the preferred source of energy for the brain (Furman and Noli, 1993). Studies have shown that breakfast meal is associated with improved strength and endurance in the late morning as well as better attitude towards school work (Murphy, 1998). Sustained mental work requires blood glucose and its metabolic components which are obtained from the first meal of the day (Marika, 2003). The consumption of breakfast by children prevents adverse reaction like irritability, fighting and fatigue (Murphy, 1998).

Despite the definite advantage of breakfast in children, studies have shown that there has been a consistent decline in the breakfast consumption of children in both the developing and the Western world (Rampersand and Pereira, 2005). These authors reported a decline in the breakfast consumption since the mid 1960s and the situation is getting worse with increase in urbanization in the developing world and the busy life style of parents that accompanies it. The skip of breakfast on regular basis affect the nutrient requirement of children, precipitates malnutrition leading to poor physical and

mental growth, health problems such as frequent colds and infections due to decrease immunity (Marika, 2003).

This study was therefore designed to compare the breakfast consumption of school children in urban and rural areas of Nsukka and determine their reasons for not taking breakfast.

MATERIALS AND METHODS

A cross-sectional study was conducted in urban and rural areas of Nsukka in Enugu State. Ninety children between the ages of 10 – 12 years, consisting of 60 children from the urban area and 30 rural children were studied. Information on breakfast consumption of these children was obtained with the use structured validated questionnaire. This study lasted for period of 12months.

Data Analysis: The data were analysed using the statistical package for social science (SPSS). Descriptive statistics (frequency distribution, percentages), were used to analyze the data. Chi-square analyses were used to compare the variables.

RESULTS

The result showed that 60 % of the children lived in the urban areas and 40 % were rural dwellers. In the urban area 60 % of the children were 12 years above and the remaining 40 % were between 10 – 11 years. The children that lived in the rural area, 26.7 % of them were 12years and above while 73.3 % were between the ages of 10 – 11 years. In the urban area 76.6 % of the households had fathers as the head of the house hold and 16.7% of the household had mothers as family heads. In the rural areas 96.7% of the household heads were fathers while 3.3 % were mothers.

A significant number (60 %) of the family heads in the rural areas were farmers while 55 % of the urban fathers were civil servants (Table 1). There were more children (93.4 %) who were between the ages of 2 – 9 years in the urban areas compared to the rural who had 43.3 % of this age range.

A significant percentage of the urban dwellers (83 %) purchased most of their foods compared to the 33 % of the rural dwellers (Table 2). Break fast consumption by children in the rural and urban areas of Nsukka indicated that rural children had more breakfast (90 %) than their rural counterparts (78 %) (Table 3). The urban dwellers indicated that their reason for not taking breakfast were lack of time, unavailability of food and not being hungry. While the rural participants reported that their reasons were no food and not being hungry. However more of the rural children (90 %) ate breakfast compared to 78 % in the urban (Table 4).

Food consumed as breakfast included bread and tea (14.8 % in rural and 36.2% in urban areas of Nsukka), beans (rural 25.8 %, urban 6.6 %), akara and pap (rural 14.8 %, urban 6.6 %), cornflakes/biscuits (0 % in rural and 8.3 % in urban), okpa (10.0 % in rural and 8.0 % in urban) and cooked meals (33.3 % in rural and 20.0 % in urban) (Table 5).

DISCUSSION

Breakfast intake and quality of food consumed is important to a child's nutritional status as it may affect the mental and physical development of children, as well as the health of the child (Dams and Metzl, 2005). Malnutrition in all its forms remains a major problem in most developing countries of the world. Protein energy malnutrition with micronutrients deficiency is common in the developing countries (Egal and Lopriore, 2006). These authors indicated that this could be attributed to inappropriate diets in terms of quantity, quality and safety in both rural and urban areas. Skipping breakfast will affect a child's food quantity and the type of breakfast meal will affect the quality of the nutrient intake.

The result of the study showed that a higher percentage of the rural children (90 %) consumed breakfast compared to the 78 % in the urban area. In the rural area 10 % of the children did not take breakfast compared to the 21.7 % of the urban children. This could be attributed to availability of food that was higher in the rural families compared to the urban families. The rural families (66.7 %) cultivated food compared to the 16.7 % of the urban family that had some home produce but depended more on purchasing their food. Egal and Lopriore (2005) indicated that 90 % of the foods consumed in urban areas are mostly purchased. These authors showed that there might be problem of access as well as affordability as food is expensive in most urban areas. This may explain the high availability of food in the homes of the rural families; there was always food to prepare breakfast meals for the children.

The mothers in the rural areas were mainly housewives; they had more time to prepare cooked breakfast meals for the children before going to school. In the urban areas the mothers were mostly civil servants who had demanding jobs that kept them away from home. Furthermore the rural mothers utilized left over foods from the previous day's dinner as breakfast meals for their children.

