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SHORT COMMUNICATION

HAEMATOLOGICAL AND PHYSIOLOGICAL PARAMETERS OF WEST AFRICAN DWARF GOATS AS INFLUENCED BY COAT VARIATION AND SEX

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Abstract

Twenty four West African Dwarf (WAD) goats of both sexes (12 bucks and 12 does) raised under intensive system and weighing between 5 and 11 kg with different coat colours (Black, Brown, Tan and White) were used for this study to evaluate the effects of sex and coat colour on their haematological and physiological parameters in south-western Nigeria. Blood sampling was done weekly for 8 weeks. Parameters examined were Red Blood Cell count (RBC), White Blood Cell count (WBC), Haematocrit (HCT), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), Mean Corpuscular Volume (MCV), Haemoglobin Concentration (Hb) Red Cell Distribution Width (RDW), Pulse Rate (PR), Respiratory Rate (RR), Rectal Temperature (RT) and Skin Temperature (ST). Results showed that coat colour had significant effects ($p<0.05$) on MCV, MCH and RDW. Goats with White coat colour had the highest MCV and MCH values of 14.8±0.25 Fl and 5.3±0.06 pg respectively. Goats with Tan coat colour had the highest RDW value (25.1±0.30%). West African dwarf does had higher ($p<0.05$) WBC, RBC, Hb, HCT and MCHC than WAD bucks. There was significant ($p<0.05$) interaction of coat colour and sex on WBC, MCV, and MCHC. West African dwarf does with White coat colour had the highest WBC count and MCHC of 27.9±2.27 x109/L and 385.5±6.16 g/L respectively, while the WAD does with Tan coat colour had the highest MCV value (15.2±0.31 Fl). West African dwarf bucks with White coat colour had the highest MCV while WAD bucks with Tan coat colour had the highest WBC count and MCHC. Sex had significant ($p<0.05$) effect on the PR in goats. Does had higher PR (95.0±0.65 bm-1) than bucks (92.48±0.499 bm-1). However, there were no significant ($p>0.05$) influence of sex on RR, RT and ST. Variation in coat colour had significant ($p<0.05$) effect on PR and RR, while RT and ST were similar ($p>0.05$) among goats of different coat colours. White coat coloured goats recorded the highest value of PR (97.2±0.10 bm-1) which was similar ($p>0.05$) to the observed value for goats with Black coat colour. Goats with Black coat colour had higher ($p<0.05$) RR (36.7±0.43 fm-1) compared to goats with other coat colours. Interaction of coat colour and sex was significant ($p<0.05$) on PR and RR in WAD goats. White does had the highest PR (100.79±1.631bm-1), while Black bucks had the highest RR (37.43±0.541 fm-1). The study concluded that sex and coat colour had great influence on some haematological and physiological indices in West African dwarf goats managed intensively.

Keywords: Coat Colour, Haematological and Physiological Parameters, Sex, WAD Goat

INFLUENCE DE LA VARATION DU PELAGE ET DU SEXE SUR LES PARAMETRES HEMATOLOGIQUES ET PHYSIOLOGIQUES DES CHEVRES NAINES D'AFRIQUE DE L'OUEST

Resume

La présente étude, réalisée dans le sud-ouest du Nigeria, a utilisé vingt-quatre chèvres naines d'Afrique de l'Ouest (WAD : West African Dwarf goats) des deux sexes (12 boucs et 12 chèvres), élevées en système intensif et pesant entre 5 et 11 kg, avec des pelages de différentes couleurs (noir, marron, havane et blanc) dans le but d'évaluer l'influence du sexe et du pelage sur leurs paramètres hématologiques et physiologiques. Des échantillons de sang ont été prélevés toutes les semaines pendant 8 semaines. Les paramètres ci-après ont été examinés: le nombre de globules rouges (RBC), le nombre de globules blancs (WBC), l'hématocrite (HCT), l'hémoglobine corpusculaire moyenne (MCH), la teneur corpusculaire

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moyenne en hémoglobine (MCHC), le volume globulaire moyen (MCV), la concentration d'hémoglobine (Hb), la variation de la grosseur des globules rouges (RDW), le pouls (PR), la fréquence respiratoire (RR), la température rectale (RT) et la température de la peau (ST). Les résultats ont montré que la couleur du pelage avait des effets significatifs (p <0,05) sur le MCV, la MCH et la RDW. Les chèvres au pelage blanc avaient les plus valeurs MCV et MCH les plus élevées, respectivement de 14,8 ± 0,25 Fl et de 5,3 ± 0,06 pg. Les chèvres au pelage havane avaient la plus haute valeur RDW (25,1 ± 0,30%). Les femelles avaient des valeurs plus élevées (p <0,05) de WBC, RBC, Hb, HCT et MCHC par rapport aux mâles. On a noté une interaction significative (p <0,05) de la couleur du pelage et du sexe sur le WBC, le MCV et la MCHC. Les chèvres (femelles) WAD au pelage blanc avaient les valeurs WBC et MCHC les plus élevées, respectivement de 27.9±2.27 x109/L et 385.5±6.16 g/L, tandis que les chèvres au pelage havane avait la valeur MCV la plus élevée (15,2 ± 0,31 Fl). Les boucs au pelage blanc avaient la valeur MCV la plus élevée, tandis que les boucs au pelage havane avaient les valeurs WBC et MCHC les plus élevées. On a constaté que le sexe avait un effet significatif (p <0,05) sur le PR. Les chèvres (femelles) avaient le PR plus élevé (95.0±0.65 bm-1) par rapport aux boucs (92.48±0.499 bm-1). Cependant, on n'a pas relevé d'influence significative (p> 0,05) du sexe sur le RR, le RT et la RT. La variation de la couleur du pelage a montré un effet significatif (p< 0,05) sur le PR et le RR, tandis que la RT et la ST étaient similaires (p > 0,05) pour les animaux des différents pelages. Les chèvres au pelage blanc ont enregistré la plus forte valeur de PR (97.2±0.10 bm-1), qui était similaire (p> 0,05) à la valeur observée pour les chèvres au pelage noir. Les chèvres au pelage noir avaient une RR (p <0,05) plus élevée (36.7±0.43 fm-1) par rapport aux chèvres ayant des pelages différents. On a constaté que l'interaction du pelage et du sexe avait une influence significative (p <0,05) sur le PR et le RR chez les WAD. Les chèvres au pelage blanc avaient le plus haut PR (100.79±1.631bm-1), tandis que les boucs au pelage noir avaient la plus haute RR (37.43±0.541 fm-1). L'étude a conclu que le sexe et la couleur du pelage ont une grande influence sur certains indices hématologiques et physiologiques des chèvres naines d'Afrique de l'Ouest élevées en système intensif.

Mots-clés : Couleur du pelage ; Paramètres hématologiques et physiologiques ; Sexe ; Chèvre naine d'Afrique de l'Ouest

Introduction

Coat colour plays an important role in the adaptation of West African Dwarf (WAD) goat. The higher incidence of smooth, short and straight hair in extensively managed WAD goats in South-Western Nigeria relative to the curly, woolly type suggests that smooth hair is an adaptive feature that facilitates body temperature regulation under hot humid conditions (Ozoje, 2002). The importance of coat type in heat absorption and heat loss in adaptation to harsh environments has been reported (Peters *et al.,* 1982; Fadare *et al.,* 2012). Coat coloration in WAD goats varies widely, ranging from black to brown and white or combinations of these in different proportions. This large variation is an indication of a traditional population where selection has not been practised (Odubote, 1994a, b).

Coat colour is a highly repeatable character and could adapt animals to different climatic zones as well as influencing the performance of various animals (Odubote, 1994a; Ebozoje and Ikeobi, 1998). Effect of coat colour on body weight of WAD goats had been observed (Odubote, 1994b). The author reported an increase in weight with a decrease in pigmentation intensity. Prolificacy, fecundity, litter size (at birth and weaning) and weaning weights have been shown to be significantly affected by coat colour in the WAD goats (Ebozoje and Ikeobi, 1998). Age at first kidding and birth weight increased with pigmentation intensity with black does giving birth at a relatively younger age (447 days) compared with brown (468 days) and white (519 days) does. Black does also had the largest litters both at birth and weaning. Percentage mortality was higher among white does (Ebozoje and Ikeobi, 1998).

Survival of WAD goats in the hot humid tropics is determined by their defence mechanisms against infectious agents (Daramola and Adeloye, 2009). Blood parameters are important indices of physiological and pathological changes in an animal (Okoruwa and Ikhimioya, 2014) and may give some

insights to the production performance potentials of WAD goats (Aikhuomobhogbe and Orheruata, 2006). Various reports (Aba-Adulugba and Joshua, 1990; Nottidge *et al.,* 1999; Tambuwal *et al.,* 2002) have documented haematological and biochemical parameters of domestic species in Nigeria with only few being specific to goats (Daramola and Adeloye, 2009; Adedeji *et al.,* 2011). There is a great variation in the haematological and blood biochemical parameters among breeds of goats (Azab and Abdel-Maksoud, 1999; Tambuwal *et al.,* 2002) and in this regard, it may be difficult to formulate a universal metabolic profile test for goats. These differences have further underlined the need to establish appropriate physiological baseline values for various breeds of livestock in Nigeria, which could help in the realistic evaluation of the management practice, nutrition and diagnosis of their health conditions (Opara *et al.,* 2010).

The environment is a major factor that can positively or negatively affect goat performance. Increased body temperature and respiratory rate are the most important signs of heat stress in goats (Alam *et al.,* 2011) which results in significant decrease in dry matter intake (Holter *et al.,* 1997), milk yield (West, 2003), milk quality (Beede and Shearer, 1996) and reproductive performance (Hanser, 2009). Hence, physiological adjustment is essential in order to maintain normal body temperature and to prevent hyperthermia (Al-Haidray, 2000).

Furthermore, the knowledge of variation of coat pigmentation will enable breeders and animal producers to select for animals (of both sexes) that will respond less to environmentally induced stress such as temperature, sunlight and rainfall. This study focused on determining the effects of coat colour and sex on haematological parameters and physiological indices of apparently healthy WAD goats under intensive management condition.

Materials and Method

Experimental Site

The study was carried out at the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The experimental station lies within the forest region on latitude 7°N and longitude 3.5°E (Google Earth, 2006). The experiment was conducted during the month of February and April when the environmental temperature was highest.

Experimental Animal and Management

Twenty four WAD goats of both sexes (12 bucks and 12 does) and of varied coat colours comprising Black (n = 6), White (n = 6), Brown (n = 6) and Tan (n = 6) were used for the experiment. The goats were sourced from local farmers, quarantine and maintained under intensive system of management. Routine managements such as cleaning of the pen, washing the feeder and drinker of the goats, cleaning their hay racks, checking the animal for any signs of illness before feeding daily were carried out. The animals were quarantined for 28 days before introducing them into the experimental pens. During the period, antibiotics (Oxyteracycline L. A. injection), multivitamins, dewormer (albendalzole) and other medications were administered to the animals to maintain them on good health.

The animals were housed separately on the basis of their sex and coat colour. The goats were maintained on 50% Napier grass (Pennisetum purpureum) hay and supplemented with 50% mixed concentrate which consists of wheat offal (45%), maize (25%), palm kernel cake (10%), soybean meal (15%), bone meal (2.0%), oyster shell (2.0%) and salt (1.0%). Animals were fed 5% of their body weight daily. Feeding was done twice daily by providing hay in the morning and concentrates in the evening. Water was provided *ad libitum*.

Determination of Physiological Parameters

Pulse rate (PR), respiratory rate (RR), skin temperature (ST) and rectal temperature (RT) were measured on a daily basis early in the morning at 08.00h. Pulse rate was measured with the aid of stethoscope according to Ajala *et al.,* (2000). Digital clinical thermometer was used to monitor RT. The thermometer was inserted and pressed gently against the lining of the rectum. The RR was measured by observing

Table 1: Haematological and physiological parameters of WAD goats of different coat colours

		Coat Colour Type			
Parameters	**N**	**Black**	**Brown**	**Tan**	**White**
Haematological:					
WBC ($\times 10^9$/L)	24	19.84±1.035	19.53±1.035	17.40±1.067	20.43±1.388
RBC ($\times 10^{12}$/L)	24	17.64±0.458	17.82±0.458	17.85±0.472	17.89±0.614
Hb (g/L)	24	93.02±2.780	95.19±2.780	94.84±2.866	95.50±3.730
HCT (%)	24	26.05±0.750	26.45±0.750	26.29±0.773	26.28±1.007
MCV (Fl)	24	14.73±0.186^{ab}	14.87±0.186^{ab}	14.59±0.192^{b}	14.82±0.250^{a}
MCH (pg)	24	5.19±0.043^{ab}	5.27±0.043^{ab}	5.19±0.044^{b}	5.28±0.058^{a}
MCHC (g/L)	24	357.59±2.811	358.92±2.811	359.20±2.897	362.03±3.771
RDW (%)	24	24.57±0.290^{b}	24.19±0.290^{b}	25.11±0.299^{a}	25.05±0.389^{ab}
Physiological:					
PR (bm^{-1})	168	95.14±0.744^{ab}	91.49±0.744^{b}	91.06±0.744^{b}	97.19±0.099^{a}
RR (fm^{-1})	168	36.72±0.428^{a}	32.95±0.428^{b}	31.68±0.428^{c}	34.93±0.574^{b}
RT(°C)	168	37.82±0.071^{ab}	37.66±0.07^{b}	37.74±0.07^{ab}	38.06±0.095^{a}
ST (°C)	168	38.43±0.035^{a}	38.21±0.035^{b}	38.43±0.035^{b}	38.54±0.047^{a}

^{a,b} means on the same row with different superscripts are significant ($p<0.05$)
N= Number of observation, WBC = White Blood Cell, RBC= Red Blood Cell, Hb= Haemoglobin, HCT= Haematocrit, MCV= Mean Corpuscular Volume, MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Concentration, RDW=Red Cell Distribution Width. PR= Pulse Rate, RR= Respiratory Rate, RT= Rectal Temperature, ST= Skin Temperature

the number of flank movement per minutes. The skin temperature was measured by placing a digital thermometer on the skin of the goats for 3 minutes after which the readings were recorded.

Blood Sample Collection and Determination of Blood Parameters

Five millilitres (5ml) of blood was drawn from the jugular vein by venipuncture of the goats. The blood sample from each of the goats was emptied gently into labelled tubes containing K2 Ethylene Diamine Tetra Acetate (EDTA) as anticoagulant for the determination of haematological parameters. Blood samples were collected from each goat on weekly basis and samples were sent for laboratory analysis immediately after collection for the determination of haematological parameters. All blood parameters were determined using the auto haematology analyser BC-2800 Vet (Mindray). The haematological parameters determined were haematocrit (HCT), Red Blood Cell count, haemoglobin (Hb) and White Blood Cell count (WBC), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC). Red cell Distribution Width (RDW) was derived automatically by the auto haematology analyser BC-2800 Vet (Mindray).

Statistical Analysis

All the data generated were analysed using the General Linear Model of SAS (2005) statistical while the significant means was separated using Duncan Multiple Range Test within the same package

Results

Table 1 shows the effect of coat colour on haematological and physiological indices of WAD goats. The MCV and MCH values were significantly higher ($p < 0.05$) in goats with White coat colour than those with Black and Brown coat colours, while goats with Tan coat colour had the least value. The value for RDW was significantly higher ($p < 0.05$) in Tan coloured goats compared to goats with Black and Brown coat colour with the least RDW value being observed in goats with White coat

colour. The values of WBC, RBC, Hb, HCT and MCHC were similar (p>0.05) in all the goats having different coat colours.

Coat colour had significant effect (p<0.05) on the physiological parameters of WAD goats. Those with White or Black coat colour exhibited higher (p< 0.05) PR compared to those with Brown or Tan coat colour. The RR was significantly (p<0.05) affected by coat colour. Goats with Black coat colour had the highest RR (36.7±0.43 fm^{-1}) while RR in goats with White coat (34.9±0.57 fm^{-1}) > Brown coat (32.95±0.428 fm^{-1}) > Tan coat (31.68±0.428fm-1) coloured goats. The effects of coat colour on RT was significant (P<0.05). Goats having White coat colour recorded the highest RT (38.1±0.10 °C), followed by Black coat (37.82±0.071 °C), Tan coat (37.74±0.07 °C) and Brown coat (37.66±0.07°C) coloured goats. Coat colour and sex had significant effect (p<0.05) on PR with White does having the highest PR (100.79±1.631 bm^{-1}) followed by the Black does (96.88±1.153 bm^{-1}), while the PR of Black, Brown and White bucks goats were similar (p>0.05). Tan bucks and Brown does had the lowest PR values.

Table 2 shows the effect of sex on the haematological and physiological indices of WAD goats. Sex significantly (p<0.05) influenced the values of WBC, RBC, Hb, HCT and MCHC in the WAD goats with does having higher values in all these parameters. However, values of MCV, MCH and RDW were similar (p>0.05) in both bucks and does. Sex had no significant (p>0.05) influence on the measured physiological parameters of WAD goats except PR in which the does exhibited higher (p<0.05) PR (95.0±0.65 bm-1) than bucks (92.5±0.50 bm-1).

Table 3 depicts the haematological and physiological parameters of WAD goats as influenced by interaction of coat colour and sex. Coat colour and sex significantly (p<0.05) influenced the WBC, MCV and MCHC in WAD goats. West African dwarf does with White coat colour had the highest WBC count ((27.94±2.267 109/L) and the least count of WBC (12.93±1.603 109/L) was observed in the bucks with White coat colour. Does with Tan coat colour had the least count of WBC (13.65±1.700 109/L) while the highest WBC count (21.14±1.288 109/L) was observed in the

Table 2: Influence of sex on haematological and physiological indices WAD goats

Parameters	N	Bucks	Does
Haematological:			
WBC (×10^9/L)	96	17.43±0.692^b	21.17±0.907^a
RBC (× 10^{12}/L)	96	16.46±0.306^b	19.13±0.401^a
Hb (g/L)	96	86.82±1.823^b	102.45±2.438^a
HCT (%)	96	24.39±0.50	28.15±0.658^a
MCV (Fl)	96	14.82±0.124	14.68±0.163
MCH (pg)	96	5.20±0.029	5.27±0.038
MCHC (g/L)	96	355.82±1.879^b	363.05±2.465^a
RDW (%)	96	24.67±0.194	24.79±0.254
Physiological:			
PR (bm^{-1})	168	92.48±0.499^b	94.96±0.645^a
RR (fm^{-1})	168	34.16±0.287	33.98±0.371
RT(°C)	168	37.55±0.048	38.09±0.061
ST (°C)	168	38.29±0.023	38.52±0.030

^{a,b} means on the same row with different superscripts are significant (p<0.05)
N= Number of observation, WBC = White Blood Cell, RBC= Red Blood Cell, Hb= Haemoglobin, HCT= Haematocrit, MCV= Mean Corpuscular Volume, MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Concentration, RDW=Red Cell Distribution Width. PR= Pulse Rate, RR= Respiratory Rate, RT= Rectal Temperature, ST= Skin Temperature

Table 3: Interaction effect of Sex and Coat colour on haematological and physiological parameters of WAD goats

		Bucks				Does			
Parameters	**N**	**Black**	**Brown**	**Tan**	**White**	**Black**	**Brown**	**Tan**	**White**
Haematological:									
WBC (×109/L)	168	17.53±1.309[d]	18.11±1.309[d]	21.14±1.288[c]	12.93±1.603[f]	22.16±1.603[b]	20.94±1.603[c]	13.65±1.700[e]	27.94±2.267[a]
RBC (× 1012/L)	168	15.93±0.579	17.01±0.579	16.92±0.570	16.00±0.709	19.34±0.709	18.63±0.709	18.78±0.752	19.77±1.003
Hb (g/L)	168	84.17±3.517	90.00±3.517	86.50±3.461	86.63±4.307	101.88±4.307	100.38±4.307	103.19±4.568	104.38±6.091
HCT (%)	168	23.46±0.949	24.91±0.949	23.61±0.934	25.57±1.162	28.63±1.162	27.99±1.162	28.98±1.233	27.00±1.644
MCV (Fl)	168	14.67±0.235[e]	14.68±0.235[e]	13.94±0.232f	15.99±0.288[a]	14.80±0.288[d]	15.05±0.288[c]	15.24±0.306[b]	13.64±0.408[f]
MCH (pg)	168	5.18±0.054	5.21±0.054	5.05±0.053	5.36±0.067	5.21±0.067	5.33±0.067	5.33±0.071	5.20±0.944
MCHC (g/L)	168	360.13±3.555[c]	359.33±3.555[d]	365.27±3.499[b]	338.56±4.355[g]	355.06±4.355[e]	358.50±4.355[d]	353.13±4.619[f]	385.50±6.158[a]
RDW (%)	168	24.00±0.367	24.32±0.367	25.78±0.361	24.60±0.449	25.14±0.449	24.06±0.449	24.44±0.477	25.50±0.635
Physiological:									
PR (bm-1)	672	93.41±0.942[c]	93.14±0.942[c]	89.80±0.942[d]	93.59±1.153[c]	96.88±1.153[b]	89.84±1.153[d]	92.32±1.153[c]	100.79±1.631[a]
RR (fm-1)	672	37.43±0.541[a]	34.09±0.541[b]	32.10±0.541[b]	33.04±0.663[b]	36.02±0.663[a]	31.80±0.663[c]	31.27±0.663[c]	36.82±0.937[a]
RT (oC)	672	37.47±0.090[b]	37.47±0.090[b]	37.73±0.090[b]	37.55±0.110[c]	38.17±0.110[a]	37.86±0.110[b]	37.76±0.110[b]	38.56±0.155[a]
ST (oC)	672	38.32±0.044	38.15±0.044	38.46±0.044	38.22±0.054	38.55±0.054	38.27±0.054	38.39±0.054	38.87±0.076

[a,b,c,d,e,f] means on the same row with different superscripts are significant ($p<0.05$)

N= Number of observations, WBC = White Blood Cell , RBC= Red Blood Cell, Hb= Haemoglobin, HCT= Haematocrit, MCV= Mean Corpuscular Volume, MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Concentration, RDW= Red Cell Distribution Width, PR= Pulse Rate, RR= Respiratory Rate, RT= Rectal Temperature, ST= Skin Temperature

WAD bucks with Tan coat colour. White WAD does had the highest MCV value (15.99±0.228 Fl) but the least MCV value (13.64±0.408 Fl) was observed among the does. The WAD does with White coat colour had the highest MCHC (385.50±6.158g/L) while least MCHC (338.56±4.355g/L) was observed in the White WAD bucks. However, RBC, Hb, HCT, MCH and RDW were not affected (p>0.05) by the interaction of coat colour and sex.

Coat colour and sex significantly (p<0.05) influenced all the physiological parameters measured except ST. White does had the highest PR (100.79±1.631 bm-1) followed by Black does (96.88±1.153 bm-1). The PR of Black, Brown and White bucks were similar. Tan and Brown does had the lowest PR values. Black bucks had the highest RR (37.43±0.541 fm-1), followed by White does (36.82±0.937 fm-1). The RR of Tan and White coat coloured bucks goats were similar (p>0.05), while the RR of Black and White does were significantly different (p<0.05). West African dwarf does with Black or White coat colour had higher (p<0.05) RT compared to the values of RT recorded for does and bucks other coat colours.

Discussion

Non- significant effect of coat colour on RBC, WBC and Hb is at variance with the report of Adedeji *et al.,* (2011) while the result obtained in this study on HCT agrees with their report. This differences may be as a result of management systems employed on the animals on data were collected (extensive vs intensive management systems). The observations of Decampos *et al.,* (2013) in these parameters on extensively managed sheep is in line with this study except RBC which was influenced by coat colour variation. The range of values reported in this study is lower than those earlier reported (Okonkwo *et al.,* 2011) on WBC (9.03 x 109/l – 9.46 x 109/l) and RBC (4. 08 x 1012/l - 4.11 x 1012/l) but higher in Hb (90.0g/l – 97.2 g/l) and HCT (27.8% – 29.9%). Higher values of WBC (12.0 x103µl – 12.5 x103µl) and HCT (30.01% - 30.4%) was reported (Adedeji *et al.,* 2011) in Black, Brown and White WAD goats in Ogbomoso compared to this study. These authors also reported higher WBC in Black WAD goats and lower WBC values in Brown and White WAD goats compared to this study. The RBC values (11.56 x 106µl – 13.12 x 106µl) reported in Black, Brown and White goats by Adedeji *et al.,* (2011) is lower to findings of this study while the values obtained for Hb in Black and Brown WAD goats are similar. The Hb result obtained in this study is within the normal range of 8.0g/dl – 12.0 g/dl (Fraser and Mays, 1986). There is no information on the effect of coat colour on MCV, MCH, MCHC and RDW in WAD goats. However, report on WAD sheep indicated that coat colour variation had no significant effect on these parameters (Decampos *et al.,* 2013) which agrees with the findings in this study.

The WAD does had higher WBC values compared to the bucks. This agrees with the observation of Tambuwal *et al.,* (2002) on Red Sokoto goats but contrary to reports on Pangolin goats (Oyewale *et al.,* 1997) in which bucks and does were reported to have similar values. The observed variation may be attributed to physiological stress response arising from their social behaviour which consists of aggressiveness and hierarchical fights. (Aikhuomobhogbe and Orheruata, 2006). Higher RBC values of WAD does is at variance with the report of Tambuwal *et al.,* (2002) for Red Sokoto goat, Olayemi *et al.,* (2009) and Okonkwo *et al.,* (2011) for WAD goats but agrees with the findings of Daramola *et al.,* (2005) for same breed of goat. This result is at variance with Fadare *et al.,* (2012) who reported similar values for WAD ewes and ram.

Changes in ST, PR, RR and RT have been widely used as indices of physiological adaptability to various environmental and climatic conditions (Silanikove, 1992; Olayemi *et al.,* 1996). In this study, the highest PR was observed in Black and White Wad goats. This is at variance with the report of Adedeji (2012) in which Black goats had the highest PR and White goats had the lowest PR. The observed variation in PR could be attributed to the differences in management systems. Black and White goats had similar PR due to

non exposure to solar radiation compared to extensive system. Highest RR in Black WAD goat is consistent with the previous report (Adedeji, 2012) in which Black goat in Ogbomoso had the highest RR. The RR in this study is lower than the values reported by the author. Respiratory rate has been reported as a practical and reliable measure of heat load (Okoruwa, 2013). The implication therefore, is that under intensive management system, Black goats still carry higher heat load compared to goats with other coat colours. A RR of 20.0 bm-1has been reported to be an indicator of heat stress in sheep and goat (Okoruwa, 2014). It follows that all the goats irrespective of coat colour were under heat stress in the study. The values of RT in this study is higher than those reported for intensively (Okoruwa, 2014) and extensively (Adedeji, 2012) managed WAD goats with Black goat having the highest RT values and Brown goats having the lowest RT value contrary to (Adedeji, 2012) who reported that White goat had the lowest RT. The value of ST was higher in Black, Tan and White WAD goats suggesting that goat with these coat colour had higher vasodilatation of skin capillary bed which increased the blood flow to the skin surface to enhance dissipation of heat (McManus *et al.,* 2009). Values of skin temperature in this study is higher than what was previously reported (Okoruwa, 2014) for intensively managed WAD goats but lower than the values reported for goats exposed to solar radiation without specific reference to coat colour by the same author.

Does had higher PR than bucks contrary to the report of Adedeji (2012) in which bucks was reported to have higher PR than does. Non-significant effect of sex on RR, RT and ST is in agreement with the earlier reports (Adedeji, 2012). Coat colour and sex interacted to influence some of the haematological and physiological parameters of WAD goats. This agrees with the observations of Adedeji (2012).

Conclusion

The study concluded that variation in coat colour and sex had regulatory effects on the haematological and physiological parameters of WAD goats reared intensively. This has implication for selection and breeding of WAD goats for improved productivity. Therefore, environmental modifications and nutritional strategies would be required to reduce the effect of heat stress in these animals.

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EFFECTS OF LIMITING FEED ACCESS TIME AND RE - ALIMENTATION ON PERFORMANCE OF GROWING RABBITS IN A HUMID TROPICAL ENVIRONMENT

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Abstract

This experiment was carried out to study the effect of limiting feed access time on the performance of growing rabbit. Forty eighty (48) male rabbits of mixed breeds (Chinchilla x Dutch x California White) with an average weight of 600g. The rabbits were divided into 4 groups of 12 rabbits each after balancing for live weight. The rabbits were randomly assigned to four feed access times which serve as the treatments. These are: Treatment 1 (3hrs), Treatment 2 (6hrs), Treatment 3 (9hrs) and Treatment 4 (24). Each treatment had twelve individually caged rabbits serving as the replicates. The limiting of feed access time was carried out for four weeks and rabbits subsequently allowed unlimited feed access time for another three weeks during which data were collected on performance (feed intake and weight gain) and carcass characteristics of rabbits. Limiting feed access time had significant effect ($P<0.05$). Result showed that restriction had a significant effect on total feed intake, total weight gain (TWG), average daily weight gain (AWG), feed: gain, average protein intake and protein efficiency. The total feed intake and average daily feed intake of Rabbits on Treatments 1, 2 and 3 were not significantly different ($P > 0.05$) from each other but were significantly different ($P < 0.05$) from the rabbits on Treatment 4. The total and average weight gain of rabbits on treatment 4 was observed to be significantly higher than those of other treatments while the TWG and AWG of rabbits on treatment 3 were comparable to that of Treatment 2 but significantly higher than that of treatment 1. Rabbits on Treatment 3 had the lowest (best) Feed: Gain ratio which was significantly different from values obtained for rabbits on Treatments 1, 2 and 4. During re-alimentation, similar compensatory growth occurred in all restricted re-alimented groups but the rabbits in treatment 3 had the highest compensatory growth followed by treatment 2 and treatment 1 respectively. The result of this study indicates that limiting feed access time is a viable model for reducing feed intake and improving feed conversion of rabbits.

Keywords: Feed access-time, re-alimentation, rabbit, performance.

EFFETS DE LA LIMITATION DU TEMPS D'CCESS AUX ALIMENTS ET DE LA REALIMENTATION SUR LA PERFORMANCE DE LAPINS EN CROISSANCE DANS UN ENVIRONNEMENT TROPICAL HUMIDE

Resume

Cette expérience a été menée dans le but d'étudier l'effet de la limitation du temps d'accès aux aliments sur la performance des lapins en croissance. Quarante-huit (48) lapins mâles de races mixtes (Chinchilla x Dutch x California White), pesant en moyenne 600g, ont été utilisés pour l'étude. Les lapins ont été divisés en quatre groupes de 12 lapins chacun après équilibrage de poids vif. Ils ont été répartis de manière aléatoire à quatre différents temps d'accès aux aliments, qui ont servi de traitements : Traitement 1 (3h), Traitement 2 (6h), Traitement 3 (9 h) et Traitement 4 (24h). Chaque traitement comportait douze lapins mis dans des cages individuelles et servant de répétitions. La limitation du temps d'accès aux aliments a été réalisée pendant quatre semaines ; et les lapins ont eu un accès illimité aux aliments pour une autre période de trois semaines pendant laquelle des données ont été recueillies sur la performance (la prise alimentaire et le gain de poids) et les caractéristiques des carcasses des lapins. La limitation du temps d'accès aux aliments a eu un effet significatif ($P <0,05$). Les résultats ont montré que cette restriction a eu un effet significatif sur la prise alimentaire totale, le gain pondéral total (TWG), le gain de poids journalier moyen (AWG), le ratio alimentation/ gain pondéral, l'absorption moyenne de protéines et l'efficacité protéique. La prise alimentaire totale et la prise alimentaire journalière moyenne des lapins soumis aux

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Traitements 1, 2 et 3 n'étaient pas significativement différentes (P> 0,05) les unes des autres, mais étaient significativement différentes (P <0,05) de celles des lapins au Traitement 4. Le gain pondéral total et le gain pondéral moyen des lapins au Traitement 4 étaient significativement plus élevés que ceux des autres traitements, tandis que le TWG et l'AWG des lapins au Traitement 3 étaient comparables à ceux des lapins au Traitement 2, mais nettement supérieurs aux lapins soumis au Traitement 1. Les lapins au Traitement 3 avait le plus faible (meilleur) ratio alimentation/gain pondéral, lequel était significativement différent des valeurs obtenues pour les lapins aux Traitements 1, 2 et 4. Pendant la période de réalimentation, une croissance compensatoire similaire a été notée dans tous les groupes réalimentés (qui avaient été soumis aux restrictions), mais les lapins au Traitement 3 ont enregistré la plus forte croissance compensatoire, suivis respectivement des lapins au Traitement 2 et au Traitement 1. Le résultat de cette étude montre que la limitation du temps d'accès aux aliments est un modèle viable de réduction de la prise alimentaire et d'amélioration de la conversion alimentaire chez le lapin.

Mots-clés: Temps d'accès aux aliments, réalimentation, lapin, performance.

Introduction

Rabbit production has the potential of alleviating the animal protein shortage in developing countries (Biobaku and Dosunmu 2005). According to Cheeke (1980), Rabbits have a number of attributes which lead to a very high biological potential for meat production. These attributes among others include high feed conversion efficiency even on high roughage diets, high rate of reproduction, rapid growth rate and a high degree of genetic diversity, both within and between breeds. Rabbits are also suited to both small scale production (backyard, self-sufficiency) and to large scale intensive commercial production.

In every livestock business, feed is a major factor in cost of production because feed cost is almost 60-80% of the production cost (Freetly *et al.,* 2001; Clark *et al.,* 2000). This is as a result of the hike in prices of some conventional ingredients such as soya bean meal, groundnut cake, fish meal, maize, etc and the competition between man and livestock for such ingredients. Therefore, the efficiency of livestock business can be increased by reducing feed cost for profit maximisation; hence the need to focus attention not only on rabbit production but how to reduce cost of production and still get an optimum yield. Reducing feed cost can be done by introducing restricted feeding system. In the last decade, a lot of researches were conducted on feed restriction in rabbits (Tumova *et al.,* 2004; Yakubu *et al.,* 2007); however, there are few reports on similar investigations in the humid tropical environment. This study, therefore, seeks to investigate the effects of limiting feed access time and re-alimentation on performance of growing rabbit in such an environment.

Materials and methods

Experimental Site

The experiment was carried out at the rabbitry unit of the Directorate of University Farm, Teaching and Research Section, Federal University of Agriculture, Abeokuta, Nigeria. The farm lies within latitude 7° 10´ N, longitude 3° 2´ E and altitude 76 mm. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of about 1037 mm and temperature of about 34.7° C. The relative humidity ranges from 63 to 96 % in the rainy season (late March to October) and from 55 to 82 % in the dry season (November to early March) with an annual average of 82 %. The seasonal distribution of annual rainfall is approximately 44.96 mm in the late dry season (January-March); 212.4 mm in the early wet season (April-June); 259.3 mm in the late wet season (July-September) and 48.1 mm in the early dry season (October-December) as recorded in Google Earth (2013).

Experimental Animals and their Management

Forty (48) growing rabbits of mixed breed (Chinchilla x Dutch x California White) and sexes with an average weight of 600g were assigned to four feeding regimens after balancing for live weight and sexes in a

completely randomized design. The rabbits were individual housed in naturally ventilated cages with dimension of 55 x 35 x 45 cm, raised 90 cm above the floor in an open sided house which allowed for cross ventilation. Each cage was equipped with two flat bottom wide earthen pots of 10 cm diameter with inner lips (2 mm) to prevent wastage. One served as the feeder while the other was the drinker. The rabbits were treated for endo and ecto parasites using Ivomec® at 1ml/50 kg live weight. Thereafter, they were acclimatized for a week, during which they were fed concentrate and forages ad libitum.

Twelve, individually caged rabbits (each animal serving as a replicate) were assigned to each of the feeding regimen in a feeding trial that lasted for seven weeks. The composition of the diet is presented in Table 1. Diet was based on feed composition used for growing rabbits on the Teaching and Research Farm which was developed in line with the recommendations of Hall (2010) and Merck (2011). The major ingredients (i.e. maize, groundnut cake and soy bean meal) were milled through a screen mesh size of 2.5 mm in a hammer mill. Other ingredients were already in milled forms at the point of purchase. The various ingredients were individually weighed out in their milled form into a rotary feed mixer and mixed to get the experimental diet. The feed was fed in mash form. The four feeding regimens are as follows:

i. Three hours of access time to concentrate feeding for four weeks followed by a period of re-alimentation for the next three weeks.
ii. Six hours of access time to concentrate feeding for four weeks followed by a period of re-alimentation for the next three weeks.
iii. Nine hours of access time to concentrate feeding for four weeks followed by a period of re-alimentation for the next three weeks.
iv. ad libitum concentrate feeding for seven weeks

Feeding time on each replicate commences by 7:00hrs, the duration of the respective feed access times were determined by use of stop watches. Feeders were removed at the termination of each feed access time from the concerned animals and their feed intake determined by subtraction of left over from the feed offered. The rabbits were however allowed unlimited access to drinking water.

Data collection

Feed intake was determined daily by subtracting the feed left-over from the feed supplied. Weight gain was collected on weekly basis. Feed Conversion Ratio (FCR) was determined as:

$$\text{Feed conversion ratio} = \frac{\text{Average Feed Intake (g/rabbit)}}{\text{Average Daily Weight Gain (g/rabbit)}}$$

Carcass characteristics

Twenty (20) rabbits consisting of five rabbits per treatment were selected for carcass evaluation based on the closeness of their liveweight (LW) to the mean treatment weight and slaughtered after 12 hours fast. After complete bleeding, the sacrificed rabbits were dressed by flaying, eviscerated and sectioned into parts. The cut parts, namely, head, fore limb, thoracic cage, loin and hind limb, were dissected according to Blasco and Ouhayoun (1993) as described below:

- The head was separated from the body by cutting it through the section between occiput and atlas vertebra.
- The fore limb was separated by cutting it through section between the 7th and 8th thoracic vertebra following the prolongation of the rib when cutting the thoracic wall.
- The thoracic cage was taken as a section between the last thoracic and the first lumber vertebra following the prolongation of the 12th rib when cutting the thoracic wall.
- The loin section was between the 6th and 7th lumber vertebra cutting the abdominal wall transversely to the vertebral column.
- The hind legs was separated by cutting it through the os coxae and posterior part of m. iliopsoas, m. psoas major and m. iliacus.
- The paws were removed at the carpal and tarsal joints. The parts were weighed and recorded.
- The dressed weight and dressing percentage were calculated as follows:

Dressed weight = Live weight - Offal weight

where,

Offal weight = Gastro intetinal weight (GIT) + Internal Organs weight

Dressing out Percentage (DOP) % = (Dressed weight/Live weight) x 100

The weight of the internal organs, viz: heart, liver and kidney were also taken and expressed as a proportion of the rabbit's live weight.

Chemical and statistical analysis

Experimental diet samples were subjected to proximate analysis according to the methods of AOAC (1995). The detergent components were determined by the procedure developed by Goering and van Soest (1970). Metabolisable energy (ME) value of the test diet was calculated by the method of Wardeh (1981). All data collected were subjected to statistical analysis appropriate for a completely randomized design layout using Minitab Analytical Computer Package (Minitab Inc., 1999). Significant differences between the treatment means were determined using the Duncan's Multiple Range Test of the same statistical package.

Results and discussion

Table 2 shows the effect of limiting feed access time on growth performance of rabbits. Limiting access time to feed significantly affected ($P < 0.05$) the performance of rabbits during the period of restriction. Statistically similar mean values (875.64, 884.12 and 898.17g) were observed for live weight gain of rabbits on limiting feed access time which differed significantly ($P < 0.05$) from the value (969.56g) obtained for rabbits on 24 hours feed access time. Average daily weight gains of rabbits on limited feed access time (3, 6 and 9 hours) were 25.76, 23.51 and 19.39% respectively less than the daily weight gain of rabbits on 24 hours feed access time during the four weeks of feed restriction. The results of this study was similar to an earlier report of Adeyemi *et al.,* (2013) in the same environment. Decrease in body weight gain during restriction is a function of plane of nutrition (Snetsinger, 1994), thereby resulting in inadequate intake of nutrients required to sustain rapid growth and development (Esonu *et al.,* 2002). Same trend as weight gain was observed for feed intake and feed cost. It was also observed that it cost more to produce a unit weight gain as the feed access time was prolonged from 3 hours to 24 hours, however, there did not appear to be a difference in the cost of feed per kilogramme weight gain between rabbits on 9 and 24 hours feed access time. During feed restriction, there may be increase in feed efficiency (Tumová *et al.,* 2002; Dalle Zotte *et al.,* 2005) and improved nutrient digestibility (Tumová *et al.,* 2003; Di Meo *et al.,* 2007). These assertions are in line

Table 1: Composition of experimental diet (% as-fed)

Ingredient	**(%)**
Maize	47.50
Groundnut cake	10.00
Soybean meal	8.00
Wheat offal	31.00
Bone meal	3.00
Salt	0.25
Vitamin/mineral premix*	0.25
Total	**100.00**
Determined Analysis (% DM)	
Dry matter	89.45
Protein	18.74
Ether extract	4.58
Crude Fibre	15.68
NDF	34.29
ADF	20.54
ADL	3.31
Ash	4.25
Calculated Metabolisable Energy+ (KJ /Kg)	10.93

**contains Vit. A 4000000IU; Vit. D. 800000IU; Vit. E 40000mg; Vit. K_3 800mg; Vit. B_1 1000mg; Vit. B_2 6000mg; Vit. B_6 5000mg; Vit. B_{12} 25mg; Niacin 6000mg; Pantothenic acid 20000mg; Folic acid 200mg; Biotin 8mg; Manganese 300000mg; Iron 80000mg; Zinc 20000mg; Cobalt 80mg; Iodine 400mg; Selenium 40mg; Choline 800000mg*

Table 2: Growth performance of rabbits subjected to different feed access time

	Treatments			
	3hrs	**6hrs**	**9hrs**	**24hrs**
Initial Weight	607.75±5.11	608.11±5.06	607.25±5.09	608.64±5.16
Live Weight at end of Restriction	875.64±7.55^{b}	884.12±7.39^{b}	898.17±7.18^{b}	969.56±7.50±7.28^{a}
Weight gain during Restriction	267.89±4.33^{c}	276.01±4.80^{bc}	290.92±4.18^{b}	360.92±4.07^{a}
AWG Restriction(g/rabbit)	9.57±0.25^{c}	9.86±0.17^{b}	10.39±0.42^{b}	12.89±0.26^{a}
FI during Restriction(g/rabbit)	1239.00±25.05^{d}	1484.00±27.11^{c}	1634.00±26.55^{b}	2114.00±26.22^{a}
AFI Restriction(g/rabbit/day)	44.25±1.28^{c}	53.00±1.15^{b}	58.36±1.20^{b}	75.50±1.19^{a}
FC during Restriction	4.63±0.33^{c}	5.38±0.18^{b}	5.62±0.20^{ab}	5.86±0.34^{a}
Cost / kg feed (N)	72.55	72.55	72.55	72.55
FCW during Restriction (N)	335.55±8.16^{c}	390.07±9.05^{b}	407.51±8.57^{ab}	424.94±8.43^{a}
Live Weight at end of Re-alimentation	1210.80±15.10^{c}	1224.53±18.22^{bc}	1243.20±20.03^{b}	1305.42±16.14^{a}
Weight gain during Re-alimentation	335.16±4.21	340.41±4.16	345.03±3.85	335.86±5.06
AWG Re-alimentation (g/rabbit)	15.96±1.67	16.21±2.10	16.43±1.89	15.99±2.25
FI during Re-alimentation (g/rabbit)	1792.87±19.56	1827.01±19.56	1854.23±19.56	1855.22±19.56
AFI during Re-alimentation (g/rabbit)	85.37±3.28	87.00±3.04	88.29±3.16	88.34±3.43
FC during Re-alimentation	5.34±0.66	5.36±0.41	5.37±0.53	5.24±0.50
Feed Cost/kg Weight during Re-alimentation (N)	387.42±6.11	388.87±4.34	389.59±5.16	380.16±6.10
Weight Gain for Entire Period	603.05 c ±8.03	616.42 c ±7.91	635.95 b ±8.21	696.78a±8..34
ADG Entire Period (g/rabbit)	12.31±0.39	12.58±0.20	12.98±0.31	14.22±0.47
FI Entire Period	3031.00 d±27.19	3311.00 c ±28.45	3488.00 b±27.33	3969.00 a ±28.65
AFI Entire Period (g/rabbit)	61.86±3.28	67.57±3.28	71.19±3.28	81.00±3.28
FC Entire Period	5.03±0.41	5.37±0.58	5.48±0.49	5.67±0.45
FCW Entire Period (N)	364.93±5.88	389.59±6.06	397.57±5.90	413.26±6.21

$^{a, b, c}$ *Means within the same row with differing superscripts are significantly different (P<0.05)*
AWG= Average Weight Gain; AFI= Average Feed Intake; FCW= Feed Cost/kg Weight FI= Feed Intake; FC= Feed Conversion

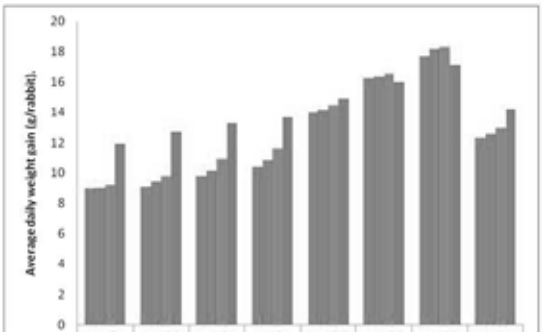

Figure 1: Weight change trend of rabbits subjected to different feed access time

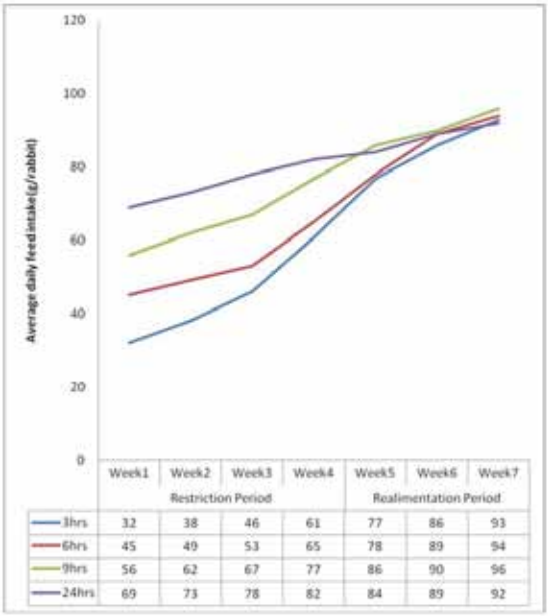

Figure 2. Daily Feed Intake trend of rabbits subjected to different feed access time

with results of this present study as progressive reductions in feed conversion ratio of rabbits were observed with decreasing feed access time.

Rabbits on 3 hours of feed access time appeared to be the most efficient in terms of feed conversion ratio while rabbits on 24 hours feed access time were the least efficient (4.63 vs 5.86). During the three weeks of re-alimentation when all rabbits were fed ad *libitum*, average daily weight gain of rabbits previously subjected to limiting feed access time were similar to those of rabbits on 24 hours feed access time. Feed intake was also not significantly (P>0.05) different among rabbits earlier subjected to limited feed access time of 6, 9 and 24 hours. The feed conversion ratio during the re-alimentation period was similar for all treatments.

The trend of average weight gain in the course of the experiment is presented in Fig.1. In the period, from Week 1 through Week 4, subjecting growing rabbits to limiting feed access time elicited a lower daily weight than those fed ad libitum. In the re-alimentation period when the same set of rabbits were reverted to full feeding, the daily weight gain showed an upward rise between weeks 4 and 6 such that average daily gains of 15.96, 16.21 and 16.43 g for rabbits on limited feed access times of 3, 6 and 9 hours respectively compared to a value of 15.99 g for rabbits on *ad libitum* feeding for the entire feeding duration. Perrier (1998), explained that a reduction in feed intake provoked a reduction of live weight at the end of the restriction period but an improvement in weight gain camparable to the weight gain of *ad libitum* fed rabbits was obtained during the re-alimentation period. Similar observations were made by Foubert *et al.,* (2008) and Adeyemi *et al.,* (2013).

The pattern of feed intake during the experiment is shown in Fig. 2. The trend showed that the feed intake was consistently lower for rabbits on limited feed access time compared with the continuously *ad libitum* fed rabbits during the 4 weeks of restricted feeding. Feed intake however took an upward projectile during the re-alimentation period and eventually the feed intakes of rabbits previously on 6 and 9 hours of feed access time overtook the intake of rabbits previously un-restricted. This observation was in accord with the report of Ledin (1984) that the restricted-fed rabbits during re-alimentation showed a tendency to consume more feed per day than those that were fed continuously ad libitum. Adeyemi *et al.,*(2013) observed that rabbits on previously restricted but later *ad libitum* fed consumed significantly more feed than their continuously restricted counterparts. This finding was

Table 3: Carcass cuts, abdominal fat and relative organ weights of rabbits subjected to different feed access time

	Treatments (Feed Access Time)			
Performance Indices	**3hrs**	**6hrs**	**9hrs**	**24hrs**
Dressed Weight (g)	690.09^{b} ±9.24	713.32^{ab} ±10.11	740.35^{ab} ±9.63	797.43^{a} ±10.46
Dressing out percentage	58.96^{b} ±0.81	60.03^{ab} ±0.55	61.67a ±0.84	62.77^{a} ±0.73
Retail Cuts (% Liveweight)				
Head weight	6.10^{a} ±0.09	5.60^{ab} ±0.21	5.23^{b} ±0.09	5.43^{b} ±0.20
Thoracic Cage	10.61±0.03	10.57±0.03	10.49±0.02	10.68±0.02
Fore Limb	8.80 ±0.06	8.73±0.15	8.40 ±0.15	8.37 ±0.12
Hind Limb	18.95 ±0.35	19.53 ±0.27	19.83 ±0.33	19.70 ±0.40
Loin	12.55±0.25	12.48±0.21	12.40±0.25	12.65±0.15
Abdominal fat	0.62^{d} ±0.02	0.79^{c} ±0.02	0.93^{b} ±0.01	1.68^{a} ±0.01
Organs (% Liveweight).				
Heart weight	0.40 ±0.01	0.39 ±0.01	0.41 ±0.02	0.41 ±0.01
Liver weight	2.57±0.12	2.40 ±0.15	2.56 ±0.9	2.53 ±0.07
Kidneys weight	0.54±0.01	0.56 ±0.02	0.57 ±0.03	0.55 ±0.02

$^{a, b.}$ Means with different superscript in the same row for the same item differ significantly (p <0.05).

however at variance with the report of Boisot *et al.,* (2003), who observed that the restricted rabbits (80% of *ad libitum* intake) had lower daily feed intake (-18.4%, P<0.001) than the *ad libitum* ones during re-alimentation.

The overall performance showed that rabbits on ad libitum feeding for the whole experimental period had the heaviest liveweight, being 7.25, 6.19 and 4.77 % heavier than rabbits on 3, 6, and 9 hours of feed access time respectively. Overall feed intake was equally less on rabbits subjected to restricted feeding time. The report of Govaerts *et al.,* (2000) indicated that feed restriction suppresses growth during the restriction period, but the retarded growth can be compensated with greater future intake

The effect of limiting feed access time on the carcass characteristics of rabbits is presented in Table 3. Limiting feed access time had influence (P<0.05) on dressed weight, dressing-out-percentage, and head weight. Dressed weight and dressing out percentage increased significantly with prolongation of feed access time while head weight as percentage of liveweight reduced with increasing feed access time. Thoracic cage weight, loin weight, fore and hind limbs weight expressed as a percentage of liveweight were not significantly (P>0.05) affected by feeding regimen. A similar observation was made for the organs (heart, liver and kidney). According to de Oliveira *et al.,* (2013), feed restriction can result in several metabolic changes that lead to lower body weight, immune depression and modified function of the digestive system. Re-feeding, however, can rapidly restore the morphology and functions of the intestine, repairing the intestinal atrophy and normalizing the permeability of the mucosa (Ortega et al., 1996). Lawrence and Fowler (2002), explained that the viscera of animals show fast responses to feed restriction by the reduction in their sizes and metabolic activities. Tumová *et al.,* (2006) opined that it is possible that a priority is given to the internal organ maintenance in periods of feed scarcity. Tumová *et al.,* (2003) also did not report differences in the absolute weight of the lungs, kidneys and liver in rabbits subjected to feed restriction at different ages; however, there was a higher absolute heart weight in restricted animals. Studying the feed restriction effects in rabbits, Tumová *et al.,* (2007) observed that, with feed restriction, kidney weight was reduced in restricted rabbits as compared with the rabbits fed ad libitum. However, the liver had its weight reduced due

to feed restriction, but its weight was similar to the rabbits fed *ad libitum* after re-feeding.

Tumová *et al.,* (2006) explained that during re-alimentation, priority is given to the development of the internal organs that grow more quickly than the other parts of the body. Similar results were reported by Yakubu *et al.,* (2007), who studied the effects of feed restriction (feeding for eight 8 h/d or a skip-a-day system) on weaned rabbits for five weeks. The authors reported that there was no difference in the weight and carcass yield, relative weights of the liver, kidney and heart. Bovera *et al.,* (2008) studied the effects of 100 and 200 g/kg reduction in free feeding of growing rabbits on the carcass characteristics and reported that there was no difference in the hot or chilled carcass weights or in the weights of the liver and heart.