Table 1: Occupation of family heads and family size in the rural and urban areas of Nsukka

Socio-Economic characteristic	Rural		Urban	
	Frequency	Percentage	Frequency	Percentage
Occupation of family heads				
Civil service	2	6.7	33	55.0
Trading	18	60.0	8	13.3
Farming	4	13.3	-	-
Teaching/lecturing	6	13.3	19	31.7
Total	30	100	60	100
Size of Family				
Age 2 – 6 years	6	20.0	31	51.7
Age 7-9 years	7	23.3	25	41.7
Age 10 years & above	17	56.7	4	6.7
Total	30	100	60	100

Table 2: Sources of food consumed by families in rural and urban areas of Nsukka

Sources of food	Rural		Urban	
	Frequency	Percentage	Frequency	Percentage
Partly home produce	20	66.7	10	16.7
Some purchased	-	-	-	-
Mostly purchased	10	33.3	50	83.3
Total	30	100	60	100

$X^2 = 5.880$; df = 1; p = 0.015

Table 3: Breakfast intake of rural and urban children

Breakfast intake	Rural		Urban	
	Frequency	Percentage	Frequency	Percentage
Children that ate breakfast	27	90	47	78.3
Children without breakfast	3	10	13	21.7
Total	30	100	60	100

$X^2 = 34.109$; df = 30; p = 0.277

Table 4: Reasons for not consuming breakfast in rural and urban areas of Nsukka

Reasons for lack of breakfast consumption	Rural		Urban	
	Frequency	Percentage	Frequency	Percentage
No food	2	6.7	4	6.7
No time	1	3.3	4	6.7
Not hungry	1	3.3	5	8.3
Those that consumed breakfast	27	90	47	78.3
Total	30	100	60	100

$X^2 = 0.750$; df = 1; p = 0.38

Table 5: Type of food consumed as breakfast by rural and urban children of Nsukka areas

Type of food	Rural		Urban	
	Frequency	Percentage	Frequency	Percentage
Bread and tea	4	14.8	17	36.2
Beans	7	25.8	4	6.6
Akara and pap	4	14.8	4	6.6
Cornflakes, processed food, biscuits	-	-	5	8.3
Okpa	3	10.0	5	8.0
Cooked meals	9	33.3	12	20.0
None	3	10.0	13	21.7
Total	30	100.0	60	100.0

$X^2 = 34.109$; df = 30; p = 0.277

On the contrary this is not the practice in the urban areas. Traditionally breakfast used to be a large meal eaten before school and designed to carry families through a large part of the day (Murphy, 1998).

Today this tradition is disregarded because people in urban areas are short of time and stay away from home for most of the day. Urban parents have resorted to giving their children processed food,

easily available foods (Egal and Lopriore, 2006). This in line with the result of the study that showed that urban mothers gave their children such foods as biscuit, cornflakes and indomie or street foods compared to the rural children who were given more of home made cooked food.

Conclusion: The rural children consumed breakfast more than the children in the urban area. Factors that were contributory to this result include food availability in the homes of rural dwellers. Other factors that affect breakfast intake were family size, occupation and of the heads of family and educational level. Studies have shown that regular skipping of breakfast precipitates many nutrient deficiencies as well poor physical and mental growth, malnutrition, health problems, low immunity and susceptibility to infections in children (Marika, 2003). It is therefore important that mothers be given public health education on the importance of breakfast intake and the detrimental effect of frequent skipping of breakfast.

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ANIMAL RESEARCH INTERNATIONAL

Volume 6 Number 1, April 2009

CONTENTS **PAGES**

1. **MORPHOLOGICAL STUDIES OF VOMERONASAL ORGAN IN THE WILD JUVENILE RED- FLANKED DUIKER *Cephalophus rufilatus* (GRAY 1864) -** IGBOKWE, Casmir Onwuaso and OKPE, Godwin Chidozie **932 – 937**

2. **DIAGNOSIS OF NASAL MYIASIS IN THE WEST AFRICAN DWARF (WAD) SHEEP AT UMUDIKE, ABIA STATE, SOUTH-EASTERN NIGERIA -** IKPEZE, Obiora Osegboka **938 – 941**

3. **SURVEY OF KETOSIS AND HYPOPROTEINAEMIA IN SLAUGHTERED CATTLE IN THE SAHEL REGION OF NIGERIA -** IGBOKWE, Ikechukwu Onyebuchi, OKONKWO, Sam Ndubisi, HAMZA, Haja Gana, IGBOKWE, Nanacha Afifi **942 – 945**

4. **RETROSPECTIVE ANALYSIS OF DISEASE CONDITIONS AMONG REPRODUCTIVE DOMESTIC RUMINANTS IN SOKOTO, NIGERIA -** UMARU, Mohammed Aminu, ADEYEYE, Adewale Ayodeji, ABUBAKAR, Aminu and GARBA, Hamidu Sharubutu **946 – 948**

5. **DISTRIBUTION AND SEASONAL ABUNDANCE OF ANOPHELINE MOSQUITO SPECIES IN NGURU, YOBE STATE, NORTH-EASTERN NIGERIA -** LAMIDI, Tajudeen Babatunde **949 – 952**

6. **MORPHOLOGICAL FEATURES OF FETAL AND ADULT ADRENAL GLANDS IN KANO BROWN GOATS (*Capra hircus*) -** NWAOGU, Innocent Chima and FRANCIS, Blessing **953 – 957**

7. **NUTRIENT COMPOSITION OF CEREAL BASED ORAL REHYDRATION SOLUTIONS FOR MANAGEMENT OF DIARRHOEA IN INFANTS -** ONYECHI, Uchenna Agatha and AGU-UDEMBA, Mary Ogechi **958 – 961**

8. **COMPARATIVE STUDY OF BREAKFAST INTAKE AMONG SCHOOL CHILDREN IN URBAN AND RURAL AREAS OF NSUKKA -** ONYECHI, Uchenna Agatha and UGWUNNADI, Ginikachi **962 – 965**

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