Abdominal fat was highest ($P<0.05$) in rabbits on 24 hours feed access time which was more than double the abdominal fat content of the rabbits on limited feed access time of 9 hours which was the highest value among the restricted rabbits. The amount of feed offered per day played vital role in the deposition of abdominal fat which therefore had direct bearing on the quality of carcass produced. Limiting- feed access led to depletion of apparent rate of glycogen as measured by muscle acidity (McPhee and Trout, 1995) resulting to reduction in subcutaneous fat and increase in rate of lean growth in pigs (McPhee *et al.,*1988). According to Njoku *et al.,*(2012), the level of feed offered greatly influence fat deposition in animals. Some other workers had also shown that feed restriction affects fat tissues more than lean tissue deposition when applied during the finishing phase. Therefore, restricted feeding leads to leaner carcasses compared with *ad libitum* feeding (Wood *et al.,*1996; Lebret *et al.,* 2001).

In terms of economies however rabbits on restriction were significantly more efficient and also had significantly less feed cost/kg weight gain. Rabbits on 24 hours feed access time required additional N 48.33, N 23.67, N 15.69 worth of feed to gain a kilogramme of weight compared to rabbits on 3, 6 and 9 hours of feed access time. It is believed that this additional cost on feed by the control rabbits will give the rabbits subjected to limited feed access time an economic edge and hence will present a better gross margin.

Conclusion

Limiting feed access time of rabbits is a viable model for reducing feed intake and improving feed conversion. Compensatory growth was observed in the rabbits subjected to restriction but later *ad libitum* fed. Body weight compensation was almost complete in the rabbits previously subjected to restricted feeding times of 3, 6 and 9 hours per day which were only 7.21, 6.90 and 4.75% less than rabbits on the control treatment. The observed decrease in dressing out percentage with increasing stiffness of restriction is an indication of the fact that feed restriction may have its own disadvantages except when re-alimentation is allowed for adequate period. From the findings of this study, it is recommended that growing rabbits can be subjected to a three-week feed restriction of not more than 20% provided at least four weeks of *ad libitum* feeding is allowed for compensatory growth.

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INCIDENCE OF FOOT AND MOUTH DISEASE OUTBREAKS IN ILESHA BARUBA, KWARA STATE-NIGERIA

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Abstract

Sero-diagnostic assay using NS-Blocking ELISA kit (PRIOCHECKR) was conducted to ascertain the incidence of Bovine Foot and Mouth Disease (FMD) outbreaks in three Fulani camps located at Bode/ Babanne and Sinawu/Tumbunya wards in Ilesha baruba district of kwara state. This study identified 842 FMD infected cattle based on history and clinical sign from a total of 4,248 cattle. Randomly obtained sera from ninety blood samples collected across the herds were screened. This study revealed overall incidence of 18.9% with 19.8% morbidity and 0.92% mortality especially in calves. Sero-positivity amongst representative screened cattle showed 71.1% occurrence. However, demographic factors (age, breed and sex) indicated more young (54.7%) white Fulani (46.9%) cows (62.5%) were positive to FMD, although not significant (P>0.05) by chi square analysis. Outbreak re-occurrence within the three herds demonstrated characteristic absence of immunity between infections of FMD virus serotypes which enhances cattle susceptibility to another serotype while or having recovered from an existing infection due to another serotype. NSP-ELISA confirmed these infected cattle as non-vaccinated which have being exposed to infection <40> days especially amongst young white Fulani cows as observed. This reported incidence confirmed increasing FMD outbreaks as the serotypes responsible for this sero-positivity is needed to be ascertained if effective control effort is to be instituted.
Key words: Incidence, FMD, outbreaks, Ilesha Baruba LGA

INCIDENCE DES FOYERS DE FIÈVRE APTHEUSE À ILESHA BARUBA DANS L'ÉTAT DE KWARA AU NIGERIA

Resume

Un test de sérodiagnostic utilisant le kit NS-Blocking ELISA (PRIOCHECKR) a été effectué pour déterminer l'incidence des foyers de fièvre aphteuse (FA) dans trois camps foulani situés dans les circonscriptions de Bode / Babanne et Sinawu / Tumbunya dans le District d'Ilesha Baruba de l'État de Kwara. Cette étude a recensé 842 bovins infectés de fièvre aphteuse sur base des antécédents et des signes cliniques, sur un total de 4.248 bovins. Des sérums obtenus de manière aléatoire à partir de quatre-vingt-dix échantillons de sang prélevés dans les troupeaux ont été examinés. Cette étude a révélé une incidence globale de 18,9%, avec des taux de morbidité et de mortalité respectivement de 19,8% et 0,92%, en particulier parmi les veaux. La séropositivité des échantillons représentatifs de bovins examinés a révélé un taux de fréquence de 71,1%. Cependant, les facteurs démographiques (âge, race et sexe) ont montré qu'un nombre plus élevé de jeunes (54,7%) vaches (62,5%) de race foulani blanc (46,9%) était positif pour la fièvre aphteuse, bien que l'infection ne soit pas importante (P> 0,05) selon l'analyse du chi carré. La réapparition des foyers dans les trois troupeaux a montré une absence d'immunité caractéristique entre les infections aux sérotypes du virus de la fièvre aphteuse, qui accroît la susceptibilité des bovins à un autre sérotype pendant la guérison ou la convalescence suivant une infection existante due à un autre sérotype. Le test NSP-ELISA a confirmé que ces bovins infectés n'avaient pas été vaccinés et avaient été exposés à l'infection <40> jours en particulier les jeunes vaches foulani blanc observées. Cette incidence rapportée a confirmé une augmentation du nombre de foyers de fièvre aphteuse, ainsi, les sérotypes responsables de cette séropositivité doivent être déterminés pour qu'un effort de contrôle efficace puisse être mis en place.
Mots-clés : Incidence ; Fièvre aphteuse ; Foyers ; Ilesha Baruba LGA

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Introduction

Foot-and-mouth disease (FMD) is a contagious viral disease affecting cloven-hoofed livestock, principally cattle, pigs, sheep, and goats. The virus (FMDV) is a highly variable RNA virus that exists as seven immunologically distinct serotypes, belonging to the family *Picornaviridae* which in most cases can be further subdivided into a number of topotypes [1]. These distinct serotypes include Type A, O, C (European types), South African types (SAT1, SAT2, SAT3) and Asiatic Type. Cumulative incidence of FMD serotypes showed that six of the seven serotypes (O, A, C, SAT-1, SAT-2, SAT-3) have occurred in Africa [2]. FMD is the single most devastating animal disease constraint to international livestock product trade which requires control to protect the western industrialized livestock commerce and on the other hand, the livelihood and income generation of developing countries, where FMD continues to be endemic [3]. In Nigeria, FMD was detected and diagnosed clinically among trade cattle in Borno Province in 1929 [4]. Subsequently, the disease spread widely amongst cattle along several trade routes in northern parts of the country with little or no control measure being instituted ensuing into several outbreaks around the country [5]; [6]; [7]. These reports confirmed FMD endemicity with serious economic losses [8] as inaccuracy of occurrence [9] have been associated to none reporting of disease outbreaks [5] due to inefficient reporting system [10] and this has made planning for prevention and disease control very difficult [11]. In spite of this FMD endemicity, there is paucity of reported information as regards the disease incidence in Kwara state, where a high concentration of cattle herds are found with insufficient control efforts which has made the disease endemic with mild course and mortality [12]. Therefore, this study seeks to ascertain the incidence of FMD outbreak in Ilesha Baruba cattle herds, using sero-diagnostic NS-ELISA kit. This would provide assessor information on FMD in the study area (a Nigerian border town with Benin Republic) in order to design appropriate control measure.

Material and Methods

Study Area

Ilesha Baruba is a major town and district in Baruten Local Government Area of kwara state [13], where the Cattle International market is located, for sales and distribution of cattle originating from Mali, Togo, Benin, Cote de voire/Burkina Faso and Senegal to other parts of Nigeria. The unique location of Baruten Local Government Area in North western part of kwara state in Nigeria that shares boundaries in the West with Benin Republic, in the South with Irepo Local Government Area of Oyo State, in the North with Babana district in Borgu LGA of Niger State and in the East by Kaiama LGA of Kwara State [14]. The road distance from Kosubosu (LGA headquarters) in Yashikira district to Ilorin (administrative division) about is 503km which facilitates human and livestock traffic. They people mainly engage in agricultural, livestock keeping and trading activities with Batonu being the major language, but Hausa, Fulani, Yoruba and Bokobaru are also spoken in the area [13].

Study design

The purposive study conducted involved FMD cattle herd outbreaks that occurred in three locations namely, Bode I, Bode II (Gberrebereru) in Bode/Babanne ward and Bukaru-Rontuwa in Sinawu/Tumbunya ward in Ilesha Baruba district of Baruten Local Government Area in kwara state between December and March, 2011. The herds were conveniently sampled based on owner compliance and presence of clinical disease on first examination. For each herd, six (6) infected cattle were randomly selected examined and whole blood samples were collected from presumptive clinically infected ninety (90) FMD cattle across the fifteen (15) outbreaks for sera separation. This sampling was conducted within day 3 and 10 days post FMD infection report.

Sample collection

The blood (5-10mls) was aseptically collected through the jugular vein of well restrained cattle using sterile hypodermic 18G 11/2 needle and 10ml syringe during market

sampling. This blood was transferred into clean labeled 5ml plastic bottles (ANTECR) without anticoagulant and allowed to stand at room temperature at an angle of 45° for sera separation from the cellular component. These sera were transferred into cryovials, labeled and properly packed on ice for transportation to the laboratory, stored at 4°C and later -70°C until use.

Serological assay using FMDV-NS ELISA

Antibody detection to FMDV NSP in bovine sera was conducted using PrioCHECKR FMDV-NS blocking ELISA following the manufacturers' protocol [Prionics Lelystad B.V.: The Netherlands]. This assay was conducted at the FMD laboratory, National Veterinary Research Institute, Vom.

A percentage Inhibition (PI) of < 50% was considered negative which was interpreted as tested animal that had not been exposed to FMD within the previous 40 days. A PI of ≥ 50% and above was considered positive as evidence of recent exposure <40> days to FMD [15].

Statistical analysis

The number of sero-positive reactors was expressed in simple descriptive statistics such as percentage as prescribed [16] and subjected to chi square analysis.

Results

This study in Baruten LGA showed, out of the 15 outbreaks investigated in the study area, three (3) herds experienced repeated outbreaks. These outbreaks, thus involved 12 herds in three locations namely Bode I, Bode II, and Bukaru – rontuwa. The first investigated outbreak was on 21st December, 2010 and the last on 31st March, 2011 in the same herd, which was tagged outbreak 1 and 5 respectively (Bode II). Other herds that experienced repeated occurrence was outbreaks 8 and 13 (Bode I) as well as 7 and 12 (Bukaru- Rontuwa). Out of a total of 4,248 cattle at risk (in contact) in 15 outbreaks during the study period under review, 842 were clinically affected and 39 calf dead was recorded with morbidity, mortality and case fatality rates of 19.82%, 0.92% and 4.63% respectively (Table 1) and overall incidence of 18.9% for FMD outbreaks in the study period.

Out of ninety randomly selected cattle with typical clinical signs amongst identified 842 cattle, 53 were female (cows) and 37 male (bulls) and sero-diagnosed, as 40 (62.5%) and 24 (37.5%) positive cows and bulls respectively with overall sero-positivity of 71.1%. The incidence of FMD outbreaks according to breed revealed white Fulani had highest occurrence 46.9% (30/64) while Sokoto gudali and Red Bororo had 34.4% (22/64) and 18.6% (12/64) respectively as indicated in Table 2. The incidence of FMD by age showed 54.7% young cattle (6months-3yrs) and 45.3% Adults (>3-5years) as indicated in Table 2. However, this FMD outbreak cases was not statistically significant (P>0.05) with sex, breed and age respectively by chi square analysis.

Discussion

Antibodies to FMD viral nonstructural proteins (NSPs) have often been used as indicators of infection, irrespective of vaccination status [17] in outbreak scenarios. This assay enhances the capacity of most field practicing clinicians in FMD diagnosis following presumptive disease assessment based on presences of ruptured or unruptured vesicles (clinical signs and herd history).

Sero-diagnostic study of FMD outbreak herds in this study area indicates overall incidence of 18.9% in Table 1. This is higher than 9.8% reported [18] which could be due to poor control and vaccination efforts as documented [12] facilitating FMD outbreaks in the last 3-4 decades. Another likely reason could be associated with the closed clustered nature of the Fulani herds and proximity of Baruten forest and river morshi where direct and indirect contact between infected and susceptible cattle sharing common grazing and watering points as previously documented [18] leading to vicious cycle of exposure to the causative virus manifesting as increase observed sero-positivity. The high sero-positivity obtained in this study confirmed insufficient vaccination efforts over the years as NSP-ELISA kit has the

Table 1: Bovine Foot and Mouth Disease outbreaks observed in Ilesha Baruba district

Outbreak ID	Location	Herd size	No. affected	No. of death Calves
2*	Bode I	380	60	5
3		78	22	1
8		200	40	2
13		200	20	2
14*		380	20	3
15		280	50	1
1*	Bode II	300	50	3
4		220	80	3
5*		300	100	3
6		260	60	2
9		250	70	2
10		350	80	4
7*	Bukaru-rontuwa	450	100	4
11		150	30	1
12*		450	60	3
Total		**4,248**	**842 (19.82%)**	**39 (0.92%)**

*Repeated outbreaks** *Overall incidence 18.9%*** *Case fatality rate 4.63%****

Table 2: Demographic factors associated with FMD infected cattle in Ilesha Baruba district

FMD Status	Sex						
	Bull	Cows	White Fulani	Sokoto Gudali	Red Bororo	6 months-3 yrs	>3-5yrs
Positive	24 (37.5%)	40 (62.5%)	30 (46.9%)	22 (34.4%)	12 (18.6%)	35 (54.7%)	29 (45.3%)
Negative	13	13	11	7	8	12	14
Total	37 (26.7%)*	53 (44.4%)*	41	29	20	47	43

*Sero-positivity 71.1%** X^2*=0.5, df=1 and* X^2 *= 1.6, df=2*

capacity to detect FMD infected, non vaccinated cattle which have being exposed to infections <40> days [15] as the kit targets antibodies to non-structural proteins in non vaccinated infected animals as against structural proteins used for FMD vaccination differentiation.

The observed repeated outbreaks could be associated with un-controlled introduction of new cattle into the herd due to cross movements between herds and markets in these areas. The re-occurrence of outbreak in Bode II could be associated with few animals been initially affected by the FMDV resulting to persistence of the virus in the herd and probably following immune-suppression the resultant second phase outbreak was observed. The re-infection outbreak recorded in Bukaru- Rontuwa district may be attributed to fresh infection due to another serotype following cattle movement and environmental contamination as this location is proximal to the cattle trek route from paraku (Benin) – Ilesha (Nigeria) while the repeated occurrence in Bode I could be attributed to cattle migration between Bode I and Bode II due to close proximity, in search of pasture and water as well as the use of common service providers. Furthermore, the re-occurrence

of these three outbreaks in the study area for whatever associated factor most clearly demonstrates the characteristic absence of cross immunity between serotypes of FMD virus which enhances cattle susceptibility to another serotype while or having recovered from an existing infection due to another serotype [19]; [20].

In this study, cattle have being most significant in FMDV maintenance, as recovered cattle were often not removed from the herds. Thus, subclinical infections may constitute important viral reservoir and possible carrier role in transmitting the disease can also be associated with outbreak occurrence following introduction of new animals into the herds.

FMD demographic distribution factors based on age, breed and sex indicates more young (54.7%) white Fulani (46.9%) cows (62.5%) were positive to FMD, although not significant by chi square as this observation could be associated with small sampled size, but confirmed susceptibility of all sex, age and breeds to the disease. This is in line with previous report [5] which indicated high morbidity in both exotic and indigenous breeds and all ages of cattle with high mortality in calves than adult breeds. Previous reports [6] showed serotype A, SAT1, and SAT2, while [5] indicated serotypes A and SAT2 as well as [7] documented serotypes O and SAT2 were associated to outbreak in different parts of country. However, sero-typing of positive sera from this FMD outbreak survey is still on-going

In conclusion, FMD outbreaks is on the increase as disease affects non-vaccinated cattle breeds of all sex and ages especially amongst young white Fulani cows in this observed herd outbreaks. Serotype confirmation is therefore necessary for effective control strategy implementation.

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PHYSIOLOGICAL RESPONSE OF HEAT STRESSED BROILER CHICKENS TO SUPPLEMENTAL ELECTROLYTES AND ASCORBIC ACID

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Summary

Effect of supplementing the drinking water of broilers reared under natural heat stress with ammonium chloride (NH4Cl), sodium bicarbonate (NaHCO3), calcium chloride (CaCl2) and ascorbic acid (AA) on physiological response was investigated. A 200, one-day Arbor acre chicks were randomly allotted to five treatments in a completely randomized design. Each treatment was in quadruplicate of ten chickens. Treatment 1 (T1) was the control with water without any supplement while treatments 2 (T2), 3 (T3), 4 (T4) and 5 (T5) had their water supplemented with 0.5% NH4Cl, NaHCO3, CaCl2 and 300ppm AA respectively. At week 7, the respiratory rate (breath/minute) were 96.34, 78.88, 69.43, 74.25 and 82.75 for birds on T1, T2, T3, T4 and T5 respectively and was higher ($p<0.05$) for birds on T1. Rectal temperature of birds from weeks 3-6 were similar ($p>0.05$) and within the normal range except at week 7 for birds. Heterophil:Lymphocytes ranged from 0.33-0.50 and values were similar ($p>0.05$) for all treatments. Water intake of birds was not affected by the treatment ($p>0.05$). Mortality of birds on T1, T2, T3, T4, and T5 were 5%, 2.5%, 0%, 2.5% and 0% respectively. Supplemental electrolytes and AA lowered the respiratory rates and level of mortality of heat stressed broilers in this trial.

Keywords: Supplemental electrolytes, Ascorbic acid, Heat stressed broilers, Rectal temperature, Respiratory rate

RÉACTION PHYSIOLOGIQUE DES POULETS DE CHAIR SOUS STRESS THERMIQUE À UNE SUPPLÉMENTATION EN ÉLECTROLYTES ET EN ACIDE ASCORBIQUE

Résumé

La présente étude a analysé l'effet de la supplémentation de l'eau potable des poulets élevés sous stress thermique naturel par du chlorure d'ammonium (NH4Cl), du bicarbonate de sodium (NaHCO3), du chlorure de calcium (CaCl2) et de l'acide ascorbique (AA) sur leur réaction physiologique. Deux cents (200) poussins d'un jour Arbor acre ont été répartis de manière aléatoire à cinq traitements, dans un schéma complètement aléatoire. Chaque traitement comportait quatre groupes de dix poulets. L'eau dans le Traitement 1 (T1) qui a servi de témoin n'a reçu aucun supplément, tandis que l'eau dans les Traitements 2 (T2), 3 (T3), 4 (T4) et 5 (T5) ont reçu un supplément à 0,5%, respectivement de NH4Cl, NaHCO3, CaCl2 et 300ppm AA. À la semaine 7, la fréquence respiratoire (respiration / minute) était de 96,34, 78,88, 69,43, 74,25 et 82,75 respectivement pour les oiseaux aux traitements T1, T2, T3, T4 et T5, et était plus élevée ($p <0,05$) pour les oiseaux soumis au traitement T1. La température rectale des oiseaux aux semaines 3-6 était similaire ($p> 0,05$) et se situait dans la plage normale, sauf à la semaine 7. Le ratio hétérophiles/ lymphocytes se situait dans la fourchette 0,33 - 0,50 et les valeurs étaient similaires ($p> 0,05$) pour tous les traitements. La consommation d'eau par les oiseaux n'a pas été affectée par les traitements ($p> 0,05$). La mortalité des oiseaux aux T1, T2, T3, T4, et T5 étaient respectivement de 5%, 2,5%, 0%, 2,5% et 0%. La supplémentation en électrolytes et en acide ascorbique a abaissé les fréquences respiratoires et le niveau de mortalité des poulets de chair sous stress thermique dans cet essai.

Mots-clés : Supplémentation en électrolytes ; Acide ascorbique ; Poulets de chair sous stress thermique ; Température rectale ; Fréquence respiratoire

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Introduction

High environmental temperature is one of the most serious factors affecting the production performance of broiler in both tropical and sub tropical regions of the world (1, 2). Broilers are homeothermic, they maintain their body temperature while the external temperature is relatively constant. They are comfortable in a range of temperature called thermo neutrality or comfort zone ranging from 18°C to 22°C (3). Within this zone, energetic efficiency is maximized due to minimal energy needed for the maintenance of body temperature.

As environmental temperature increases, the thermal equation is disturbed and birds tend to correct the equation by dissipating heat through non-evaporative cooling. Non-evaporative heat loss fails when environmental temperature equals to the body temperature of birds and heat can be lost by the evaporation of moisture from the respiratory tract through increased respiration (panting). This leads to respiratory alkalosis which has been correlated with reduced feed consumption, growth, survival (4) and increased heterophil:lymphocyte ratio (5).

The negative effects of high ambient temperature on poultry performance can be minimized by electrolytes and ascorbic acid as they are necessary to maintain physiological functions during hot weather (6, 7, 8, 9). These practices have been reported to reduce mortalities and/or elevate growth rate (10). A level of 0.5% sodium bicarbonate has been reported (11) to stimulate feed and water intake in broilers. In the Nigerian humid tropical environment however, the utilization of electrolytes in ameliorating the adverse effect of heat stress in broiler is not adequately documented. This study therefore was conducted to evaluate the effect of selected electrolytes and ascorbic acid supplementation in drinking water on the physiological response of broilers raised in a natural heat stress environment of the hot humid tropical climate.

Materials and Methods

The study was carried out at the Teaching and Research Farm of the University of Ibadan, Ibadan which is located between latitudes 60010" and 90010" North of the equator and longitudes 30 and 60 of the Greenwich for a period of seven weeks. A total of 200 day-1 old Arbor acre broiler chicks strain were used for the experiment. After one week of brooding, they were weighed and randomly allotted to five treatments. Each treatment was replicated four times with ten birds per replicate in a completely randomized design. Ambient temperature and humidity of the poultry house were recorded daily at 8, 13 and 20 hrs using thermo hygrometer. Broiler starters and finishers' diets containing 3000 kcal/kg ME, 23% CP and 3000 kcal/kg ME and 19% CP respectively were formulated and were offered ad libitum to the birds throughout the course of the experiment. The composition of the experimental diets has been previously documented (Majekodunmi et al., 2013) and is shown in Table 1. Clean water in which test electrolytes or ascorbic acid has been added was provided ad libitum. Treatment 1(control) was without any electrolytes or vitamin, Treatment 2 (0.5% ammonium chloride), Treatment 3 (0.5% sodium bicarbonate), Treatment 4 (0.5% calcium chloride), Treatment 5 (300 ppm ascorbic acid).

Respiratory rate (RR) was measured by direct observation of the birds and recorded in breath/minute. Rectal temperature (RT) was measured using digital rectal thermometer probe inserted into the rectum. Water intake was monitored on daily basis throughout the experimental period. Blood samples were collected from two randomly picked birds from each replicate via brachial vein. Blood smears were stained using May-Grunwald and Giemsa stains approximately 4 hours after preparation with methyl alcohol fixation. Leucocytes differentials (heterophils, lymphocytes, eosinophils, monocytes and basophils) were counted for each smear, Heterophil-Lymphocyte ratio (H/L) was calculated (Gross and Siegel, 1983) and mortality also monitored. Data generated were analyzed using analysis

Table I: Gross composition of experimental diets

Feed ingredients (%)	Starter diet	Finisher diet
Maize	52.00	52.00
Wheat offals	7.73	7.73
Soyabeans	35.00	30.00
Palm kernel meal	-	4.50
Palm oil	2.50	3.00
Oyster shell	0.50	0.50
Dicalcium phosphate	1.50	1.50
Salt	0.25	0.25
Methionine	0.15	0.15
Lysine	0.06	0.06
Broiler premix	0.25	0.25
Avatec	0.06	0.06
Calculated analysis	100	100
Crude Protein	22.97	19.06
Metabolizable Energy Kcal/kg	3007.7	3018.9
Calorie:Protein Ratio	136.4:1	152.8:1

1kg of premix contains:
Vitamin A-10,000,000 IU;Vitamin D3-2,000,000;Vitamin E-20,000 IU ;Vitamin K-2,250mg;Thiamine B1-1,750mg; Riboflavin B2- 5,000mg; Pyridoxine B6- 2,750mg; Niacin-27,500mg;Vitamin B12-15mg; Pantothenic acid- 7,500mg; Folic acid-7500mg; Biotin-50mg; Choline chloride-400g;Antioxidant-125g; Magnesium-80g; Zinc-50mg; Iron-20g; Copper-5g; Iodine-1.2g; Selenium-200mg; Cobalt-200mg

of variance (SAS, 1999). Significant treatment means were compared using Duncan's option of the same software.

Results

The recorded ambient temperature and relative humidity during the experimental period were 30.90°C - 36.73°C and 58.48 - 89.24% respectively. Table 2 shows the respiratory rate of heat stressed broilers given water supplemented with electrolytes and ascorbic acid. Significant differences ($p<0.05$) were observed among treatments in week 3 and 7. At week 7, the effect of electrolytes and ascorbic acid on birds respiratory rate was significant ($p<0.05$). Birds on T2, T3, T4 and T5 (78.88, 69.43, 74.25 and 82.75 breath/minute respectively) had lowered RR than those on T1 (96.34 breath/minute).

The results of the rectal temperature (RT) of heat stressed broilers given water supplemented with electrolytes and ascorbic acid is depicted in Table 3. The RT values observed in this trial at week 3, 4, 5 and 6 were statistically similar ($p>0.05$) except at week 7 where value obtained for birds on T5 (41.68°C) was significantly different ($p<0.05$) from the values obtained for birds on T1 (41.43°C) and T2 (41.43°C).

Table 4 shows the effect of the treatments on the heterophil to lymphocyte ratio of heat stressed broilers which were not significantly ($p>0.05$) affected by the treatments.

Figure 1 shows the overall mean intake of water throughout the experimental period. Water intake in this trial was not significantly affected ($p>0.05$) by the treatments. However, birds on T3 had the highest water intake (242.23ml/day) with the lowest recorded for birds on treatment 5 (226.24ml/day).

The highest mortality (5%) was recorded in T1 (control: without any supplement) compared with all other treatment groups as shown in Figure 2. Among the supplemented treatment groups, no mortality (0%) was recorded in birds on T3 (sodium bicarbonate) and T5 (ascorbic acid) while

2.5% mortality was observed in birds on T2 (ammonium chloride) and 4 (calcium chloride) groups.

Discussion

The recorded range of ambient temperatures during this experiment (30.90°C - 36.73°C) was consistently above the thermo neutral zone (18°C-22°C) for broiler (3) indicating exposure of birds to perpetual heat stress (14). A range of relative humidity observed was quite high. High humidity above 60% has been reported to impair heat transmission from body core to the peripheral at 35°C but facilitate it at 30°C in broiler chicken of 4-week age (15). The prevailing weather data were clearly indicative that the experimental birds were perpetually under heat stress.

The RR observed in this study showed the positive effect of the treatments on RR of the birds in agreement with the previous findings (16) of reduced panting rate in heat-stressed chickens given ascorbic acid. Another report (17) also showed that supplementation of the drinking water of broiler with electrolyte increased apparent respiration efficiency by 27%.

High body temperature is one of the responses of birds to high ambient temperature. Birds usually maintain constant body temperature but when the internal heat production and heat gain from the environment exceeds the rate of heat dissipation, body temperature increases. The observation in this trial agreed with the report (18) on the non significant effect of supplemental electrolytes on rectal temperature of heat stressed birds. Also, there was reported (19) insignificant effect of ascorbic acid on the RT of chicks maintained at 22°C or when exposed to temperature of 43°C. However, a significantly lower rectal temperatures in ascorbic acid supplemented heat stressed birds was earlier documented (16).

The earlier extensive review by authors (21) enunciated the roles of heterophils as phagocytic cells designed to defend organism against infections by bacteria, viruses, or foreign particles, while lymphocytes play important roles in immunity, particularly in the production of antibodies. One of the physiological responses of exposure to stress is the release of glucocorticoids, causing dissolution of lymphocytes leading to lymphopenia. On the other hand the increased release of heterophil by the bone marrow accentuate their number in circulation, but their phagocytic and bactericidal activities are usually very low. There was reported (22) significant reduction in lymphocyte and increased heterophil values in broiler chickens after 2 hour of heat stress exposure which consequently increased H/L ratio from 0.25 to 0.43. Also, another author (12), reported normal H/L ratio of about 0.4 which could rise to 8 in birds under severe stress. In this study however, the heterophil:lymphocyte ratio range of 0.30-0.50% was observed with no particular trend of treatments effect and which might be adduced to enhanced adaptive response to long term heat exposure and the treatments.

The response obtained from birds on T3 in term of water intake agreed with the earlier findings (11) of noted increased water intake in chickens when given water supplemented with 0.5% sodium bicarbonate. Another author (23) also showed that the addition of NaHCO3 to drinking water markedly increased the water consumption in broiler birds. It was later demonstrated (24) that increased water intake benefited birds by acting as a heat receptor as well as enhancing heat dissipation which consequently increased survivability.

The lowered mortality rate recorded in the supplemented groups compared with the control group demonstrated the ameliorating effects of electrolytes and ascorbic acid in this experiment. This is in consonance with the reported (25, 26) lowered mortality in heat stressed birds given water supplemented with Vitamin C and sodium bicarbonate compared to unsupplemented control in heat stress conditions. Conversely, sodium bicarbonate was observed (27) to have no effect on the livability rate of broilers.

Table 2: Respiratory rate of heat stressed broiler given water supplemented with electrolytes and ascorbic acid

Week	T1	T2	T3	T4	T5	SEM
3	75.75[ab]	80.63[a]	76.20[ab]	69.68[b]	77.18	1.49
4	71.25	72.18	70.41	68.09	71.26	2.16
5	76.04	72.16	68.43	71.83	72.33	2.26
6	106.34	107.25	108.00	104.09	109.08	1.59
7	96.34[a]	78.88[b]	69.43b	74.25[b]	82.75[ab]	2.31

[a,b]: means on the same row with different superscripts are significantly different(p<0.05) SEM - Standard error of mean.T1-Control,T2-Ammonium chloride,T3-Sodium bicarbonate,T4 – Calcium chloride,T5- Ascorbic acid

Table 3: Rectal temperature of heat stressed broiler given water electrolytes and ascorbic acid

Week	T1	T2	T3	T4	T5	SEM
3	41.30	41.18	41.08	40.98	41.10	0.05
4	40.90	40.95	40.94	40.71	41.03	0.07
5	41.30	41.26	41.41	41.41	41.43	0.04
6	41.73	41.76	41.83	41.79	41.75	0.03
7	41.43[b]	41.43[b]	41.63ab	41.60[ab]	41.68[a]	0.03

[a,b:] means on the same row with different superscripts are significantly different(p<0.05) SEM - Standard error of mean.T1-Control,T2-Ammonium chloride,T3-Sodium bicarbonate,T4 – Calcium chloride,T5- Ascorbic acid

Table 4: Heterophil to Lymphocytes ratio of heat stressed broilers treated with electrolytes and ascorbic acid

Week		T1	T2	T3	T4	T5	SEM
Week4	H	26.41	24.41	27.18	27.08	26.25	0.49
	L	68.33	69.41	66.81	67.08	67.16	0.55
	H/L	0.39	0.36	0.41	0.41	0.39	0.01
Week5	H	29.00	29.75	27.75	26.62	27.00	0.86
	L	63.87	62.37	67.12	67.00	67.12	0.87
	H/L	0.46	0.50	0.42	0.40	0.41	0.02
Week6	H	27.75	22.25	26.50	27.25	26.00	0.85
	L	67.50	59.62	69.62	67.37	66.75	1.49
	H/L	0.43	0.37	0.38	0.40	0.39	0.01
Week7	H	23.62	26.25	23.62	23.62	26.00	0.60
	L	67.50	66.37	70.62	69.12	68.37	0.59
	H/L	0.35	0.41	0.33	0.34	0.38	0.01

H- Heterophil, L-Lymphocyte, H/L- Heterophil Lymphocyte ratio. SEM - Standard error of mean.T1-Control, T2-Ammonium chloride,T3-Sodium bicarbonate,T4 – Calcium chloride,T5- Ascorbic acid

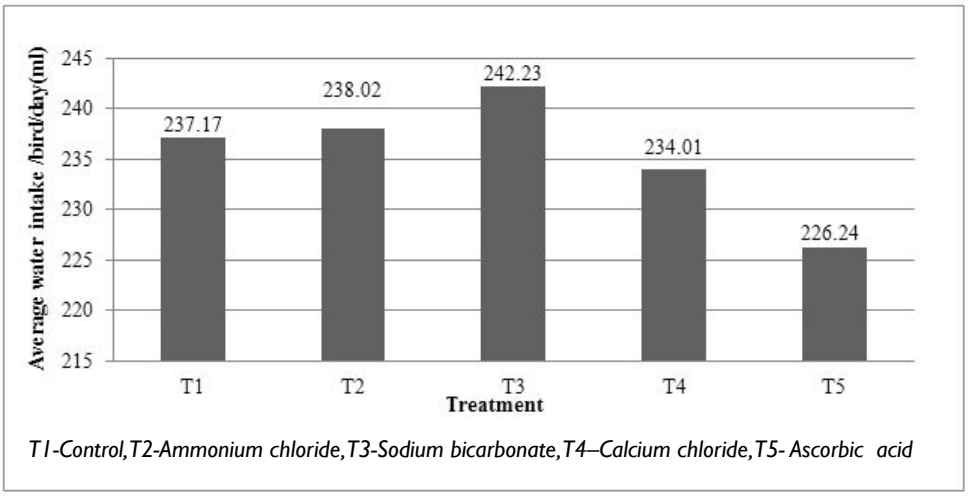

Figure I: Average water intake of heat stressed broiler given electrolytes and ascorbic acid

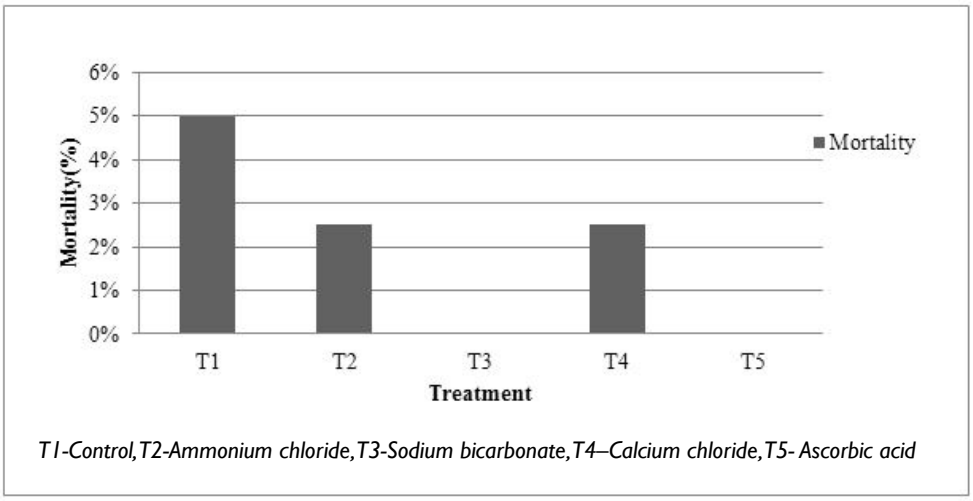

Figure 2: Mortality of heat stressed broiler treated with electrolytes and ascorbic acid

Conclusion

Under the condition of this study, ammonium chloride, sodium bicarbonate, calcium chloride and ascorbic acid in the water of heat stressed broilers lowered the respiratory rate and increased survivability. However, further study should be undertaken on the use of higher concentration of ascorbic acid in water for broiler. The dietary water supplementation with electrolytes and or ascorbic acid should be considered during heat stress because of their noted potential positive economic impact particularly with regards to effect on chickens livability.

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EPIDEMIOLOGY OF ONCHOCERCA RAILLETTIE IN DONKEYS AT TUMBOOL CITY AND ITS INFLUENCE ON SOME SERUM CONSTITUENTS

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Abstract

In this study, 50 donkeys of both sexes were examined for diagnosis of onchocercosis in Tumbool city, Gezira State-Sudan. The animals were examined in Tumbool Veterinary Hospital and Tumbool's livestock market during September to October 2010. Out of 50 donkeys examined, 17(34%) were found positive for microfilaria in skin samples without sex influence in infection rate. whereas, a significant increase (P<0.05) among old animals was recorded. The effects of the infection on serum total proteins, albumin, glucose and Cholesterol were investigated.

EPIDÉMIOLOGIE D'ONCHOCERCA RAILLETTIE CHEZ LES ÂNES DE LA VILLE DE TUMBOOL ET SON INFLUENCE SUR CERTAINS CONSITUANTS DU SÉRUM

Résumé

Dans la présente étude, 50 ânes des deux sexes ont été examinés pour diagnostic de l'onchocercose dans la ville de Tumbool, dans l'Etat de Gezira au Soudan. Les animaux ont été examinés à l'Hôpital vétérinaire de Tumbool et le marché d'animaux de Tumbool, de septembre à octobre 2010. Des 50 ânes examinés, 17(34%) étaient positifs pour les microfilaires dans les prélèvements de peau, mais on n'a pas relevé aucune influence du sexe sur le taux d'infection. Cependant, une augmentation significative (P<0.05) a été notée parmi les animaux âgés. Les effets de l'infection sur les protéines totales, l'albumine, le glucose et le cholestérol ont été étudiés.

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Introduction

Eastern of Gezira is one of most heavily populated state with animals such as donkeys, camels, small ruminants and a few of horses. The donkeys are becoming an important animals in Sudan and specially in Gezira State, they represent the major transporting systems some rural area. Onchocercosis is a chronic dermal disease of man and animals caused by worms belonging to genus onchocerca (Soulsby, 1982). The intermediate host is usually is a midges, culicoides spp. or black flies belonging to the genus Simulium. Large number of animals that did not show clinical signs indicated the presence of microfilridae in the skin. Previous studies on Sudanese horses and donkeys showed that Onchocerca cervicalis and Onchocerca railletti were common (EL Sammany and Hussein, 1983; ELKheir and EL Sinnary, 1989; Husna and Seri 2004; Ahmed, 2008).

The present study was designed to report the occurrence of the disease in Tumbool city and to study the effectes of microflarial infection on some blood biochemical profiles on naturally infected donkeys.

Materials and Methods :

Study area and animals

This study was under taken at Tamboul town in Eastern Gerzira State central of Sudan it was conducted during the period from September to October, 2010. Fifty Sudanese local breed donkeys (males and females) were examined for the presence of onchocercosis, using parasitological methods.

Parasitological Examinations:

Skin snips (0.5 cm in diameter) were taken from the mid dorsal line of donkeys. The area was cleaned, shaved and cut carefully from skinfullness by sharp plant scalpel. Snips were weighted and washed in running tap water and then put into One mL normal saline in sterile containers and incubated at room temperature for 4-5 hours. then 5.0 µL of the suspension were taken by a micropipette and examined under a microscope, the detected microfilaria were counted as (mff/gm skin).

Biochemical Examinations:

Blood Samples (5.0ml) from the jugular vein were taken into plane tubes and sera were separated at room temperture and stored at -20°C for analysis.

Serum total proteins:

The value of total proteins was determined by Buiret method (King and Wooton, 1956). The optical density of the developing colour was measured at 540 nm using Corning colorimeter 252 (CIBA Corning, England). The total proteins values was calculated in g/100ml.

Serum albumin:

Serum albumin concentration was determind by Bromocreasol green method (BCG) according to Bartholarmew and Delary(1966). The absorbance was red at 608nm using Corning colorimeter (CIBA Corning, England). Albumin valus was calculated in g/100ml.

Plasma globulins:

The serum globulins (g/100ml) for each sample was obtained by subtracting the values of plasma albumin from the total proteins values.

Plasma glucose:

The plasma glucose was determined after enzymatic oxidation in the presence of glucose oxidase hydrogen peroxidase formed reacts under catalysis of peroxidase with phenol and 4- aminophenzone to form a red- violet quinoneimine dye as indicator. The intensity of developing colour was measured at 500nm using (CIBA Corning, England) The glucose values was calculated in g/dl.

Plasma Cholesterol :

The cholesterol was red at 590 nm in Corning colorimeter. The values was calculated in mmol/L.

Analysis of data:

Data obtained were analysed to

generate means, percentages and comperisons using the computerized programme Statistical Packages for Social Science (SPSS, 10.0). significance was considered at P<0.05.

Results

Prevalence of Onchocerca infection:

In this study, out of 50 donkeys examined, 17 donkeys were found positive for microfilaria in skin snips with overall prevalence as 34%. The breakdown of this prevalence according to sex is shwon in table(1) with no significant variation due to their sex. The prevalece among male and female donkeys were (33.3%) and (34.5%), respectively. The effect of age on the prevalence of microfilariae was depicted in table (2). Highest infection rate was recorded in donkeys of age group 7-10 years (64.3%) followed by donkeys at age 4-6 years(25%) whereas, lower prevalence (20.8%) was recorded in younger ones.

Parasitic burden:

The parasitic burden has been recorded as mean number of microfilariae per gram of skin(mff/gm skin) and represented in Figure (1). The mean count of mff /g skin in donkeys 1-3 years old was found to be 1083, ranging between 100- 2400 mff/gm skin. In animals of age group 4-6 years, the mean mff/gm skin count increased to 1444, ranging between 1000-2000 mff/gm skin. In old donkeys the mff counts increased and found to be 2040 with relatively wide range (1330 - 9000) mff/gm skin. In all age groups, naturally infected females were found to harbour high counts of mff/g skin than males Figure (2).

Biochemical Profiles:

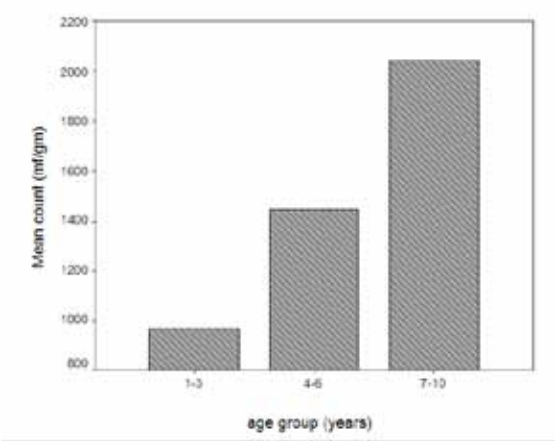
Table (3) summerized the mean values of tested metabolites in infected and uninfected donkeys. Naturally infected animals showed significant(P<0.05) increase in the levels of serum total proteins, albumin, globulins when compared with uninfected donkeys . Likewise the level of glucose was also elevated in infected animals. The concentration of serum cholesterol was decreased in infected donkeys when compared to uninfected ones.

Table 1: Prevalence of Onchocerca raillettie in Sudanese donkeys at Tumbool city during September-October 2010

Sex of animal	Number of animal examined	No. with mff +ve	% mff +ve
Male	21	7	33.3%
Female	29	10	34.5%

Table2: Prevalence of Onchocerca raillettie in Sudanese donkeys at Tamboul city according to animal age during September-October 2010

Age group	Prevalence	
	No examined	No. of mff +ve (%)
1-3 years	24	5 (20.8%)
4-6 years	12	3 (25%)
7-10 years	14	9 (64.3%)



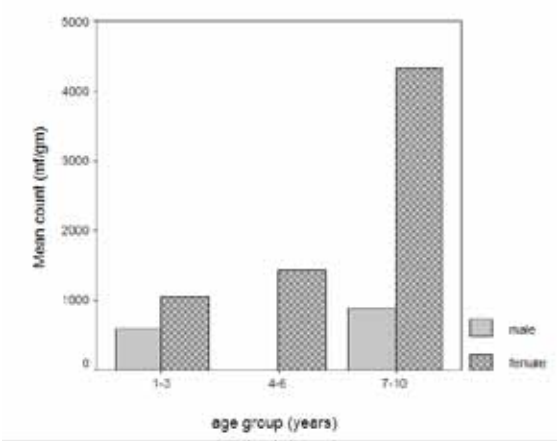


Table 3: Effects of natural infection of Onchocerca raillettie on some serum Metabolites of Sudanese donkeys during September-October 2010

Metabolite	Mean ±SD.		P- value
	Mff +ve (n=17)	Mff –ve (n=33)	
Total proteins (mg/ml)	12.5±5.3	9.3±4.6*	0.029
Albumin (mg/ml)	4.5±1.5	3.6±0.6*	0.006
Globulins (mg/ml)	8.0±5.2	5.6±4.4*	0.037
Glucose (mmol/l)	148.9±71.8	123.3±72.1	0.238
Cholesterol (mmol/l)	163.0±38.8	202.0±54.2*	0.011

Discussion

The eastern of Gezira State is heavily populated with domesticated livestock species yet, limited surveys and records were available concerning animal onchocercoisis. The most recently available records on donkey diseases was reported by Ahmed (2008). Onchocerca cervicalis and Onchocerca railletti were common in Sudanese horses and donkeys (EL Sammany and Hussein, 1983; EL Kheir and EL Sinnary, 1989; Husna and Seri 2004). In this study skin mff of Onchocerca raillieti was identified in donkeys at Tumbool city. The overall prevalence rate 34% which is similar to that reported by El-Sammany (1981). The prevalence indicated by the presence of skin mff was related to animals age where an increasing pattern in infection rate (25%) was recorded in age group 4-6 years and a highest rate (64%) in donkeys aged 7-10 years old. This is agree with the fact that chronic parasitic infections increased with an increasing time of exposure. The adult female worms of onchocerca spp. are viviparous and produce millions of microfilariae per year, they may live for 15 - 20 years forming nodules around them as a result of host reaction (Schultz-key *et.al.,* 1980). The variations in mff count in this study (1330- 9000) mff/gm skin in donkeys aged 7-10 years, compared to a previous count (6000-57000) mff/gm by Husna and Seri, (2004) in Khartoum state during february-march, may be due to the season of sampling, technique applied, geographical variations and the physiological status of the animals. The epidemiological picture showed an increase prevalence and mff burden in female donkeys than males, this could be attributed to the stress factors prevailing more in females than males.

The significant increases in total proteins and globulins in infected animals may be related to the presence of the mff paralleled with an increase in the immunoglobulins to combact the infection. The finding is in agreement with that reported in previous

study (Husna *et al.,* 2008) where the profile of total proteins in calves seems to be associated with an increase in globulins level. In the present study the obtained values of total proteins, albumin and globulins are higher than those in our previous study on donkeys by Seri and Husna (2006) and within the similar range reported by Jordana *et al.,* (1998). Such variations in serum constituets are subjected to variations in feeding, environmental and physiological variation between the animals under study.

A significat decrease in cholesterol level and a non significant elevation in serum glucose in infected donkeys need more studies to clarify their role in animal onchocerciasis.

Conclusion:

The present study confirmed that infection with Onchocerca railleti was prevalent mostly in adult donkeys. The parasitic burden is high and the nature of infection was chronic and seemed to has a significant effect on biochemical profiles of infected animals.

Impact of the research

This work helps to assess the current situation of animal onchocerciasis in the area and the possibility of co- transmission of human onchocerciais in non endemic areas.

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TESTICULAR AND RELATED SIZE EVALUATIONS IN NIGERIAN SAHEL GOATS WITH OPTIMAL CAUDA EPIDIDYMAL SPERM RESERVE

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Abstract

Testicular sizes of animals are important for identification of those with adequate sperm production. The aim of this study was to define the testicular and related size estimates that would be associated with optimal cauda epididymal sperm counts (ESC) in Sahel goats based on postmortem evaluations. A stratified quota sample population of 125 male goats inclusive of all testicular sizes was taken at a slaughterhouse in Maiduguri, Nigeria. The bucks were aged 18-30 months and weighed 17.04 ± 2.99 (12-25) kg. Body, testicular and epididymal weights of each goat with other related size measurements were estimated. ESC was determined from homogenized tissue using a manual cytometer. At the cut-off ESC of >1.1 × 109 sperm heads, 66 (52.5%) of the goats had optimal ESC which was associated with testicular weight of 59.90 ± 16.10 (31.4-86.2) kg, gonado-somatic index of 3.51 ± 0.69 (2.0-4.5) g/kg and scrotal circumference of 19.07 ± 1.29 (17.0-21.8) cm. The ESC correlated better with age than body weight of the animals and correlated also with testicular and scrotal size variables and epididymal weights. The size variables of the scrotum and testis correlated with one another. These findings provide data that may be used to anticipate adequate antemortem sperm reserve based on testicular size during preliminary selection of sires for breeding from a sexually mature Sahel buck population.

Keywords: Optimal sperm output, testicular size, scrotal size, Sahel goat, Nigeria

PREVALENCE DE PATHOLOGIES PULMONAIRES MACROSCOPIQUES CARACTERISTIQUES DES PORCS A L'ABATTOIR DE MAKURDI DANS L'ETAT DE BENUE AU NIGERIA

Résumé

Compte tenu de l'importance du rôle des porcs dans l'alimentation quotidienne et comme sources de revenu et de la population porcine relativement grande de l'État de Benue et des effectifs porcins des États voisins, la présente étude transversale avait pour but d'établir une estimation de la prévalence des lésions pulmonaires macroscopiques définissables chez les porcs abattus à Makurdi. Les lésions ont été classifiées et caractérisées de manière grossière selon le type et la sévérité. Le test d'association entre la prévalence de pathologies pulmonaires et les différentes variables de l'étude a été effectué en utilisant une analyse bivariée. Dans l'ensemble, 36,4% (146/401) des porcs avaient des pathologies pulmonaires, dont l'emphysème 5 (1,3%), la pneumonie enzootique 11 (2,7%), la pleuropneumonie 12 (3,0%), la tuberculose 3 (0,8%) et la pneumonie vermineuse 115 (28,7%). L'âge du porc était statistiquement significatif (P <0,0001) pour les pathologies pulmonaires. De plus, la classification des poumons a révélé que 83 (20,7%) et 63 (15,7%) des poumons étaient légèrement et sérieusement affectés, entraînant une condamnation partielle ou totale. Les poumons apparemment en bonne santé 255 (63,6%) étaient plus susceptibles d'être indemnes de lésions (P <0,0001). Les lésions tuberculeuses et pneumoniques étaient les lésions pulmonaires les plus fréquemment identifiées parmi les lésions observées à l'abattoir. Nos résultats révèlent des taux de prévalence relativement élevés des lésions respiratoires caractéristiques des porcs. Ces résultats sont une indication de la présence de pathologies sur le terrain et ont révélé même des cas d'importance pour la santé publique, rappelant ainsi aux inspecteurs de viande, aux vétérinaires et aux éleveurs de porcs au Nigeria l'importance des maladies respiratoires des porcs et leurs éventuels facteurs de risque. Enfin, cette

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étude préconise une surveillance approfondie des pathologies pulmonaires des porcs ainsi que la nécessité de sensibiliser les éleveurs de porcs au Nigeria à l'importance des soins vétérinaires afin de réduire les impacts des maladies respiratoires sur la production porcine par des mesures de contrôle appropriées et efficaces.

Mots-clés : Pathologies pulmonaires macroscopiques ; Prévalence ; Maladies respiratoires ; Porc abattu ; État de Benue ; Centre-nord du Nigeria

Introduction

The breeds of goats in Nigeria are either dwarf (West African Dwarf type, WAD) or long-legged (Sahel type). The ecotypes of Sahel goats in northern Nigeria are Borno White (BW), Kano or Savannah Brown (KB) and Red Sokoto (RS), with no morphological features for external differentiation apart from coat color (Bourn *et al.,* 1994; Igbokwe *et al.,* 1998; Butswat and Zaharadden, 1998; Blench, 1999; Kwari *et al.,* 2004). Investigations of Sahel bucks to establish baseline data required for evaluation of their reproductive health are scanty, but reports are available on their potential for sperm production (Ogwuegbu *et al.,* 1985; Kwari and Ogwuegbu, 1992; Daudu, 1994; Bitto and Egbunike, 2006a,b; Maina *et al.,* 2006a,b,c; Bitto *et al.,* 2008; Ugwu, 2009; Oyeyemi *et al.,* 2011).

Normospermia could be anticipated when cauda epididymal sperm reserve is adequate, since the sperm output in the semen depends on the quantity of sperm stored in the cauda epididymides (Berndston, 1977). Reference values of testicular size and sperm cell counts in cauda epididymides of Nigerian goats at postmortem or after castration, based on adequate number of reference individuals, were not accessible, but such values ought to be available to indicate normal variations observed in healthy populations so that it would be possible to identify individuals having abnormal values in unhealthy conditions (Geffré *et al.,* 2009). Four postpubertal WAD goats at 5 months of age weighing 8.9-11.0 kg in the early dry season had cauda epididymal sperm reserve of 1.57 ± 0.32 (1.2-1.9) × 109 (Bitto and Egbunike, 2006a). At the age of 12-14 months and weighing 19.52 ± 1.25 kg, 15 WAD goats were reported to have cauda epididymal sperm reserve of 1.46 ± 0.26 (1.2-1.7) × 109 (Ugwu, 2009). The WAD goats, in these reports, were intensively managed and fed adequately with supplements to obviate the effect of under-nutrition on reproductive capacity (Bitto and Egbunike, 2006a; Ugwu, 2009) and could be presumed to represent reproductively sound animals in the population. There is no evidence that the potential for sperm production differed between WAD and Sahel breeds (Alade *et al.,* 2006). Increasing age and body weight positively correlated with testicular sizes of goats (Mekasha *et al.,* 2007; Raji *et al.,* 2008; Kabiraj *et al.,* 2011; Shoyombo *et al.,* 2012). Larger testes correlated with their scrotal circumferences (Alade *et al.,* 2006, 2007, 2009). Testicular and cauda epididymal sperm reserves positively correlated with testicular weights and scrotal circumferences in RS goats (Daudu, 1984).

The Sahel goat has adequate sperm production at 3 months of age with sperm cell concentration increasing with age (Maina *et al.,* 2006a). The quality of sperm was reported to improve with age and later diminish with ageing of the buck beyond 30 months, but sperm quality was better in the dry than wet season (Maina *et al.,* 2006b; Oyeyemi *et al.,* 2011). Bilateral testicular hypoplasia (Igbokwe *et al.,* 2011) and atrophy (Mshelbwala and Igbokwe, 2010) associated with small-sized testes and aspermatogenesis occur among Sahel bucks (Abba and Igbokwe, 2012). Unilateral cryptorchid Sahel bucks had similar sperm concentration with normal bucks, but the percentage of sperm cell abnormalities was higher than normal (Igbokwe *et al.,* 2013). Breeding programmes require assurance of the reproductive capacity of sires, but in areas with low technical and laboratory support for semen evaluation, farmers may need reference range of testicular sizes, without extraneous mitigating conditions, that may be associated with adequate sperm reserve for reproductive efficiency.

In this study, the testicular sizes of sexually mature Nigerian Sahel goats were evaluated with their scrotal and epididymal sizes and testicular and cauda epididymal sperm counts with the aim of identifying goats with optimal sperm output from testicular and related size variables.

Materials and Methods

One hundred and twenty five apparently healthy male Sahel goats in good body condition aged 18-30 months and weighing 10-25 kg, presented for slaughter at the metropolitan abattoir, Maiduguri, Nigeria, were selected by stratified quota sampling to capture those with various testicular sizes from small to large sizes with bilateral symmetry and the right-sided testis was consistently used for the study. They were aged by dental examination and weighed. The scrotal length (SL) and circumference (SC) were estimated with measuring tape. The testes (with their epididymides), with bilateral symmetry and without apparent lesions other than varying size, were collected and transported in ice pack to the laboratory where the testes and epididymides were separated by dissection and weighed. The gonado-somatic index (GSI, g/kg) was estimated as the ratio of each testicular weight to body weight. The epididymo-somatic index (ESI, g/kg) was also estimated as a ratio of each epididymal weight to body weight. Testicular longitudinal length (TLL) and mid-circumference (TMC) were estimated with a measuring tape. Sperm heads in homogenized testicular and cauda epididymal tissues were counted with a manual cytometer (haemocytometer) as earlier described by Amann and Lambiase (1969) and Igbokwe et al., (2009) with dilution of homogenates to facilitate counts and dilution factor used in the final calculation of counts. Optimal cauda epididymal sperm reserve was adjudged as ≥1.1 × 109 sperm cells (Bitto and Egbunike, 2006a; Ugwu, 2009).

The data obtained were summarized as means ± standard deviations, means were compared by two-way analysis of variance with Tukey post-hoc test and coefficients (r) of correlation were determined using computer software (GraphPad Instat, 1993 version, http//:www.graphpadinstat.com). Correlation coefficients were significant ($p < 0.05$) at >0.3 (Singha, 1992).

Results

Sixty six (52.8%) out of 125 bucks had normal cauda epididymal sperm cell count of >1.1 × 109, and the data on their ages, BW, testicular (TSC) and cauda epididymal (ESC) sperm counts, scrotal, testicular and epididymal size variables are summarized in Table 1. The correlation coefficients in the relationships among the variables are presented in Table 2. The BW of the bucks increased ($p < 0.05$) with age and the sperm counts from the testes and cauda epididymides were higher ($p < 0.05$) at 30 months than 18 and 24 months of age. BW correlated ($r = 0.49$-0.70) with testicular and epididymal size variables (SC, SL, TW, TLL, TMC), but did not correlate ($r = 0.15$-0.27) significantly ($p > 0.05$) with GSI and sperm counts (TSC, ESC). GSI correlated with TW ($r = 0.80$) and EW ($r = 0.77$) as well as SC, SL, TLL and TMC ($r = 0.58$-0.80), but failed to correlate significantly ($p > 0.05$) with TSC ($r = 0.22$) and ESC ($r = 0.25$). ESC correlated significantly ($p < 0.05$) with scrotal size variables (SC, SL), some testicular size variables (TW, TLL, TMC) and EW, whereas TSC did not have significant ($p > 0.05$) correlation with these variables. However, ESC correlated ($r = 0.55$; $p < 0.05$) with TSC as EW also correlated ($r = 0.92$; $p < 0.05$) with TW. The size variables of the scrotum and testis correlated ($r = 0.70$-0.77; $p < 0.05$) with one another.

Discussion

Majority of the bucks surveyed had optimal ESC and those with lower ESC than the cut-off sperm count were excluded from this report, having been evaluated for hypospermatogenesis and aspermatogenesis as earlier reported (Abba and Igbokwe, 2012). The bucks with optimal and sub-optimal ESC had similar age range; the later had lower testicular weights (3.5-54.1kg) and gonado-somatic index

Table 1: Age - related variations in body weights, testicular and epididymal size estimates and sperm counts in Nigerian Sahel goats.

	Age (Months)				
Parameters	**18 (n=14)**	**24 (n=25)**	**30 (n=27)**	**All goats (n=66)**	**Range (Min.-Max.)**
Body weight (kg)	14.00±1.13[a]	16.67±2.82[b]	18.74±2.29[c]	17.04±2.99	12.0-25.0
Sperm cell count (x109)					
Cauda epididymal	1.68±0.31[a]	1.68±0.38[a]	2.34±0.80[b]	1.94±0.67	1.12-4.66
Testicular	0.14±0.10[a]	0.15±0.01[a]	0.27±0.20[b]	0.23±0.30	0.03-1.88
Scrotal size					
Length (cm)	8.39±0.68[a]	9.66±2.32[b]	9.89±0.61[b]	9.29±0.91	7.5-11.0
Circumference (cm)	17.82±0.67[a]	18.87±1.22[b]	19.91±1.01[c]	19.07±1.29	17.0-21.8
Testicular size					
Gonado-somatic index (g/kg)	2.85±0.38[a]	3.43±0.67[b]	3.98±0.41[c]	3.51±0.69	2.0-4.5
Weight (g)	39.58±5.73[a]	56.30±11.26[b]	74.34±7.65[c]	59.90±16.10	31.4-86.2
Longitudinal length (cm)	8.94±0.68[a]	10.02±1.07[b]	11.13±0.79[c]	10.23±1.20	7.8-12.9
Mid-circumference (cm)	10.23±0.65[a]	11.36±0.87[b]	12.71±0.62[c]	11.57±1.30	9.1-13.7
Epididymal size					
Weight (g)	6.46±1.17[a]	8.15±1.53[b]	10.11±0.69[c]	8.57±1.82	4.6-11.7
Epididymal-testicular weight ratio (g/g)	0.16±0.02[a]	0.15±0.02[a]	0.13±0.01[b]	0.15±0.02	0.11-0.19
Epididymo-somatic index (g/kg)	0.46±0.08[a]	0.49±0.10[ab]	0.54±0.05[b]	0.51±0.08	0.28-0.64

[a,b,c] *Means ± standard deviation with different superscripts are significantly different (p<0.05)*

Table 2: Correlation coefficients* (r) in matrix of relationships among testicular and related variables and associated sperm counts.

Variables	**GSI**	**SC**	**SL**	**TW**	**TLL**	**TMC**	**EW**	**ESC**	**TSC**	**BW**
Gonado-somatic index (GSI)	1									
Scrotal circumference (SC)	0.58	1								
Scrotal length (SL)	0.59	0.84	1							
Testicular weight (TW)	0.80	0.77	0.72	1						
Testicular longitudinal length (TLL)	0.60	0.74	0.70	0.89	1					
Testicular mid-circumference (TMC)	0.76	0.77	0.76	0.96	0.89	1				
Epidydymal weight (EW)	0.77	0.68	0.64	0.92	0.83	0.89	1			
Cauda epididymal sperm count (ESC)	0.25	0.34	0.30	0.36	0.35	0.37	0.39	1		
Testicular sperm count (TSC)	0.22	0.15	0.20	0.16	0.12	0.17	0.21	0.55	1	
Body weight (BW)	0.15	0.60	0.49	0.70	0.76	0.69	0.60	0.27	0.04	1

**r ≥ 0.3 is significant (p < 0.05)*

values (0.4-2.8 g/kg) than the former (Abba, 2011; Abba and Igbokwe, 2012). The incidence of testicular hypoplasia and atrophy had been reported recently among our Sahel goat populations (Mshelbwala and Igbokwe, 2010; Igbokwe *et al.,* 2011), suggesting the need to determine the appropriate testicular sizes with optimal sperm output. This report provides such data on Sahel bucks with optimal ESC in the semi-arid Sahel region and agrees with some limited data earlier reported of some testicular size parameters of mature RS and BW bucks (Raji *et al.,* 2008). RS bucks, aged 24-30 months, had mean testicular weight of 83.7 g at mean body weight of 17.8 kg (Daudu, 1984); and the GSI was 4.7 g/kg (Abba, 2011). At 12-36 months, RS bucks weighed 22.5-30.0 kg with testicular weights of 55.0-103.0 g (Raji *et al.,* 2008) and GSI of 2.4-3.4 g/kg (Abba, 2011); whereas, BW bucks weighed 18.6-28.9 kg with testicular weights of 50.0-100.5 g (Raji *et al.,* 2008) and GSI of 2.6-3.5 g/kg (Abba, 2011). In the present study, the testicular weights of Sahel bucks were 31.4-86.2 g where body weights were 12.0-25.0 kg giving the GSI as 2.0-4.5 g/kg.

The age for sexual maturity for Sahel bucks is 3-12 months (Maina *et al.,* 2006a). The earliest age reported for adequate sperm production was 5 months in WAD bucks (Bitto and Egbunike, 2006a) and 5.7 months in British bucks (Ahmad and Noakes, 1996). Tropical male goats were reported to reach puberty and sexual maturity at 3.2 and 4.4 months of age, respectively (Payne and Wilson, 1999), but male Nubian goats reached puberty at 8 months of age (Chakraborty *et al.,* 1989). The Sahel bucks, in this study, were expected to have adequate sperm output at >18 months, if the testicular sizes were appropriate and testicular hypoplasia was precluded. As the bucks got older up to 30 months of age, the sperm output was increased because the bucks had increasing BW and testicular size. The testes of Sahel goats grow along with the body until mature body weight is attained at ≥30 months of age (Mshelbwala, 2010). Previous reports indicated that testicular size positively correlated with sperm production in bulls, rams, boars, stallions (Foote, 1978; Amann, 1981), WAD and Cashmere goats (Walkden-Brown *et al.,* 1994; Ugwu, 2009). Therefore, the TW and related size parameters would be imperative in selecting sire that is reproductively sound as proposed by Ott and Memon (1980). Scrotal size parameters (SC, SL) correlated with BW, TW and sperm output in this study, similar to earlier reports (Ott and Memon, 1980; Bongso *et al.,* 1982; Bilaspuri and Singh, 1992, 1993; Al-Ghalban *et al.,* 2004; Alade *et al.,* 2009a,b; Oyeyemi *et al.,* 2012; Shoyombo *et al.,* 2012). The testicular size parameters (TW, GSI, TLL, TMC) increased with age indicating that testicular growth was sustained within the period because of expansion of the seminiferous tubular epithelium and associated increase in sperm output, indicating that more mature bucks will have better sperm ejaculation to enhance siring capacity. While BW of the bucks increased with age, BW had low insignificant correlation with TSC and ESC, suggesting that BW variation may not be an absolutely efficient predictor of sperm output in the bucks, in spite of the finding that BW had strong correlation with testicular size (TW, TLL, TMC) and moderate correlation with scrotal size (SC, SL). The strong correlation between TSC and ESC justifies the dependence of ejaculate sperm count on testicular sperm production and cauda epididymal sperm reserve. However, there was lack of remarkable dependence of testicular sperm count on testicular and related size variables among the goats. It may be apparent that biometric evaluations may establish assumptions of testicular sperm production, but assessment of quality of sperm ejaculates will still be necessary to have enhanced assurance of reproductive soundness of siring Sahel bucks.

In conclusion, the data in this report highlighted a relationship between morphometric parameters associated with size of testis and the sperm reserve that could influence semen quality in terms of sperm output. The impact is anchored on the provision of reference data for the locality on the testicular size measurements which may be useful in prediction of adequate sperm production and normospermia during preliminary selection of sires for breeding purposes.

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RISK FACTORS ANALYSIS AND IMPLICATIONS FOR PUBLIC HEALTH OF BOVINE TUBERCULOSIS IN THE HIGHLANDS OF CAMEROON

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Abstract

Bovine tuberculosis (TB) is a neglected zoonosis of cattle that is prevalent but under-investigated in Cameroon. Based on epidemiological data of the disease, this study was designed to assess the risks and public health implications for zoonotic M. bovis infection in cattle and humans in the highlands of Cameroon. Evidence of bovine TB in cattle in the study region was confirmed by the following surveys: abattoir slaughter meat inspection and TB lesion detection rates of 0.20% – 1.69% (over 60.94% of all pathologies that warranted partial or whole carcass condemnation were due to TB lesions); sero-prevalence rates of 37.17% and comparative cervical tuberculin test estimations of 4.67% – 7.15%, 12.02% – 15.67% and 20.56% – 24.98% at the ≥ 4mm, ≥ 3mm and ≥ 2mm cut-off points, respectively. Genomic deletion analysis of cultured isolates showed evidence of M. tuberculosis from suspected cattle tissue and M. bovis from infected human sputa while spoligotyping identified five cattle M. bovis strains including four unique spoligotype patterns that had not been previously described. The study revealed that the presence of infected animals, age, sex, breed and husbandry practices served as significant ($P<0.05$) risks to the prevalence and exposure of bovine TB in cattle. The feedbacks from cattle professionals suggested that there was high possibility of cattle to cattle and cattle to human transmission of bovine TB through intimate and repeated cattle / cattle and cattle / human interactions, unawareness of TB control measures, consuming unpasteurised milk and eating raw meat. The findings of this study have important public health implications requiring prompt and decisive actions from the Cameroonian authority towards controlling zoonotic bovine TB in both humans and animals.

Key words: Bovine tuberculosis, epidemiology, risk factors analysis, public health implications, Cameroon.

ANALYSE DES FACTEURS DE RISQUE ET IMPLICATIONS POUR LA SANTE PUBLIQUE DE LA TUBERCULOSE BOVINE DANS LES HAUTES TERRES DU CAMEROUN

Résumé

La tuberculose bovine (TB) est une zoonose négligée des bovins qui est répandue mais sous-étudiée au Cameroun. Sur la base des données épidémiologiques de la maladie, cette étude a été conçue pour évaluer les risques et les implications pour la santé publique de l'infection zoonotique à M. bovis chez les bovins et les humains, dans les hautes terres du Cameroun. Des preuves de tuberculose chez les bovins dans la région de l'étude ont été confirmées par les investigations suivantes : inspection des viandes d'abattage et taux de détection des lésions de tuberculose de 0,20% - 1,69% (plus de 60,94% de toutes les pathologies qui justifiaient une condamnation partielle ou totale des carcasses étaient dues aux lésions de tuberculose) ; les taux de séroprévalence de 37,17% et des estimations des tests cervicaux comparatifs à la tuberculine de 4,67% - 7,15%, 12,02% - 15,67% et 20,56% - 24,98% respectivement aux valeurs limites de ≥ 4mm, ≥ 3 mm et ≥ 2 mm. L'analyse de délétion génomique des isolats cultivés a révélé une présence de M. tuberculosis dans les tissus de bovins suspectés et M. bovis dans les crachats des humains infectés, tandis que le spoligotypage a identifié cinq souches de M. bovis chez les bovins, y compris quatre traits de spoligotypes uniques qui n'avaient pas été décrits auparavant. L'étude a révélé que la présence d'animaux

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infectés, l'âge, le sexe, la race et le système d'élevage ont servi de facteurs de risque significatifs (P <0,05) pour la prévalence et l'exposition à la tuberculose bovine chez les bovins. Les évaluations faites par les professionnels de l'élevage permettent de penser à une forte possibilité de transmission bovin-bovin et bovin-homme de la tuberculose bovine, suite à des interactions intimes et répétées bovin – bovin et bovin-homme, à la méconnaissance des mesures de contrôle de la tuberculose, à la consommation de lait non pasteurisé et de viande crue. Les résultats de cette étude ont des implications importantes pour la santé publique, qui nécessitent des mesures promptes et décisives de l'autorité camerounaise en faveur du contrôle de la tuberculose bovine zoonotique chez les humains et les animaux.

Mots-clés : Tuberculose bovine ; Epidémiologie ;Analyse des facteurs de risque ; Implications pour la santé publique ; Cameroun

Introduction

The use of tuberculin skin test to diagnose bovine tuberculosis (BTB) in cattle is a non-implemented control policy in Cameroon but the existence of BTB in livestock has since been considered based on the identification of TB lesions during slaughter / meat inspections (Doufissa, 1993; MINEPIA, 2002; Awah-Ndukum *et al.,* 2005). The zoonotic implications of BTB are neglected in Cameroon and scanty attentions are given to the implementation of existing laws on its control and reduction. Information on the disease epidemiology and interface in animals and humans is largely unknown. There is dearth of reliable national data on the magnitude and distribution of BTB in Cameroon but many habits such as the consumption of unpasteurised fresh cow's milk and milk products, the consumption of raw meat and close human – livestock contact (Awah-Ndukum *et al.,* 2010) have been cited in many communities. These factors favour the emergence and transmission of zoonotic TB due to M. bovis in animals and humans (Cosivi *et al.,* 1998; Biet *et al.,* 2005; Etter *et al.,* 2006; Shitaye *et al.,* 2007). Furthermore, there is evidence of other conditions also existing in different husbandry systems that promote the transmission of M. bovis between infected cattle and "clean" cattle and / or humans. Long trekking, large herds and frequent overcrowding of cattle (O'Reilly and Daborn, 1995; Omer *et al.,* 2001; Ayele *et al.,* 2004; Neil *et al.,* 2005) often associated with transhumance usually create ideal environments for increase herd-to-herd, and thus animal-to-animal contacts from different areas.

The lack of active BTB surveillance in Cameroonian livestock, close human – animal interactions in the management of herds and a culture of keeping animals until they die of disease or old age in traditional pastoral systems provide suitable conditions for the emergence and transmission of animal diseases including Zoonosis (e.g. BTB). The potential threat of zoonotic TB due to M. bovis to human health, even at a low prevalence cannot be overemphasized. In fact little is also known of the extent of BTB in Cameroon and the risky practises in the different farming systems. The prevalence and risk analysis of BTB in cattle and humans in Cameroon are under-investigated, and the threat of human M. bovis infection has not been investigated in the country, and the hazards of zoonotic BTB is increasingly becoming a major concern to the veterinary and medical services. In order to determine the involvement of BTB in the morbidity and mortality of TB in Cameroon, broad multidisciplinary investigations need to be conducted on the sources and identification of TB causing agents, routes of transmission, associated risk factors and epidemiology of TB among humans and animals.

The Western and Adamawa highland regions are among the top populated areas in Cameroon with over 100 humans and 20 cattle per Km2 and are bordered by BTB endemic countries (Nigeria, Chad and Central African Republic). Based on the comprehensive investigation of the prevalence and tubercle bacilli strains of bovine TB in cattle in the highlands of Cameroon (Awah-Ndukum *et al.,* 2005, 2010, 2012a, 2012b), studying the public health implications of BTB in cattle as major keys to modelling control of the disease in

livestock and humans in Cameroon is therefore fundamental.

In this context, this study built on records of high prevalence of BTB in cattle; various tubercle bacilli strains isolated in cattle and very closed human-livestock contacts in the highland areas of Cameroon (Awah-Ndukum *et al.,* 2005, 2010, 2012a, 2012b) to review risk factors for exposure and transmission of zoonotic BTB infection to cattle and cattle professionals, and its public health significance.

Materials and methods

Evidence of bovine TB in cattle in the Adamawa plateaux and Western highland regions was confirmed by the following surveys: abattoir slaughter meat inspection and TB lesion detection rates of 0.20% – 1.69% (over 60.94% of all pathologies that warranted partial or whole carcass condemnation were due to TB lesions); sero-prevalence rates of 37.17% and comparative cervical tuberculin skin test estimations of 4.67% – 7.15%, 12.02% – 15.67% and 20.56% – 24.98% at the ≥ 4mm, ≥ 3mm and ≥ 2mm cut-off points, respectively. Genomic deletion analysis of cultured isolates showed evidence of M. tuberculosis from suspected cattle tissue and M. bovis from infected human sputa while spoligotyping identified five cattle M. bovis strains including four unique spoligotype patterns that had not been previously described (Awah-Ndukum *et al.,* 2005, 2010, 2012a, 2012b, 2013).

Information on risk factors for bovine TB in individual cattle and herd level was obtained by examination of individual animals, flocked / grouped animals and a questionnaire interview to cattle professionals / handlers. Evaluation of cattle – human interactions, analysis of human specimens for M. bovis and questionnaire interview of cattle professionals were used to obtain risk factors for zoonotic bovine TB in cattle professionals / handlers.

Risk factors for the exposure and transmission of bovine TB infection of cattle and cattle handlers were examined by structured questionnaire surveys conducted to collect information on a range of variables. The questionnaires were divided into the following main sections: animal management and husbandry practices as well as demographic information, lifestyle, habits and awareness of zoonotic TB of willing cattle professionals in the study regions. The targeted cattle handlers included ethnic groups with a tradition of handling cattle and cattle products including the Fulani, Bororo, Foulbe, butchers, cattle owners and herdsmen / herdsboys, "Buyam sellams", and other cattle professionals. The professionals were visited in their communities, herds, abattoirs, meat shops, cattle markets and other targeted sites. Animal health and production technicians (veterinarians, para-veterinarians and some extension agricultural workers) were surveyed at their offices or job sites to appreciate their level of awareness and implementation of the existing legislation on bovine TB control. Also, regular visits were carried out to the local hospitals that carried out conventional human TB control programmes and equipped or associated with mycobacterial laboratories. Willing TB patients diagnosed through Ziehl-Neelsen microscopy of acid-fast bacilli in their sputa responded to questions about their lifestyle and interactions with animals as well as donated sputa (78 cases) for mycobacterial culture and molecular studies (Awah-Ndukum *et al.,* 2011).

The highland regions of Cameroon are made up of many multi-cultural communities (whether involved in traditional livestock production or not) with distinct vernaculars. Considerable time and patience were needed to obtain maximum cooperation of the traditional cattle professionals; and where necessary a trusted and knowledgeable intermediary was engaged. The questionnaire surveys were done during the same period as the Tuberculin Skin Test (TST) and covered the period of March to September 2009 and May to September 2010. Selection of individual cattle and herds has been described earlier (Awah-Ndukum *et al.,* 2012a, 2012b). Briefly, this was done by the random-number generation method of cattle keeping communities, cattle owners and locations of herds from records of animal livestock vaccination campaigns (CBPP, Pasteurellosis, black quarter, lumpy skin disease) at the regional delegations of

MINEPIA (Ministry of Livestock, Fisheries and Animal Industries). The selection procedure took into consideration costs, season and road accessibility (including distance and time to trek to herds) and local cultural beliefs because a farmer's willingness to participate was never guaranteed. All owners and handlers of cattle herds subjected to TST were also included in this survey.

Predesigned questionnaires were pre-tested on 81 willing animal handlers (Awah-Ndukum *et al.,* 2010) who were not included in the main survey. All respondents in the study signed a consent and confidentiality form. Explanatory analysis of 645 of approximately 1000 filled questionnaires was performed (namely 489 of 600 cattle handlers; 72 of 250 animal health and production technicians and 84 of 150 human TB patients).

Statistical analysis

The data obtained in this study were the non-parametric category. The responses for each main area of the questionnaires were classified, frequencies estimated and these data were used to explain the variables (risk factors). The data was sorted / categorized using Microsoft excels before exporting to SPSS Statistics 18 (SPSS Inc. Chicago, USA) for further analysis. The degree of association or difference between variables was compared by running the McNemar test (which approximates the chi-square test of significance) on the different classes of the data.

Results

Prevalence of bovine tuberculosis in cattle

The trend and prevalence of bovine TB by detection of TB lesions, TST and anti-bovine TB antibody assay in the Adamawa Plateaux and Western highland regions of Cameroon has been described (Awah-Ndukum *et al.,* 2005, 2010, 2012a, 2012b). Molecular characterisation of tubercle bacilli strains isolated from suspected cattle tissues

Table 1 : Prevalence bovine TB in cattle and genomic deletion analysis of cultured isolates from cattle tissue and human sputa in the highland regions of Cameroon (Awah-Ndukum *et al.,* 2012b)

Region	Tuberculin skin test (BTB reactors)						Anti-BTB antibody detection	
	≥ 4 mm cut-off		≥ 3 mm cut-off		≥ 2 mm cut-off			
	Herd	Individual	Herd	Individual	Herd	Individual	Herd	Individual
ADP N=363	11.11 (0.3 -48.3)	0.43a (0-1.11)	11.11 (0.3 -48.3)	0.40a (0-1.04)	22.22 (2.8 -60.0)	0.79a (0-1.70)	90	29.75±4.70
WHC N=1018	48.39 (30.2-66.9)	9.89[b] (8.06-11.72)	11.11 (0.3 -48.3)	17.84b (15.49-20.19)	51.61 (33.1 -69.8)	23.13b (20.54-25.72)	100	43.24±4.61
Total N=1381	40.00 (24.90-56.7)	7.41 (6.02-8.79)	48.39 (30.2-66.9)	13.25 (11.47-15.04)	45.00 (29.3 -61.5)	17.26 (15.36-19.25)	95	37.17±3.33
ADP N=727	38.26[a] (20.21 - 56.32)	4.10[b] (2.66 - 5.54)	40.00 (24.90-56.7)	5.32b (3.69 - 6.95)		7.07a (5.21 - 8.93)		
WHC N=2126	68.53[a] (57.94 - 79.12)	8.63a (6.51 - 8.44)		13.64a (12.18-15.10)		14.92b (13.40-16.43)		
Total N=2853	60.24 (50.73 - 69.76)	7.48 (6.51 - 8.44)		11.52 (10.35-12.69)		12.92 (11.69-11.15)		

** Detection of TB lesions in WHC : 0.46 (0.43 – 0.50) Awah-Ndukum et al (2012b); (0.18 - 4.25) Awah-Ndukum et al (2010)*

Table 2 : Genomic deletion analysis of tubercle bacilli strains isolated in cattle tissues and human sputa in Cameroon (Awah-Ndukum *et al.,* 2011)

Region of difference and clonal complex	Cattle (n=169)		Humans (n=78)	
	Present (Intact)	Absent (deleted)	Present (Intact)	Absent (deleted)
RD9 (nc=169; nh=78)	3# (13)	103 (113)	41 (55)	3 (14)
RD4 (nc=162; nh=78)	4 (22)	54 (81)	21 (45)	2 (19)
African 1 (nc=95; nh=29)*	5 (41)	13 (62)	0 (27)	0 (27)

**African 1 deletion typing was carried out on all isolates from cattle and humans that showed evidence of RD4 being absent.*
nc : number of isolates from cattle;nh : number of isolates from humans
 # :isolates have strictly intact or deleted RD
( ): isolates have both intact and deleted RD

Table 3 : Spoligotype patterns of M. bovis strains isolated from slaughtered cattle tissue in North West Cameroon (Awah-Ndukum *et al.,* 2013)

Isolates	Spoligotype pattern	Name	RD Af1
H37Rv	1111111111111111111001111111111110000111111	M. tuberculosis	Intact
H2O	0000000000000000000000000000000000000000000		
2122/97	1101101000001110111111111111111111111100000	M. bovis	Deleted
1	1101111000000000011111111111101111101100000	SB2161	
12	1101111000000000011111111111101111111100000	SB0953	Deleted
1	1101111000000000011111111111100000011111100000	SB2664	Deleted
1	1101111000000000011111111110010111111111100000	SB2162	
1	1101001100111000111111111111110111111111100000	SB2663	

Spoligotype pattern: 1 = presence of a spacer; 0 = loss of a spacer. The patterns were identified according to spoligotype database www.Mbovis.org (Smith and Upton, 2012).

and infected human sputa has been described (Awah-Ndukum *et al.,* 2011, 2013). However, the data are summarised in Tables 1, 2 and 3.

Overview of questionnaire surveys and responses

Overall, 64.5% of 1000 questionnaires issued in the survey were filled and returned for analysis. Over 81.5% of 600 cattle professionals, 28.8% of 250 animal health and production technicians and 56% of 150 human TB patients provided data to investigate risk factor analyses for zoonotic bovine TB in cattle and humans by way of questionnaires. The responses showed that cattle business in Cameroon was mainly carried out by men aged between 15 and 80 years (average age: 41.67±12.19); 10.5% of them were single and 89.5% married (monogamy: 61.3%; polygamy: 38.7%). Respondents had been in cattle business for an average period of 23.7 ±15.7 years and less than 12% of them had post-primary educational levels. The primary occupations of the respondents were mainly related to cattle rearing, cattle production and handling of fresh cattle products (Table 5).

Overall, there was high level (over 87.1%) of interaction between respondents and their cattle (and other livestock). Most cattle were managed in extensive and traditional pastoral husbandry systems in moderately sized herds (40 < herd ≤ 80 animals). The animals usually lived to old age (over 9 years), usually trekked up to 10 km for grazing and drinking mixed often with other herds and depended on natural pasture and water points (Tables 6). Fresh milk and meat consumption

Table 4 : Degree of interaction of cattle handlers with their cattle and other animals – human and anim

Variable	Proportion (%) of respondents (n = 489)	Contact between cattle handlers and animals (n=489: ADP=302, WHC=187)		
		Own other livestock spp	Daily contact with cattle herds	≥ 1 day contact with cattle herds per week
Highland region				
ADP	61.8	8.3[a]	87.8[a]	12.3[a]
WHC	38.2	73.8[b]	86.1[a]	13.9[a]
Total	100	33.3	87.1	12.9
Occupation				
Cattle breeder	57.7	35.5[c]	83.7[b]	16.3[bd]
Butcher	22.5	28.2[d]	97.3[c]	2.7[c]
"Buyam sellem"	7.6	64.9[e]	75.7[d]	24.3[b]
Herdsmen	12.3	13.3[d]	91.7[c]	13.3[d]
Education (school level)				
None	46.6	22.4[f]	90.3[df]	9.6[e]
Primary school	35.6	39.7[g]	86.8[df]	13.2[e]
Secondary school	10.4	53.2[h]	74.2[e]	25.8[f]
Post-secondary	1.4	71.4	71.4	28.6
Not indicated	5.9	44.8[h]	96.5[f]	3.5[g]
Duration in cattle business				
≤ 10 years	28.8	38.3[jk]	82.3[gj]	17.7[hk]
10 < X ≤ 20 years	18.6	36.3[jk]	93.4[h]	6.6[j]
20 < X ≤ 30 years	18.2	30.3[jk]	91.0[h]	9.0[j]
30 < X ≤ 40 years	16.4	27.5[jk]	90.0[hjk]	10.0[hjk]
X > 40 years	11.9	25.9[j]	79.3[jk]	20.7[jk]
Not indicated	6.1	40.0[k]	86.7[hjk]	13.3[hjk]

n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands
a-k: different letters in same column are significantly different (P<0.05)

al risk factors

Herd size (n=292: ADP=205, WHC=87)			Number of herds (n=304: ADP=208, WHC=96)	
Small herd (≤ 40 animals)	**Moderate herd (40<animals≥80)**	**Large herd (> 80 animals)**	**≤ 2 herds**	**≥ 3 herds**
22.0	49.3	28.8	79.3	20.7
42.5	52.9	4.6	83.3	16.7
28.1	50.3	21.6	80.6	19.4
24.8	50.0	22.3	80.2	19.8
50.0	50.0	0.0	100.0	0.0
40.0	60.0	0.0	100.0	0.0
38.0	44.0	18.0	80.0	20.0
18.1	52.6	0.0	79.3	20.7
44.0	42.9	13.2	83.8	16.2
50.0	55.0	0.0	71.4	28.6
25.0	75.0	0.0	80.0	20.0
0.00	80.0	20.0	0.0	0.0
45.3	46.9	7.8	83.6	16.4
42.6	51.1	6.4	92.2	7.8
25.4	50.8	23.7	86.2	13.8
10.7	58.9	30.4	78.6	21.4
16.0	44.0	40.0	42.0	58.0
25.0	50.0	25.0	60.0	40.0

Table 5 : Animal management and practices of cattle professionals – animal risk factors

Variable	Contact of owned cattle with other cattle (n=318:Yes =315, No=3)	Average daily trekking distance for grazing and drinking (n=316: ADP=208, WHC=108)		
		Long distance (>10km)	Moderate distance (5km < X ≥ 10km)	Short distance (≤ 5 Km)
Highland region				
ADP	100.0	0.0	69.2	30.3
WHC	96.8	24.1	17.6	59.3
Total	99.1	8.2	51.58	40.2
Occupation				
Cattle breeder	98.9	9.2	53.6	36.0
Butcher	100	50.0	0.0	50.0
"Buyam sellem"	100	0.0	0.0	75.0
Herdsmen	100	0.0	46.9	53.1
Education (school level)				
None	99.5	7.0	58.1	34.9
Primary school	98.9	9.9	50.5	39.6
Secondary school	96.0	14.8	22.2	63.0
Post-secondary	100	100	0.0	0.0
Not indicated	100	0.0	0.0	100
Duration in cattle business				
≤ 10 years	98.4	8.1	37.1	54.8
10 < X ≤ 20 years	98.1	8.8	43.9	47.4
20 < X ≤ 30 years	100	7.8	56.2	35.9
30 < X ≤ 40 years	100	8.3	60.0	31.7
X > 40 years	100	2.9	74.3	22.9
Not indicated	94.1	5.9	47.1	47.1

*n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands, * = Poor health and production*

Husbandry system and practice (n=347: AD=228,WHC=119)			Reasons for exploiting cattle herds (n=295: ADP=199,WHC=96)		
Extensive	**Semi-intensive / traditional husbandry**	**Intensive**	**Old age**	**Income generation**	**Poor productivity***
14.0	82.0	3.9	87.9	6.5	40.7
84.0	12.6	3.4	77.1	40.6	45.8
38.0	58.2	3.7	84.4	17.6	42.4
38.1	57.9	4.0	84.9	17.9	39.8
66.7	0.0	33.3	50.0	50.0	50.0
71.3	28.6	0.0	66.7	50.0	50.0
32.2	66.1	1.7	86.1	8.3	58.3
29.8	53.9	0.4	89.4	11.8	37.6
39.5	54.1	5.5	79.3	23.9	38.0
50.0	38.2	11.8	50.0	50.0	50.0
40.0	60.0	0.0	60.0	40.0	60.0
28.6	42.9	28.6	0.0	100.0	0.0
41.0	51.3	7.7	73.3	28.3	31.7
40.0	53.3	6.6	84.0	20.0	40.0
35.8	64.2	1.5	88.8	12.7	46.0
20.4	61.1	0.0	86.7	8.3	55.0
32.7	69.2	0.0	90.6	15.6	37.5
56.0	36.0	8.0	78.6	21.4	35.7

Table 6 : Factors affecting meat / milk consumption habit of cattle owners – human risk factors

Variable	Milks cow after each calving for human consumption (n=295: ADP=196, WHC=99)	Fresh milk consumption (n=475: ADP=296, WHC=179)			Meat consumption (n=477: ADP=297, WHC=180)	
		Pasteurised or raw	Raw milk*	Drinking fresh milk since birth	Raw meat	Suya and Kilishi†
Highland region						
ADP	93.4	82.8[a]	66.9[a]	65.2[a]	16.8[a]	97.3[a]
WHC	92.9	79.6[b]	50.8[b]	65.7[a]	14.3[a]	50.5[b]
Total	93.2	81.6	60.8	65.4	15.9	79.4
Occupation						
Cattle breeder	95.2	88.3[c]	71.1[c]	85.0[b]	13.2[b]	81.3[c]
Butcher	100.0	62.6[d]	37.4[d]	55.1[c]	15.5[b]	79.1[de]
"Buyam sellem"	80.0	68.6[d]	31.4[d]	57.1[c]	5.7[b]	60.0[e]
Herdsmen	82.0	95.0[ce]	75.0[c]	85.0[b]	31.7[c]	85.0[d]
Education (school level)						
None	96.0	90.5[f]	79.7[e]	88.7[d]	22.0[d]	83.9[d]
Primary school	88.6	74.8[g]	47.4[f]	68.4[e]	9.9[e]	79.6[g]
Secondary school	86.4	68.3[g]	38.0[g]	58.3[f]	13.3[e]	73.3[h]
Post-secondary	100	83.3	16.7	66.7	0.0	66.7
Not indicated	100	73.1[g]	46.2[f]	46.1[g]	11.5[e]	53.8[j]
Duration in cattle business						
≤ 10 years	82.8	72.5h	41.3[h]	62.3[h]	13.7[f]	79.9[k]
10 < X ≤ 20 years	91.7	81.8hj	54.5[h]	76.1[jm]	14.8[f]	75.0[k]
20 < X ≤ 30 years	98.4	85.1j	70.1[jm]	78.2[jm]	14.8[f]	78.4[k]
30 < X ≤ 40 years	96.8	87.5j	73.7[jk]	85.0[jk]	18.7[f]	83.7[k]
X > 40 years	93.6	91.2j	86.0[k]	91.2[k]	21.1[f]	86.0[k]
Not indicated	100	84.0hj	64.0[hm]	80.0[hm]	16.0[f]	76.0[k]

n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands
a-k: different letters in same column are significantly different (P<0.05)
** = Almost everybody who drank raw milk also drank boiled milk. But still prefer raw milk and sometimes drinks directly from the cow's udder.*
† = "Suya" is meat briefly roasted over hot charcoal or fire. Kilishi is a traditional Cameroonian sun dried (and sometimes briefly roasted) meat. The products are not standardized and are prepared by marinating thin sheets (kilishi) or small bundles (suya) of meat in slurry of mixed local ingredients.

Table 7: Knowledge of cattle handlers about zoonotic bovine tuberculosis and its modes of transmission – Animal to humans risks and vice versa

Variable	Mode of transmission of bovine TB to humans						
	Know bovine TB is zoonotic	Knows Milk is a vehicle	Knows raw meat is vehicle	Knows inhalation is route (aerosol)	Knowledge of number of modes of transmission		
					≥ 1 mode	≥ 2 modes	3 modes
Highland region							
ADP	51.7[a]	14.4[a]	43.6[a]	11.4[a]	48.3	18.5	2.7
WHC	62.0[b]	14.0[a]	46.4[a]	19.5[b]	59.2	18.4	2.2
Total	55.6	14.3	44.7	14.5	52.4	18.4	2.5
Occupation							
Cattle breeder	53.1[cd]	19.3[b]	43.6[bc]	16.4[c]	51.3	23.3	3.6
Butcher	63.0[c]	7.4[c]	55.6[b]	12.0[d]	62.0	11.1	1.8
"Buyam sellem"	67.6[c]	5.9[c]	35.3[c]	8.8[d]	41.2	8.8	0.0
Herdsmen	46.7[d]	8.3[c]	36.7[c]	13.3[d]	48.3	11.7	0.0
Education (school level)							
None	46.0[e]	14.3	36.6[d]	13.8[e]	43.3	18.8	2.7
Primary school	57.7[f]	14.9	47.6[e]	13.1[e]	55.4	17.9	2.4
Secondary school	85.2[g]	13.1	70.5[f]	16.4[e]	80.0	20.0	2.0
Post-secondary	100	33.3	66.7	50.0	83.3	50.0	16.7
Not indicated	58.6[f]	3.4	41.4[e]	17.2[e]	51.7	10.3	0.0
Duration in cattle business							
≤ 10 years	56.6	5.9[d]	44.8	13.2	50.7	11.8	1.5
10 < X ≤ 20 years	58.2	17.6[f]	48.4	12.1	55.0	19.8	4.4
20 < X ≤ 30 years	52.9	13.8[e]	39.1	16.1	51.7	17.2	0.0
30 < X ≤ 40 years	62.0	25.3[g]	50.6	17.7	57.0	31.6	5.1
X > 40 years	39.3	14.3[e]	32.1	12.5	39.3	17.9	1.8
Not indicated	64.3	14.3[e]	57.1	17.9	67.9	17.9	3.6

n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands {(n=477: ADP=298, WHC=179)}
a-e: different letters in same column are significantly different (P<0.05)

Table 8 : Knowledge of cattle handlers about management of bovine tuberculosis in their cattle – Animal risk factors

		Action taken if bovine TB is suspected in animal (n=369: ADP		
Variable	**Diagnosis of TB in own or adjacent herds (n=439: ADP=269, WHC=170)**	**Allow to enter food chain**	**Do Nothing or Don't know**	**Treatment of animals***
Highland region				
ADP	24.5[a]	11.6[a]	4.1[a]	72.8[a]
WHC	38.2[b]	53.9[b]	14.7[b]	18.8[b]
Total	29.8	23.3	7.0	58.0
Occupation				
Cattle breeder	23.0[ce]	22.9[c]	8.1[c]	60.8[c]
Butcher	51.1[d]	29.8[c]	3.5[d]	50.9[d]
"Buyam sellem"	17.2[e]	25.0[c]	25.0[e]	0.0
Herdsmen	35.8[C]	18.0[b]	4.0[d]	56.0[d]
Education (school level)				
None	24.4[f]	17.7[e]	6.2[f]	65.5[e]
Primary school	31.8[f]	28.7[f]	6.1[f]	53.9[f]
Secondary school	40.7[g]	36.7[g]	16.7[f]	30.0[g]
Post-secondary	50.0	60.0	0.0	40.0
Not indicated	44.0[g]	20.0[f]	10.0[f]	40.0[g]
Duration in cattle business				
≤ 10 years	32.5[hj]	35.3[h]	8.2[gh]	43.5[hl]
10 < X ≤ 20 years	33.7[hj]	18.5[j]	6.1[gh]	55.4[jl]
20 < X ≤ 30 years	27.9[k]	17.3[j]	6.7[gh]	70.7[jm]
30 < X ≤ 40 years	31.5[jk]	19.7[jk]	5.6[g]	66.2[jkm]
X > 40 years	26.4[k]	15.7[j]	7.8[gh]	64.7[hjm]
Not indicated	14.8[j]	40.9[hk]	9.1[h]	36.4[kl]

** = In Cameroon, animals suspected or diagnosed with bovine TB should be immediately removed from the herd and culled. The veterinarian carries out post mortem examinations to detect TB lesions. However, some respondents still attempt to treat with drugs (usually mixed regimens) including ethno-veterinary drugs and customary practices methods*

n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands;

a – m: different letters in same column are significantly different (P<0.05); Bovine TB in herd = 30 < X ≤ 40 years Vs. Not indicated: X2=4.000; P=0.039 and If sick Bovine TB report to vet: ≤ 10 years Vs. 10 < X ≤ 20 years: X2=5.062; P=0.021

=268,WHC=101)	Action if animal dies of suspected bovine TB (n=441:ADP=292,WHC=149)			
Small herd (≤ 40 animals)	**Allow to enter food chain**	**Large herd (> 80 animals)**	**Dispose of carcass**	**Don't know**
13.1	28.1[a]	6.8[a]	71.6[a]	37.0[a]
19.8	28.9[b]	42.9[b]	78.5[a]	11.4[b]
14.9	28.3	19.1	73.9	28.3
12.0	28.9[c]	13.9[c]	69.9[b]	31.2[c]
15.8	26.7[c]	33.7[d]	85.1[bc]	18.8[d]
50.0	26.7[c]	26.7[d]	100[bc]	6.6[e]
26.0	32.2[d]	15.3[c]	66.1[d]	3.4[e]
12.0	32.2[e]	12.1[e]	64.0[e]	39.7[f]
14.8	24.7[f]	17.5[f]	82.5[f]	22.7[g]
26.7	27.3[g]	29.6[g]	93.2[f]	6.8[h]
20.0	40.0	80.0	60.0	0.0
16.0	16.3[h]	58.3[h]	75.0[fg]	8.3[h]
15.3	31.4[j]	19.0[j]	81.8[h]	19.8[m]
24.6	25.9[j]	27.2[j]	75.3[hjk]	23.5[jm]
6.7	25.3[j]	21.7[j]	62.6[jkm]	38.5[jk]
8.5	30.1[j]	9.6[j]	79.4[hk]	30.1[jm]
19.6	29.1[j]	10.9[j]	61.8[km]	41.8[j]
22.7	25.0[j]	28.6[j]	78.6[hjk]	17.9[km]

Table 9 : Impact of bovine tuberculosis on cattle business and knowledge of cattle handlers about control of bovine tuberculosis

Variable	Previous contact with TB*		Impact of bovine TB to cattle business (n=272: ADP=151, WHC=121)	
	Human TB (n=425: ADP=292, WHC=133)	Bovine TB (n=466: ADP=297, WHC=169)	Drop in production‡ and poor health	Economic loss
Highland region				
ADP	73.8[a]	49.8[a]	15.2[a]	92.1[a]
WHC	80.0[b]	34.9[b]	33.9[b]	66.9[b]
Total	75.8	44.4	23.5	80.9
Occupation				
Cattle breeder	83.91[c]	39.9[c]	30.6[ce]	65.3[c]
Butcher	40.74[d]	64.8[d]	11.9[d]	99.0[d]
"Buyam sellam"	89.47[c]	15.4[e]	23.8[e]	90.5[d]
Herdsmen	62.96[e]	43.3[c]	34.6[c]	76.9[e]
Education (school level)				
None	76.1[f]	36.3[f]	27.5	72.5
Primary school	86.3[fg]	51.5[g]	20.6	84.1
Secondary school	90.2[g]	45.8[g]	16.2	86.5
Post-secondary	100	83.3	75.0	75.0
Not indicated	93.3[g]	57.7[g]	22.7	95.5
Duration in cattle business				
≤ 10 years	80.0	43.8	17.1	84.1
10 < X ≤ 20 years	82.3	48.9	24.6	82.5
20 < X ≤ 30 years	74.1	40.0	22.7	84.1
30 < X ≤ 40 years	86.8	52.6	29.3	73.2
X > 40 years	81.8	36.8	30.8	73.1
Not indicated	100	39.3	31.4	81.2

n = total number of respondents, ADP = Adamawa Plateau, WHC= Western highlands; a-d: different letters in same column are significantly different (P<0.05)

**= Respondents with previous contact and knowledge of bovine TB also had previous knowledge of human TB*

†= In Cameroon: all animal disease cases should be reported to the Veterinary services but condemnation during slaughter / meat inspections is generally considered by cattle handlers as the main Government policy to remove affected animals and products from the food chain. Also, these control measures are not enforced in the animals' and rural environments but attempts are made at treating all animal diseases including tuberculosis (by any means possible). Thus this category also includes respondents who consider treatment as a control.

‡= Loosing animals (drop in total number of animals owned) was the most important factor in the category

	Awareness and implementation of bovine TB control† (n=449: ADP=282, WHC=167)		
Don't know or no effect	**Report disease to Veterinary service**	**Don't know**	**Approved of condemnation**
6.0	7.5[a]	92.5[a]	98.6[a]
15.7	25.9[b]	74.1[b]	89.2[b]
10.3	13.3	86.7	95.1
18.5[ac]	18.7[c]	82.0[c]	94.6[c]
1.0[b]	2.9[d]	81.9[c]	94.3[c]
9.5[c]	6.4[e]	54.8[b]	93.6[c]
11.5[c]	3.9[de]	88.5[d]	100[d]
16.7	13.9	90.0	94.3
6.5	10.0	90.0	96.3
10.8	16.3	83.7	97.8
0.0	60.0	40.0	50.0
0.0	18.8	81.3	96.5
12.5	10.6	98.4	94.4
7.0	16.0	84.0	97.7
11.4	9.0	91.0	90.5
12.2	11.8	88.2	97.3
7.7	11.1	88.9	98.2
6.3	35.7	64.3	91.7

habits of cattle professionals, their level of awareness and knowledge of the modes of transmission of TB including zoonotic bovine TB, their awareness and applications of the national bovine TB control programme as well as the impact of TB on the cattle industries are shown in Tables 7 – 10.

Risk factors of zoonotic bovine tuberculosis to humans

Responses of handlers of cattle and cattle products

The interviewed groups were predominantly ethnic (Fulani, Bororo, Foulbe) and non-ethnic groups with a passion for animal rearing composed of cattle breeders, herdsmen (employed by cattle breeders but may also own cattle with the herds in their care), and handlers of fresh animals products (Butchers, "Buyam Sellams"). All respondents knew about human TB and usually referred to it simply as "strong cough". Many respondents (55.6%) agreed that bovine TB can be transmitted from animals to humans, acquiring the knowledge from elders, personal observations and previous encounters, "Njangies" (Group of persons with common objectives and meeting regularly to improve targeted social, economic, cultural and or religious goals) and various communal socio-cultural meetings, formal and informal communications (radios, televisions, NGOs), extension workers as well as contacts with veterinary staff and hospital consultations. Most respondents had close and repeated interactions (daily) with animals for very long durations (over 10 years) (Table 6) and generally consumed cooked meat and boiled milk to minimize disease transmission (Table 8). However, many of them admitted to have consumed or still consume fresh raw meat (16%) and milk (61%). "Suya" and "Kilishi" (Suya is meat briefly roasted over hot charcoal or fire. Kilishi is a traditional sun dried (sometimes briefly roasted) meat. The products are not standardized and are prepared by marinating thin sheets (kilishi) or small bundles (suya) of meat in slurry of mixed local ingredients) consumption which might have been poorly prepared due to demand pressures were also common (80%) especially in cattle markets and other cattle gathering points such as "stops" during transit. Many cattle professionals knew at least one (>52%) mode of the common vehicles of transmitting bovine TB to humans (Table 9): raw fresh milk (14.3%), raw meat (44.7%) and aerosol (14.5%). Over 93% of respondents accepted milking their cows after every calving for home consumption and or sell the milk. Furthermore, over 87% of respondents reported daily practices of at least one activity that favours the transmission of zoonotic bovine TB to humans. These activities were mainly related to handling cattle and their products such as directing the animals to pasture, water points and other animal gathering centres (cattle markets, vaccinations, dipping), restraining for routine and clinical manipulations, milking, slaughtering and dressing of carcasses (Table 6– 8).

As for action taken on sick and dead animals due to bovine TB (Table 9), many respondents (up to 28%) reported consuming meat from sick or recently dead animals (cause not usually known) and or passing the meat into the human / public food chain (sell, share). They were also ignorant of the risks of exposure, transmission and potential hazards of zoonotic diseases including bovine TB. However, many respondents were not aware of what action to take if TB was suspected in their herds (60%) or if animal death (30%) was associated to bovine TB. Nonetheless, over 80% of respondents had encountered human TB (family members, friends, colleagues) and over 44% bovine TB in owned herd(s) or adjacent herds. Indeed, about 30% of respondents claimed to have noticed animals in their herds or adjacent herds with symptoms characteristic of bovine TB namely chronic cough (long lasting cough or strong cough as it was commonly described) associated with fever, weight loss / emaciation, lethargy and also death with presentation of tubercle lesions during meat inspection and during dressing of meat.

Most cattle professionals (over 80%) did not enforce or apparently did not know how to enforce the known bovine TB control measures in their animals' or herds' "semi-natural" environments (Table 10). Some respondents attempted any practice

(chemotherapy, traditional pastoral husbandry and ethno-Veterinary interventions) to keep sick animals alive (Table 10). Negative impact of bovine TB on cattle business was a common response (81%) and condemnations (95%) at slaughter / meat inspections was viewed as the main bovine TB control measure in the country. Lack of knowledge of reporting suspected bovine TB cases to the veterinary service (≈ 87%) were also noted (Table 32). Loss of animals ("bankruptcy of living banks") was the most important aspect cited as impact to cattle production and health. Overall, the ethnicity and characteristics of communities in the highlands, primary occupation, educational level and duration in cattle business of the respondents were important determining risks factors for potential exposure and transmission of bovine TB from cattle to cattle professionals.

Risk factors for bovine tuberculosis in cattle

The responses of cattle handlers showed that over 70% of cattle were kept in moderate to large herds (Table 8). Generally, many cattle lived to very old age (>84%) and in traditional extensive (38%) and semi-extensive (58%) systems of (Table 28). Many cattle trekked at least 5 km daily for grazing and drinking (60%) and there were plenty of herd / herd mixing and animal / animal contacts (99%) when different herds of same or different owners meet (Table 7) during grazing, at drinking points and other animals gathering centres. Although many respondents (≈30%) recognised bovine TB in their herds or adjacent herds, most cattle professionals (>86%) reported that they did not implement the known control measures (eg restricting movement of infected cattle, reporting disease to the veterinary services, testing of animals, etc) in their communities which were predominantly rural and in the animals' "semi-natural" or "semi-wild" environments (Tables 10 and 11). Many respondents were interested in more animals (increasing the size of their "living banks") but were not apparently aware of the negative impact of bovine TB on their animals' health and production (Table 11).

Responses of animal health technicians

The response of Animal health technicians (Veterinary Doctors and Nurses) in this survey showed that all of them were aware of the legislature governing bovine TB control in animals. All of them confirmed that strict control were not implemented, citing free and unchecked movements of cattle, lack of routine tuberculin skin test (TST) and TST and slaughter policy in the country. The responses of most veterinarians across the study confirmed frequently identifying TB lesions (>70.4%) during post mortem examination of slaughtered and dead cattle; upward trends (52.1%) of TB lesions in abattoirs and limited (43%) collaborations with Medics in the control of TB (Zoonotic TB) in the country. However, less than 45% of them agreed that the slaughter / meat inspection practices were satisfactory for the monitoring of bovine TB in the country. Partial condemnation of affected carcass was common. Whole carcass condemnations were also done if TB lesions were in multiple organs / tissues though with difficulties due to lack of enforcement to execute safety actions and lack of resources to compensate cattle professionals (butchers and cattle breeder). The meat inspectors reported that lack of cooperation from the butchers or animals owner was common and often required forced seizures of condemned carcasses (partial or whole), such as involving the police and local administrations.

Responses of human tuberculosis patients

The interviewed human TB patients reported that they frequently drank fresh milk pasteurised and or not pasteurised (32.1%), not pasteurised (19.8%), ate raw meat (2.5%) and ate "Suya" and or "Kilishi" (61.3%). Some (17.3%) were aware of zoonotic bovine TB while the others (82.7%) claimed ignorance or were having the information for the first time during this study. The respondents were composed of livestock professionals and non-professionals.

Discussion

Risk factors for bovine tuberculosis in cattle

Bovine TB is widespread in cattle herds in the highlands of Cameroon. The

numbers of TST positive reactors are indeed high in some areas (Awah-Ndukum *et al.,* 2012a; Awah-Ndukum *et al.,* 2012b). Very high circulating levels of anti-bovine TB antibodies in cattle have been detected in the regions (Awah-Ndukum *et al.,* 2012a) indicating that cattle are widely exposed to bovine TB. Also, Awah-Ndukum et al., (2012a, 2012b) reported significantly higher prevalence rates of up to 16.90% vs. 5.97% and up to 22.77% vs. 5.91% respectively, for two separate comparative TST carried out at 12 months interval of each other when severe tuberculin cut-off points compared to the OIE recommended ≥ 4-mm value for skin responses were used in the Cameroonian environment. TST positive cattle may be considered and treated as "open" cases of TB and potentially transmission sources of the infection to other animals and humans (O'Reilly and Daborn, 1995). Therefore, the animals and communities in these study areas were and are at risk of infection with M. bovis. In the study regions, higher herd infection rates (≥1 TST positive cattle) were recorded in large herds compared to small herds (Awah-Ndukum *et al.,* 2012a; Awah-Ndukum *et al.,* 2012b), suggesting that the risk of bovine TB infection in a herd of cattle increases with increase in herd size. Infected new animals introduced into the herd may contaminate in-contact animals followed by a lateral spread within the herd and also to other herds at "meeting" points. The increase in risk of cattle being infected with bovine TB with increase in herd size has been reported earlier (Cook *et al.,* 1996; Ameni et al., 2003; Asseged *et al.,* 2004). The prevalence of bovine TB in cattle in most of Africa is influenced by cattle breed, housing and gathering of animals at grazing, watering and other sites (Cosivi *et al.,* 1998; Ayele *et al.,* 2004; Ameni and Erkihun, 2007). In this study many cattle professionals kept their animals in open pasture but they also reported criss-crossing the regions with their animals for grazing and watering; and confirmed that there were / are several occasions for close and repeated contacts between different herds. Therefore, the potential for maximum transmission and prevalence of bovine TB is high in cattle in the study regions and hence the high prevalence rates of TST and anti-bovine TB antibodies reactors recorded (Awah-Ndukum *et al.,* 2012a; Awah-Ndukum *et al.,* 2012b).

Adult and old cattle have been reported to be most affected and at higher risks of bovine TB infection (Philips *et al.,* 2003; Cleaveland et al., 2007; Tschopp et al., 2009). It has also been suggested that very little or no transmission during extensive communal grazing, even on crowded pastures and spread of the disease may occur during daily gathering of many animals from different herds at one site (Tschopp et al., 2009). However, gatherings of cattle at drinking points, vaccination centres, communal night enclosures and cattle markets among others have been found to positively influence transmission of bovine TB (O'Reilly and Daborn, 1995; Cosivi *et al.,* 1998; Ayele et al., 2004). Also, young animals could be infected if grazed with heavily infected older animals (Francis, 1971) and infected cows shedding mycobacteria in their milk could be sources of early infection of young animals (Hojle, 1990; Tschopp et al., 2009). In this study, traditional extensive and semi-extensive animal husbandries were the common animal management practices reported by the respondents, where they keep all animals together irrespective of age and sex. This agrees with earlier findings (Awah-Ndukum *et al.,* 2012b) which recorded higher bovine TB prevalence rates in cattle and herd infection rates in extensive and semi-extensive management systems; irrespective of the herd size. Also, anti-bovine TB antibodies had been observed in about 95% of tested herds and in significant proportions of tested cattle irrespective of sex, age, breed, herd size, husbandry practices and health status (Awah-Ndukum *et al.,* 2012a), suggesting that all class of animals were highly exposed to M. bovis and the risk of developing bovine TB could be very high with serious public health implications. Keeping other livestock in close contact with cattle could increase the risk of positive tuberculin reactions in cattle (Etter *et al.,* 2006; Tschopp *et al.,* 2009) and over a third of cattle professionals in this survey kept livestock other than cattle (fowls, sheep, goats) in mixed herding with their cattle. A

strong association between typical and atypical mycobacterial prevalence rates in cattle in the study regions has been described earlier (Awah-Ndukum *et al.,* 2012a; Awah-Ndukum *et al.,* 2012b). This suggests high risks of exposure and transmission of multiple mycobacteria infections.

Widespread bovine TB, husbandry practices (such as large herds, gathering of animals in common spots), animal host factors (such as sex, old and aging animals), stressors (such as environmental factors, drought, long trekking to grazing and drinking spots) are the major factors influencing bovine TB infection in cattle reported in the study. These findings strongly explain the high TST and anti-BTB antibody positive reactor rates and the many M. bovis strains that have been recorded in the highland regions of Cameroon (Awah-Ndukum *et al.,* 2012a; Awah-Ndukum *et al.,* 2012b; Awah-Ndukum *et al.,* 2013).

Public health significance of bovine tuberculosis

Human TB is high and increasing in Cameroon (Noeske *et al.,* 2004; Ane-Anyangwe *et al.,* 2006) but investigation of M. bovis infection in humans is sparse. Bovine TB and zoonotic TB due to M. bovisare poorly investigated and controlled in most of Africa including Cameroon. However, multiplex PCR based deletion typing of RD9 and RD4 showed evidence of M. bovis from infected human sputa and M. tuberculosis from cattle tissues (Awah-Ndukum *et al.,* 2011) suggesting possible interactions and transmission between TB in cattle and humans which needs detailed investigation. In fact M. bovis has been reported in one human TB subject in West Cameroon (Niobe-Eyangoh et al., 2003) further indicating that zoonotic bovine TB is a real public health problem that is under estimated and underinvestigated. Five spoligotypes of M. bovis (SB0953 and four unique patterns) in cattle was widely distributed in the Western highlands; and the new patterns (SB2161, SB2664, SB2162, SB2663) have not been previously detected (Awah-Ndukum *et al.,* 2013). The potential implication for drug resistance of human TB due to these M. bovis strains in Cameroon cannot be overemphasised. Indeed, cattle to human and human to human transmission of M. bovis infection (Gibson *et al.,* 2004) and drug resistant of human TB cases related to several strains of M. bovis isolates have been reported (Gibson *et al.,* 2004; Diguimbaye-Djaibe *et al.,* 2006). A possible interface between bovine TB and human TB could therefore be suggested given that there are also many opportunities for close and repeated human-livestock interactions and cattle keeping plays important socio-economic roles in many communities in the country.

Tuberculous lesions in cattle carcasses have been widely recorded during meat inspection in abattoirs in Cameroon (Doufissa, 1993; Awah-Ndukum *et al.,* 2005; Awah-Ndukum *et al.,* 2010; Awah-Ndukum *et al.,* 2012b) including the study regions. Most cattle handlers were aware of bovine TB, its zoonotic nature and public health implications but many of them were also not informed about the modes of transmission of the disease. Butchers and other cattle professionals with low level of education were least knowledgeable and most at risk of exposure to zoonotic bovine TB. The populations' demands for meat supply are high and continually increasing and the public health threats of zoonotic bovine TB infection are very real. Consumption of unpasteurised milk was common in this study but the proportion is expected to be even higher in further rural areas where poverty levels are high, literacy levels are low, and dependency on livestock keeping is high.

Inhalation of cough spray from infected animals and ingestion of infected animal products are the main routes M. bovis can be transmitted to humans (Francis, 1971; Goodchild and Clifton-Hadley, 2001; Cassidy, 2006). However, a cow with tuberculous mastitis can shed viable tubercle bacilli to contaminate milk from up to 100 clean cows when milk pooling and bulk transportation is used (Hassanain *et al.,* 2009). The presence of bovine TB and M. bovis in milk therefore represents major sources of infection to humans and nursing calves. Most cattle professionals milked their cows and pooled the milk in units for home consumption as well as sell to local people or process locally

to various products (eg: sour milk, nounou, kounou – locally processed milk products equivalent to yogurt, cheese, butter) usually without sufficient initial heat treatment. Due to cattle professionals' poor comprehension of the hazards of zoonotic bovine TB the risks of contamination are high and there are real potential health hazards to consumers.

Furthermore, the study regions were mainly rural and the questionnaire survey showed varying levels of awareness of zoonotic bovine TB and understanding of the modes of transmission of the disease from cattle to humans, close and repeated human-cattle interactions and the consumption of raw milk and raw meat. Approximately 85% of cattle and 82% of human populations in Africa have been estimated to live in areas where animal TB is either partially controlled or uncontrolled (Ayele *et al.,* 2004; Shitaye *et al.,* 2006). Also, isolated detection of M. bovis from patients with pulmonary TB has been reported in parts of Africa including Egypt, Nigeria, Democratic Republic of Congo, and Tanzania (Cook *et al.,* 1996; Cosivi *et al.,* 1998; Kazwala *et al.,* 2001; Cadmus *et al.,* 2006; Zinsstag *et al.,* 2006; Regassa *et al.,* 2008) while epidemiologic associations between tuberculin-positive cattle and human TB have been reported in Zambia (Cook *et al.,* 1996; Regassa *et al.,* 2008). Elsewhere in the world, human TB due to M. bovis and the transmission of M. bovis from animals to man and back to animals have been reported (Fritsche *et al.,* 2004; Thoen and LoBue, 2007; Hlavsa *et al.,* 2008; Tsegaye *et al.,* 2010). There are therefore lots of circumstantial and real evidence for transboundary and intraregional transmission of bovine TB as well as threats and hazards of zoonotic TB due to M. bovis to human health in most of Africa including Cameroon.

Bovine TB has severe public health significance but it is neglected in Cameroon. The inadequacies of control measures and poor understanding of the epidemiology of TB in cattle and humans in Cameroon poses additional risks for humans particularly because of high HIV/AIDS prevalence rates (Noeske *et al.,* 2004; WHO, 2011) and for cattle if the caretakers are infected (Ocepek *et al.,* 2005; Berg *et al.,* 2009). Also, the risk of multiple strains and or dual M. bovis and M. tuberculosis infections in cattle and humans cannot be ruled out. HIV/AIDS is the greatest single risk factor for developing active tuberculosis (Raviglione *et al.,* 1993; Fatkenheuer *et al.,* 1999; Pesut *et al.,* 2008), due to decrease immunity while other risk factors (poverty, malnutrition, stress and smoking) become more pronounced and even multiplied in patients in TB risk groups (Pesut *et al.,* 2008). The poor implementation of existing legislatures governing bovine TB control and neglect of a broad approach in the control of TB in animals and humans particularly the inappropriate of collaboration between veterinary and medical professionals was widely reported in the survey.

A multidisciplinary approach mimicking the One Health Initiative approach, (Kahn *et al.,* 2007; Anonymous, 2009; Valat, 2009) where people's awareness is enhanced through continuous education of cattle professionals and the general public on hazards of TB and the potential risk of bovine TB, proper food (animal products) handling, good animal husbandry, personal hygiene and maintaining a healthy environmental is urgently needed in Cameroon to control TB. Targeted controlled movements of infected animal populations, concerted veterinary and medical efforts to maximise TB detection rates, active involvement of the populations at risk, and good health systems are essential for effective control of the disease in animals and humans. Biomedical education of people on TB symptoms in animals and humans may greatly contribute to the prevention of TB (animal TB and human TB) spread within the community.

Limitations to bovine tuberculosis control in Cameroon

Although poorly implemented, the control of animal TB in Cameroon is mainly through the regulation of animal movements, slaughter / meat inspection and post mortem examination of carcasses. TST testing and elimination of infected animals (test-and-slaughter policy) which have been used effectively in other parts of the world (Good, 2006; Palvik, 2006a; Palvik, 2006b; OIE, 2009)

are not practicable in the country due to lack of compensatory policy if infected animals are eliminated. However, testing and segregating with phase slaughtering of infected animals could be economically and technically achievable as alternative to the direct test and slaughter method (WHO, 1994). Meanwhile, the need for intensification of meat inspection, good reliable abattoir records, traceability of cases to farms and regions of origin and validation of various diagnostic tests under the Cameroon environment for direct screening of live animals for bovine TB; and real epidemiologic status cannot be overemphasised.

Animal TB and human TB affects all sectors of the community but the poor are most vulnerable (Larson, 2000a; Larson, 2000b). Also, the impact of the interrelationships between human / animal / environment / disease factors and the interplay between them are not quite understood. Government resources for monitoring animal diseases including zoonoses are poor and the capacity of the private sector to assume the responsibility is also very lacking. Tackling the problems of monitoring animal diseases and impact of animal / human interactions such as zoonotic bovine TB on human health can be achieved through collaborative veterinary and medical programmes involving policy makers, animal and human populations at risk of exposure and transmission. Furthermore, urban and peri-urban (compared to rural) livestock farming is fast growing and most livestock professionals and handlers in Cameroon are small-scale farmers, nomads, herders, wage labourers, and unemployed youths who are also poor and uneducated. Supported development, education, capacity enforcements, and constant reassessment of cattle handlers' / professionals' level of awareness are therefore critical to good human health, improving animal health and productivity through good husbandry practices as well as poverty alleviation. Further investigations are needed to assess and evaluate the extent of the problem and design feasible cost-effective control methods.

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PREVALENCE OF CHARACTERISTIC MACROSCOPIC LUNG PATHOLOGIES IN PIGS AT SLAUGHTER IN MAKURDI, BENUE STATE, NIGERIA

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Abstract

Considering the importance of pork in daily nutrition and livelihood of the people, the relatively large pig population in Benue State, coupled with others from neighbouring states, this cross-sectional study was aimed at estimating the prevalence of definable macroscopic lung lesions in pigs slaughtered in Makurdi. Lesions were scored and grossly characterized based on the type and severity. Test of association between the prevalence of lung pathologies and the different studied variables were carried out using bivariate analysis. Overall, 36.4% (146/401) pigs had lung pathologies comprising emphysema 5 (1.3%), enzootic pneumonia 11 (2.7%), pleuropneumonia 12 (3.0%), tuberculosis 3 (0.8%) and verminous pneumonia 115 (28.7%). Age of pig was statistically significant (P <0.0001) for lung pathologies. Furthermore, lung score revealed that 83 (20.7%) and 63 (15.7%) of the lungs were mildly and severely affected, respectively resulting either in partial or total condemnation. Apparently healthy lungs 255 (63.6%) were more likely to be free from lesions (P <0.0001). Tuberculous and pneumonic lesions were the most frequent lung lesion observed in pigs at slaughter in Makurdi, with a moderately high prevalence rate. This study acts as a pointer to field disease condition and has demonstrated even cases of public health importance hence, reminding meat inspectors, veterinarians and pig farmers in Nigeria of the importance of swine respiratory diseases and their possible risk factors. Finally, this study calls for an in-depth surveillance into lung pathologies of pigs, as well as the need to educate pig farmers in Nigeria on the importance of veterinary care in order to reduce the impacts of respiratory diseases on porcine production through appropriate and effective control measures.

Keywords: Macroscopic lung pathologies, Prevalence, Respiratory diseases, Slaughtered pig, Benue State, North central Nigeria

PREVALENCE DE PATHOLOGIES PULMONAIRES MACROSCOPIQUES CARACTERISTIQUES DES PORCS A L'ABATTOIR DE MAKURDI DANS L'ETAT DE BENUE AU NIGERIA

Résumé

Compte tenu de l'importance du rôle des porcs dans l'alimentation quotidienne et comme sources de revenu et de la population porcine relativement grande de l'État de Benue et des effectifs porcins des États voisins, la présente étude transversale avait pour but d'établir une estimation de la prévalence des lésions pulmonaires macroscopiques définissables chez les porcs abattus à Makurdi. Les lésions ont été classifiées et caractérisées de manière grossière selon le type et la sévérité. Le test d'association entre la prévalence de pathologies pulmonaires et les différentes variables de l'étude a été effectué en utilisant une analyse bivariée. Dans l'ensemble, 36,4% (146/401) des porcs avaient des pathologies pulmonaires, dont l'emphysème 5 (1,3%), la pneumonie enzootique 11 (2,7%), la pleuropneumonie 12 (3,0%), la tuberculose 3 (0,8%) et la pneumonie vermineuse 115 (28,7%). L'âge du porc était statistiquement significatif (P <0,0001) pour les pathologies pulmonaires. De plus, la classification des poumons a révélé que 83 (20,7%) et 63 (15,7%) des poumons étaient légèrement et sérieusement affectés, entraînant une condamnation partielle ou totale. Les poumons apparemment en bonne santé 255 (63,6%) étaient plus susceptibles d'être indemnes de lésions (P <0,0001). Les lésions tuberculeuses et pneumoniques étaient les lésions pulmonaires les plus fréquemment identifiées parmi les lésions observées à l'abattoir. Nos résultats révèlent des taux de prévalence relativement élevés des lésions respiratoires caractéristiques des porcs. Ces résultats sont une

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indication de la présence de pathologies sur le terrain et ont révélé même des cas d'importance pour la santé publique, rappelant ainsi aux inspecteurs de viande, aux vétérinaires et aux éleveurs de porcs au Nigeria l'importance des maladies respiratoires des porcs et leurs éventuels facteurs de risque. Enfin, cette étude préconise une surveillance approfondie des pathologies pulmonaires des porcs ainsi que la nécessité de sensibiliser les éleveurs de porcs au Nigeria à l'importance des soins vétérinaires afin de réduire les impacts des maladies respiratoires sur la production porcine par des mesures de contrôle appropriées et efficaces.

Mots-clés : Pathologies pulmonaires macroscopiques ; Prévalence ; Maladies respiratoires ; Porc abattu ; État de Benue ; Centre-nord du Nigeria

Introduction

Respiratory tract infections are a common occurrence in both animals and humans. Respiratory diseases have constituted significant constraints in swine production the world over (Blaha, 1992). Many of such diseases produce pathologies in the lungs resulting in some degrees of economic losses. Lung pathologies as a common finding in pigs during carcass examination (Schuh *et al.,* 200) are associated with high incidence of pneumonia (Christensen and Cullinane, 1990; Kozak *et al.,* 2004). The pathology observed is an indication of the stage of the infection rather than its severity (Pijoan, 2002) and closely reflects the occurrence of specific pathogens (Grest, 1995). When histology was compared with bacteriology as a "Gold standard" in the diagnosis of swine respiratory diseases, a specificity of 76% and 77%, respectively were observed (Hurnik *et al.,* 1993). On the other hand, slaughterhouse inspection is widely used to assess the subclinical respiratory health status of pigs. The information obtained is valuable in monitoring lesion incidence, severity, identification of risk factors and in the implementation of adequate control measures (Maes *et al.,* 2001; Fraile *et al.,* 2010).

A review of some of the literature on porcine respiratory diseases shows that characteristic pathological changes are mostly observed in the lungs and are dependent on the causal organisms involved.

In Mycoplasma infections, the cranio-lateral pulmonary lobes, especially the apical and cardiac lobes are thickened, acquiring a dense structure characterized by purple-red to reddish-brown or grey discolorations with meaty consistency (Ross, 1999).

In Pasteurella multocida involvement (enzootic pneumonia), the apical and anterior portion of the diaphragmatic lobes will show diffused dark-red to grey discolourations with other parts appearing rose-red or almost normal. In most cases there is a clear demarcation between the intact and the affected portion. Sometimes, exudates and pleuritis may be seen in the respiratory tracts (Schwartz, 2002).

Actinobacillus pleuropneumonia (APP) involvement manifests as fibrinous haemorrhagic, necrotizing pneumonia of the entire lung wing, characterized by deposits of fibrin on the visceral pleural surface resulting in adhesions to the parietal surface (Taylor, 1999).

In porcine respiratory and reproductive syndrome (PRRS), the lung surface is mottled with light and dark brown areas with thickened lung tissue (Batrell, 2008).

The most pathognomic signs observed in verimous pneumonia caused by *Ascaris suum* or Metastrongylus species are bronchitis, hyper-secretion of mucous, hypertrophy of the bronchiolar musculature and emphysematous consolidation of the diaphragmatic lobes. In some cases, the presence of greyish white adult worms may be seen in the affected lung (Lora, 2001).

Tuberculosis of pigs is characterized by caseous or tumour-like lesions in the affected lung. This depends on whether it is caused by bovine or avian type of tubercle bacilli (Sharma and Adlakha, 2003).

The utmost effects of porcine respiratory diseases cannot be over emphasized. Respiratory infections cause reduction in productivity and pork quality. They can result in chronic unthriftiness or death, reduced appetite and feed conversion efficiency, which in turn

may culminate in poor-doer-syndrome and/or stunting in recovered pigs. Rectal prolapse may result from chronic coughing. The effects of respiratory infections could be compounded by undesirable environmental factors such as dust and humidity (Stark, 1992).

The public health impact of swine respiratory infections can be felt not only by people working in pig farms but also consumers of pork as well (Blaha *et al.,* 1994; Larsson *et al.,* 1991; Tielen *et al.,* 1996).

The economic assessment of the impact of respiratory diseases on the performance of livestock is majorly based on their prevalence. Respiratory diseases may result in carcass trim loss due to extensive adhesions in the thoracic cavity (Lawhorn, 1998). Treatment and control measures costs heighten the economic losses. These diseases can increase the number of days from weaning to finish thereby incurring more costs.

In Nigeria, pork is one of the cheapest sources of animal protein especially among the people of Benue State; however, published data on the prevalence of respiratory lesions in pigs is rare. As part of our investigation on verminous pneumonia and associated helminthes of pigs at slaughter (Shima *et al.,* 2014), this study in addition was aimed at determining the prevalence status of characteristic gross lung pathologies in slaughter-weight pigs in Makurdi.

Materials and Methods

A cross-sectional study was conducted from October to December, 2009 at Wurukum market pig slaughter slab in Makurdi, the Capital of Benue State of Nigeria. All pigs presented for slaughter were observed physically for obvious signs of respiratory disease. Since the daily slaughter rate at the slaughter slab was 25 pigs on average, lungs from at least 20 randomly sampled pigs were subjected to macroscopic examination at the slaughter slab (Fablet and Bougeard, 2009). Post-mortem examination of the carcasses and organs was conducted using visual inspection, palpation and systematic incision with special attention to the lungs. Characteristic lung lesions were carefully identified and recorded for each animal. Pneumonic lesions consisted of dark red to grayish purple areas of consolidation in the apical, cardial, accessory and/or diaphragmatic lobes. Tuberculous lesions were characterized by caseous or tumour-like structures on the surface of the affected lungs. The types of lesions were characterized as described by previous studies (Pointon et al., 1990; Taylor, 1999; Lora, 2001; Schwartz, 2002; Sharma and Adlakha, 2003; Batrell, 2008). A modified system of lung scoring (Madec and Kobisch, 1982) using visual estimation of the affected lung tissue was used. Lesions were scored depending on the extent of the lesion of each lobe: Good = no lesion; Mild = lesion affecting < 25% of the lobe surface, Severe = lesion above 25% of the surface affected. Categorical demographic information for each pig sampled was recorded.

Statistical Analysis: Data collected were analyzed using STATA version 12. Chi squared statistics was used to determine the association between lung pathologies and the different study variables of interest that included source, breed, age and sex of the pigs. The tests were two-tailed and statistical significance was set at $P<0.05$.

Results

Table 1 below depicts the prevalence profile of lung pathologies by source, breed, sex and age of the pigs. Of the 401 pigs examined, 146 (36.4%) had lung lesions which comprised emphysematous lungs 5 (1.3%), enzootic pneumonia 11 (2.7%), pleuro-pneumonia 12 (3.0%), tuberculosis 3 (0.8%) and verminous pneumonia 115 (28.7%), respectively were recorded.

According to source of the pigs, 145 (36.2%) were sourced within Benue State and 256 (63.8%) were bought from neighbouring states of Adamawa, Kaduna, Nasarawa, Plateau and Taraba. The distribution of the lung pathologies by origin of the pigs showed that pigs sourced from neighbouring states combined had the highest prevalence (80; 20.0%) compared with those sourced within Benue State (66; 16.5%). However, there was no statistically significant ($P = 0.080$) association

between the prevalence of lung pathologies and sources of the pigs.

Similarly, more mixed pig breeds (247; 61.6%) were slaughtered than the local breed (154; 38.4%). Breed-specific prevalence revealed the highest prevalence of lung lesions in mixed pig breeds (89; 22.2%) than in the local breed (57; 14.2%). There was no statistically significant (P = 0.848) difference in the prevalence of lung lesions between mixed and local pig breeds.

Furthermore, more female pigs (261; 65.1%) were slaughtered compared to male ones (140; 34.9%). As regards sex-specific prevalence, highest prevalence of lung pathologies occurred in female pigs (94; 23.4%) than in males (56; 13.0%). This association was however not statistically significant (P = 0.866).

Table I: Prevalence profile of lung pathology according to source, breed, sex and age of the pigs

Variables	N (%)	Types of Lung pathology					Overall	χ^2	p-value
		[a]Ep n (%)	[b]Pp n (%)	[c]Eph n (%)	[d]VP n (%)	[e]Tb n (%)			
Source									
Benue	145(36.2)	4 (1.0)	4 (1.0)	2 (0.5)	55 (13.7)	1 (0.3)	66(16.5)	9.83	0.080
Other*	256(63.8)	7 (1.8)	8 (2.0)	3 (0.8)	60(15.0)	2 (0.5)	80(20.0)		
Breed									
Local	154(38.4)	3 (0.8)	4 (1.0)	1 (0.3)	48 (12.0)	1 (0.3)	57(14.2)	2.01	0.848
Mixed	247(61.6)	8 (2.0)	8 (2.0)	4 (1.0)	115(16.7)	2 (0.5)	89(22.2)		
Sex									
Female	261(65.1)	8 (2.0)	9 (2.2)	4 (1.0)	71(17.7)	2 (0.5)	94(23.4)	1.88	0.866
Male	140(34.9)	3 (0.8)	3 (0.8)	1 (0.3)	44 (11.0)	1 (0.3)	56(13.0)		
Age									
Juvenile	100(24.9)	2 (0.5)	2 (1.9)	0 (0.0)	37 (9.3)	0 (0.0)	41(10.2)	39.84	0.000
Adolescent	251(62.6)	7 (2.7)	6 (1.5)	4 (1.0)	59(14.7)	0 (0.0)	76(19.0)		
Adult	50 (12.5)	2 (0.5)	4 (1.0)	1 (0.3)	19 (4.7)	3 (0.8)	29(7.2)		
Score									
Severe	61(15.2)	8(2.0)	7(1.8)	3(0.8)	42(10.5)	3(0.8)	63(15.7)	429.84	0.000
Mild	85(21.2)	3(0.8)	5(1.3)	2(0.5)	73(18.2)	0(0.0)	83(20.7)		
Good	255(63.6)	0(0.0)	0(0.00)	0(0.0)	0(0.00)	0(0.0)	0(0.00)		
Overall	401(100.0)	11(2.7)	12(3.0)	5(1.3)	115(28.7)	3(0.8)	146(36.4)		

*Key: [a]Enzootic pneumonia; [b]Pleuropneumonia; [c]Emphysema; [d]Verminous pneumonia; [e]Tuberculosis; *other states*

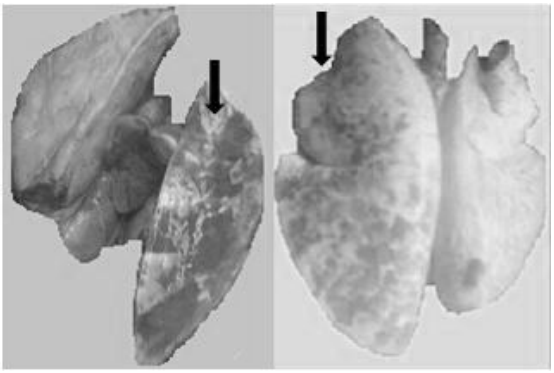

Figure 1: Pleuropneumonia (Pp) like lesion showing fibrinous haemorrhagic, necrotizing pneumonia of the entire lung wings with other half appearing intact.

Figure 2: Enzootic pneumonia (Ep) like lesion showing apical and anterior portions of the diaphragmatic lobes with diffused grey to rose-red discolourations.

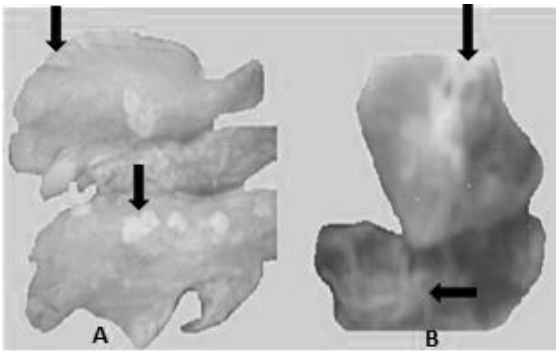

Figure 3: Verminous pneumonia like showing greyish consolidations and the presence of thread-like greyish white worms.

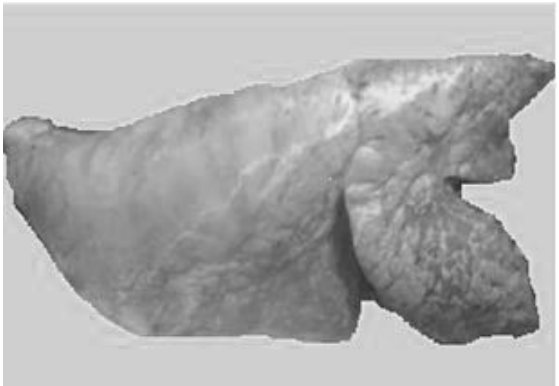

Figure 4: Lesion classified as emphysema. The entire lung appearing grossly enlarged with clear demarcations between lobes.

Figure 5: Tuberculous like lesions showing characteristic tumour-like structures in the lung.

The age distribution shows that adolescent pigs constituted the highest proportion (251; 62.6%) followed by juvenile pigs with (100; 24.9%), while adults were lowest (50; 12.5%). Age-specific prevalence indicated that adolescent pigs had the highest prevalence of lung lesions (76; 19.0%) followed by juvenile pigs with 41 (10.2%), while adult pigs had the lowest (29; 7.2%). There was a statistically significant ($P < 0.0001$) association between the prevalence of lung pathologies and the age group of the pigs.

Lastly, lung score revealed that lungs with "severe pathology" accounted for 63 (15.7%) followed by pigs with "mild lesions" (83; 20.7%), while 255 (63.6%) were apparently healthy or without noticeable gross lesions. The test of significance indicated that lungs that were scored "good" were more likely to be free from lesions ($P < 0.0001$).

Discussion

Porcine respiratory diseases are common in Nigeria but researchers have paid insufficient attention to them. In Nigeria presently, there is a scarcity of published data on respiratory pathologies of swine. But meaningful preventive and control strategies only can be effectively formulated when such diseases are identified and their epidemiology is understood. This study was aimed at providing updates on the prevalence and characteristic macroscopic lung pathologies in slaughter-weight pigs in Makurdi, Benue State, Nigeria.

The findings of this survey indicated that there was a high prevalence of lung lesions in pigs (36.4%) at slaughter in Makurdi during the studied period. The lesions comprised majorly pneumonias and tuberculosis. In addition, parasitic or verminous pneumonic

lesions constituted the most frequent observed lesion compared to tuberculous and pneumonic lesions of other forms reported in this study. These lung pathologies were the significant cause of lung condemnation at slaughter.

The prevalence of 36.4% recorded in this study is similar to the findings of Dailidavicience, (2008) who reported 36.7% prevalence in slaughtered pigs. In New Zealand, Christensen and Cullinane, (1990) reported prevalence of 55%, and Pointon, (1995) reported between 30 - 50%, whereas in Swiss and Switzerland, (Wunderli (1993) and Grest (1995) respectively reported prevalence ranges of between 21-24%, respectively. The highest prevalence of 70% was reported at a Minnesota slaughter plant (Bahnson *et al.,* 1992). The differences in the prevalence by implication could be due to differences in climate of different geographical locations and in management practices. More respiratory problems occur during cold and wet seasons (Stark *et al.,* 1992). The high prevalence of 36.4% could be due to the fact that this study was carried out during late rainy season (October) and in the dry cold season months of November and December. This agrees with the finding that wet and cold conditions often predispose to respiratory infections (Stark *et al.,* 1992). Furthermore, the highest prevalence of parasitic pneumonic lesions (28.7%) could be attributed to lack of deworming regimen and poor management systems. Rearing of pigs in backyard pens or isolated lots in dirty environment or as stray are common practices in many communities in Nigeria. These practices predispose them to infection by intermediate hosts of lungworms (earthworms). Conversely, pigs reared on concrete floor are less likely to be prone to lungworm infection.

The low prevalence of emphysema (1.3%), enzootic pneumonia (2.7%) and pleuropneumonia (3.0%) recorded in this study falls within similar reported prevalence range of 0.2% - 50% (Bahnson et al., 1992; Grest, 1995; Pointon, 1995). The low prevalence could be attributed to differences in climate change due to different geographical location, management practices and the clustering of the causal agents in space and time. Previous studies shows that enzootic pneumonia is less prevalent in warm, dry season as the climate does not favour new infections (Done, 1991; Stark *et al.,* 1992;Maes *et al.,* 2001) and lesions formed in the winter could resolve before slaughter (Done, 1991). Most of the data for this study were collected during the dry season months of November and December. In addition, most communities in Nigeria keep pigs in fewer numbers, mostly under semi-extensive or free range systems. This condition may not favour most of the factors necessary for bacterial pneumonias which are more common in intensively reared pigs (Tuovinen *et al.,* 1997).

Tuberculous lesions accounted for 0.8% which is higher than the 0.2% reported in the United States during abattoir survey (Thoen, 1999). Even though low, this prevalence of tuberculous lesions portends public health threat. The low prevalence however may not be unrelated to the localization of tuberculous lesions in organs other than the lungs. Tuberculosis has been diagnosed positively in organs other than the lungs in pigs (Cadmus *et al.,* 2010). In most cases, the infection may be in the subclinical stage and could go undetected in the lungs macroscopically. The age, breed of pig and housing factors cannot be over emphasized. A previous study reveals that older pigs and local pigs bedded on shavings infected with Mycobacterium bovis from cattle were prone to higher prevalence (Radostits *et al.,* 2000). Most of the pigs enrolled in this study was that of juvenile and adolescent pigs, however, all the tuberculosis lesions observed were in older pigs. Irrespective of the lesion type, age was found to be statistically significant ($P < 0.0001$) for the occurrence of lung lesions.

According to age distribution, the lowest prevalence of lung lesions was recorded in adults (7.2%) followed by juvenile pigs with 10.2% while adolescent pigs had the highest prevalence of (19.0%). During the course of this study, it was observed that most butchers prefer young pigs to older ones prompting most farmers to sell their stock at a tender age before they attain full-grown adult age. The exposure to antibodies and development of immunity early in life among different age groups cannot be over emphasized. The

presence of statistically significant (P<0.0001) association between age and the prevalence of lung pathologies is an indication that age could possibly be a predisposing factor to lesion development.

The female pigs in this study exhibited higher prevalence of lung lesions than male pigs. This may likely be because more female pigs were slaughtered. This could be attributed to the fact that fewer females were being kept for breeding purposes as a method of controlling pig breeding and population, in order to enhance management. In contrast to the finding of this study, high prevalence of lung lesion was reported in barrows than in sows in a similar study, but this was attributed to stress and hormonal changes due to castration (Christensen *et al.,* 1999). The absence of statistically significant (P = 0.866) association between the prevalence of lung lesion and sex in this study is an indication that both male and female pigs kept under similar conditions are equally predisposed to lung lesions producing diseases. Similarly, higher prevalence of lung lesions was recorded in cross bred pigs, and this was attributed to hereditary influence.

Pigs sourced from neighbouring states of Adamawa, Taraba, Nasarawa, Plateau and Kaduna combined had the highest prevalence of respiratory lesions compared to those that were sourced within Benue State. The absence of a statistically significant (P = 0.080) association between the prevalence of lung lesion and the source of the pigs could possibly imply that pigs from these two sources might have been exposed to similar predisposing respiratory infection pressures or conditions. Such conditions could be poor management practices like overcrowding, poor ventilation, inadequate biosecurity measures, poor hygiene, absence of chemotherapeutic regimens, etc.

As regards lung scores, the affected lungs were either partially or totally condemned implying possible financial losses. The extent of condemnation was dependent on the severity and the public health implication of such lesion. The financial losses due to the condemned lungs were not estimated. The occurrence of any lesions is an indicative of the stage of the infection rather than the severity of the infection pressure (Pijoan, 2002). The most common and severe lesions recorded were parasitic pneumonia and this data from verminous pneumonia should be important when considered this pneumonia type to be preventable by human interventions such as good deworming regimens.

Conclusion

This study has revealed a moderately high prevalence (36.4%) of respiratory lesions in pigs slaughtered in Makurdi, comprising pneumonias and tuberculosis. The study serves as an indicator for field disease conditions hence, providing preliminary epidemiological information on lung pathologies of pigs in Benue State, and in part had protected humans from potential zoonoses like tuberculosis. Although not too exhaustive, the information can be beneficial to veterinarians and farmers in targeting the risk factors in respiratory diseases. Improved herd management, hygiene and housing conditions need to be properly considered in control programmes aiming at reducing the occurrence and impact of these diseases on pigs' health.

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CAUSES OF MORTALITY IN DOGS IN AND AROUND EFFURUN/WARRI MUNICIPALITY OF DELTA STATE, NIGERIA

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Abstract

This retrospective study examined death causes in hospitalized dogs in Effurun-Warri region from 2002 to 2013. Over the past 12 years, out of 1,302 dogs presented with different medical conditions, 241(18.0%) were euthanized or died with a diagnostic claim for the cause of death. Proportional mortality was reported for the different categorizations. The ten most frequent causes of mortality recorded were ascites 25(10.4%), canine babesiosis 23(9.5%), cardiovascular diseases 12(5.0%), gastroenteritis 31(12.9%), canine parvoviral enteritis 47(19.5%), pneumonia 5(2.1%), snakebites envenomation 8(3.3%), toxicosis 36(14.9%) and trauma 20(8.3%) while mortalities from euthanasia and unexplained deaths accounted for 15(6.2%) and 10(4.1%), respectively. Breeds with the highest mortality rates were Alsatians 124(48.7%), Mongrels (mixed breeds) 40(16.9%), Rottweiler 21(10.8%), Indigenous dog breed 15(6.2%) and Doberman 14(5.8%). Age was significant for death causes (P<0.0001) with adult dogs having the highest mortalities 95(39.4%) followed by puppies 76(31.5%). Furthermore, more males 140(58.1%) had died compared to female dogs 101(41.9%). The result of this study revealed that preventable diseases and inadequate pet care were the primary causes of deaths in dogs in the study. This serves as a pointer to the relevance of improved management and veterinary attention to pets. Finally, the patterns of deaths in relation to gender, age and the temporal distribution for discrete causes calls for an in-depth study.

Keywords: Death, Causes, Proportional mortality rate, Dog, Nigeria

CAUSES DE MORTALITE DES CHIENS DANS ET AUTOUR DE LA MUNICIPALITE D'EFFURUN WARRI DE L'ETAT DU DELTA AU NIGERIA

Résumé

La présente étude rétrospective a examiné les causes de mortalité des chiens hospitalisés dans la région d'Effurun-Warri, de 2002 à 2013. Au cours des 12 dernières années, sur 1.302 chiens présentés avec différentes affections médicales, 241(18,0%) ont été euthanasiés ou sont morts de causes inconnues. Une mortalité proportionnelle a été signalée pour les différentes catégorisations. Les 10 causes de mortalité les plus fréquemment enregistrées sont les ascites 25(10,4%), la babésiose canine 23(9,5%), les maladies cardiovasculaires 12(5,0%), la gastroentérite 31(12,9%), l'entérite parvovirale canine 47(19,5%), la pneumonie 5(2,1%), l'envenimation par morsure de serpents 8(3,3%), la toxicose 36(14,9%) et les traumatismes 20(8,3%), tandis que les mortalités résultant de l'euthanasie et les mortalités inexpliquées représentaient respectivement 15(6,2%) et 10(4,1%). Les races connaissant les taux de mortalité les plus élevés étaient : les bergers allemands 124(48,7%), les chiens bâtards 40(16,9%), les chiens Rottweiler 21(10,8%), la race indigène 15(6,2%) et les chiens Doberman 14(5,8%). L'âge était un facteur significatif de mortalité (P<0,0001), les plus fortes mortalités étant notées pour les chiens adultes 95(39,4%), suivis des chiots 76(31,5%). En outre, le nombre de mâles morts 140(58,1%) était supérieur à celui des femelles 101(41,9%). Le résultat de cette étude a révélé que des maladies évitables et des soins médiocres étaient les principales causes de mortalité des chiens dans cette région. Il affirme la pertinence d'une amélioration de la prise en charge et d'un redoublement de l'attention des vétérinaires aux animaux de compagnie. Enfin, les schémas des mortalités par rapport au genre, à l'âge et à la répartition temporelle des causes discrètes demandent une étude approfondie.

Mots-clés : Mortalité ; Taux de mortalité proportionnelle ; Chien ; Nigeria

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Introduction

Domestication of dog is dated as far back as 15,000 B.C (Morey, 2006). Today, dog has become one of the most common and useful pet animals found in almost every human settlement the world over. They have been trained to perform diverse roles in the society ranging from socio-cultural to economic functions. Domesticated dogs are used as companions, pets, performing religious rites, hunting dogs, security/guards or sentinels, draught animals, as meat and bred as a means of livelihood or for commercial purposes. Due to its intelligence, dogs have been trained to assist humans in providing labour such as herding of livestock, transportation, detective work, search and rescue work, and as combat dogs. Earlier studies have reportedly proposed that higher level of self-esteem in children is associated with keeping pets (Paul and Serpell, 1996; Knobel et al., 2008).

In most civilized nations where there is high impact factor or value attached to pets, owners insure their animals. Therefore, any instance of disease or death has to be ascertained in order to lay insurance cover claims (Bonnett et al., 1997; Bonnett et al., 2005). In contrast to developing nations like ours where many people give less attention to their pets or animals, their survival is highly influenced by owner, societal and veterinary factors related to the availability of, and the willingness to access veterinary care. The environmental or natural causes of death and human intervention are believed to be very informative in monitoring the health status of pets as it could aid in planning and executing adequate preventive and control measures (Egenvall et al., 2005). Conversely, without adequate understanding of the epidemiology of any disease condition, no tangible preventive or control measure would be very effective. Investigating mortality causes in dogs is therefore important because it provides useful information on breed-specific rates, age pattern of death and gender-specific cause of death (Bonnett et al., 2005).

This study focused primarily on investigating the causes of mortality in a hospitalized dog population within Effurun-Warri municipality to provide preliminary epidemiological information on mortality of dogs in Nigeria where such data are rather unpublished.

Materials and Methods

A 12 year retrospective study was conducted on clinic data of diagnosed causes of mortality in dogs abstracted from records of dogs presented at a private animal hospital in Effurun-Warri municipality from 2002 - 2013. Effurun-Warri municipality is the economic nerve Centre and the most populated city in Delta State of Nigeria. The region has a good hold of dog population and growth with many of them being kept mostly for companionship, as pets, security or sentinel by companies and for breeding as a means of livelihood.

The mortality causes reported in this study were based on history, physical examination, clinical signs and in some cases, postmortem and laboratory findings. Only conditions that led to death were considered, and if a case had multiple conditions, only one was deemed the cause of death. Where it was impossible to ascertain the cause, the case was designated as "No diagnosis or Unexplained". This study grouped deaths by diseases conditions and analyzed results based on the influence of breed, age, sex and temporal distribution of mortality. All mixed breeds of dogs were grouped as one group. The data obtained were analyzed using bivariate statistics to test for association in relation to morality causes and the studied variables using SPSS version 20. Test of significance was set at 95% confidence limit ($P < 0.05$). Results obtained were presented as proportional mortality rates using percentages.

Results

Altogether, 1,302 dogs were presented to the hospital for various medical complaints and routine medical checkups from 2002 to 2013. A total of 241 dogs comprising 15 breeds died or were euthanized, and out of which only 10 (4.1%) had no assertion for diagnosis of the

Table 1: Breed distribution of the causes of mortality in dogs

Mortality Causes	Breeds						
	Alsatian	2Am. Eskimo	Bullmastiff	Cane cursor	Caucasian	Dalmatian	Doberman
Ascites	14	0	0		1	0	1
Babesiosis	9	1	0	0	0	0	1
Canine distemper	0	0	0	0	0	0	0
Heart diseases	5	0	0	1	0	0	1
Diabetes	0	0	0	0	0	0	1
Euthanasia	10	0	0	0	0	0	0
Gastroenteritis	20	0	1	0	0	1	0
Hepatitis	0	0	0	0	0	0	0
Tumor	1	0	0	0	0	0	0
Otitis	1	0	0	0	0	0	0
CPV enteritis	26	0	0	2	1	0	3
Pneumonia	2	0	0	0	0	0	1
Pyometritis	1	0	0	0	0	0	0
Rabies	0	0	0	0	0	0	0
Snakebite	4	0	0	0	0	0	2
Toxicosis	16	1	1	1	4	0	2
Trauma	10	0	0	0	1	0	1
No diagnosis	5	0	0	0	0	0	1
Totals	**124**	**2**	**2**	**5**	**7**	**1**	**14**

Mortality Causes	Breeds								
	Local dog	Labrador	Lassa terrier	Lhasa Apso	Mongrels	Pekingese	Rhodesian1	Rottweiler	Totals
Ascites	1	0	0	1	4	1	0	1	25
Babesiosis	1	0	0	0	9	0	0	2	23
Canine distemper	0	0	0	0	1	0	0	0	1
Heart diseases	1	1	1	0	0	0	0	2	12
Diabetes	0	0	0	0	0	0	0	0	1
Euthanasia	0	0	0	0	3	0	0	2	15
Gastroenteritis	1	0	1	0	4	0	0	3	31
Hepatitis	0	0	0	0	1	0	0	0	1
Tumor	0	0	0	0	0	0	0	0	1
Otitis	0	0	0	0	0	0	0	0	1
CPV enteritis	1	0	0	0	9	0	0	5	47
Pneumonia	1	0	0	0	1	0	0	0	5
Pyometritis	0	0	0	0	0	1	0	0	2
Rabies	1	0	0	0	1	0	0	0	2
Snakebite	0	0	0	0	0	0	1	1	8
Toxicosis	2	1	0	0	4	0	1	3	36
Trauma	5	1	0	0	1	0	0	1	20
No diagnosis	1	0	0	0	2	0	0	1	10
Totals	**15**	**3**	**2**	**1**	**40**	**2**	**2**	**21**	**241**

[1]*Rhodesian ridge back;* [2]*American Eskim*

cause of death. A crude death rate of 18.5% (241/1302) was recorded with mortality causes diagnosed under18 different health conditions.

Table 1 shows the distribution of the common mortality causes by breeds while Figure 1 depicts the proportional mortality rate. The causes of mortality recorded comprised ascites 25 (10.4%), canine babesiosis (piroplasmosis) 23 (9.5%), cardiovascular diseases 12 (5.0%), diabetes mellitus 1 (0.4%), canine distemper 1 (0.4%), gastroenteritis 31 (12.9%), euthanasia 15 (6.2%), hepatitis 1 (0.4%), otitis 1 (0.4%), canine parvovirus (CPV) enteritis 47 (19.5%), pneumonia 5 (2.1%), pyometritis 2 (0.8%), rabies 2 (0.8%), snakebite envenomation 8 (3.3%), toxicosis 30 (14.9%), trauma 15 (8.3%) and tumor 1 (0.4%) while deaths with no assertions for diagnosis of the causes of death were 10 (4.1%). There was a statistically significant difference between the mortality causes (X^2 = 251.274; df = 17; P < 0.0001).

Figure 2 depicts the mortality profile by breeds of the dogs. A total of 15 dog breeds were recorded as the most common in the studied area. Breed-specific proportional mortality rates therefore revealed that Alsatian had 124 (51.1%), American eskimo 3 (0.8%), Bullmastiff 3 (0.8%), Cane cursor 5 (2.1%), Caucasian 7 (2.9%), Dalmatian 1 (0.4%), Doberman 14 (5.8%), Indigenous (native) dog breed15 (6.2%), Labrador 3 (1.2%), Lassa terrier 2 (0.8%), Lhasa Apso 1 (0.4%), Mongrels 40 (16.6%), Rottweiler 21 (8.7%), Pekingese 3 (0.8%), and Rhodesian ridgeback 3 (0.8%) died respectively. There was no statistically significant association (X^2 = 230.80; P = 0.620) between death causes and breed even though Alsatian, Mongrels, Rottweiler, Indigenous dog breed and Doberman had appreciably higher mortality rates.

Figure 3 shows the proportional mortality of the dogs by age and sex groups. Among the age group, mortality recorded were puppies 0 - 6 months of age 76 (31.5%), adolescents 7 - 11 months of age 27 (11.2%), adult dogs 1 – 5 years of age 95 (39.4%), and senior dogs above 5 years of age 43 (17.8%), respectively had died from at least one cause of death recorded in this study. A statistically significant association (X^2 = 124.30; P < 0.0001) between death causes and age group was recorded with adult dogs and puppies been more prone to death than adolescent dogs. This study also recorded the highest mortality in male dogs 140 (58.1%) compared to the females 101 (41.9%). However, the bivariate analysis showed no statistically significant association (X^2 = 12.09; P = 0.795) between sex of the dogs and the death causes.

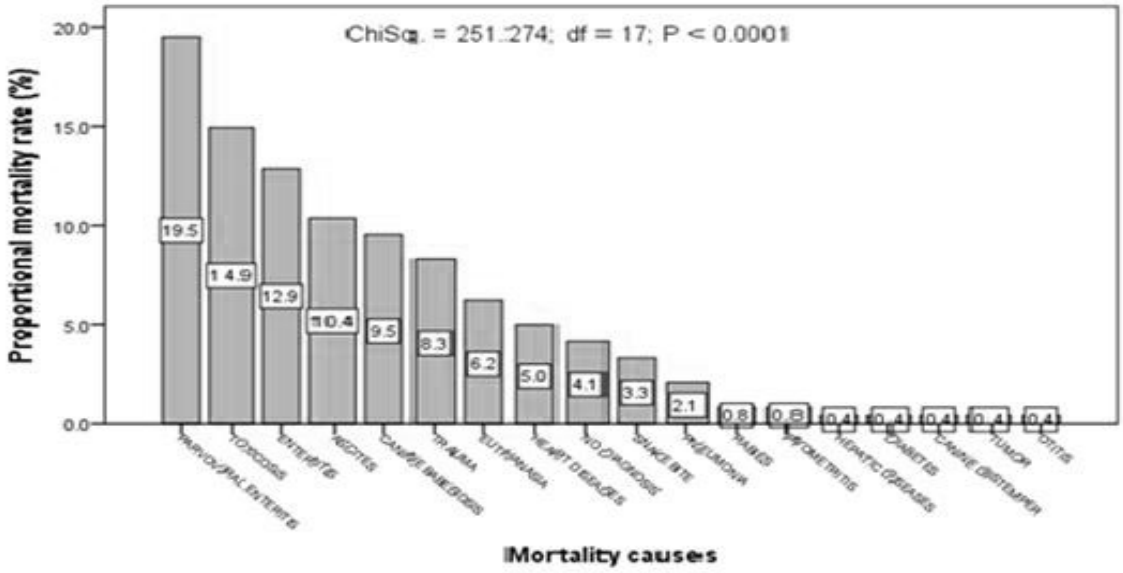

Figure 1: Profile of frequently observed causes of mortality in dogs

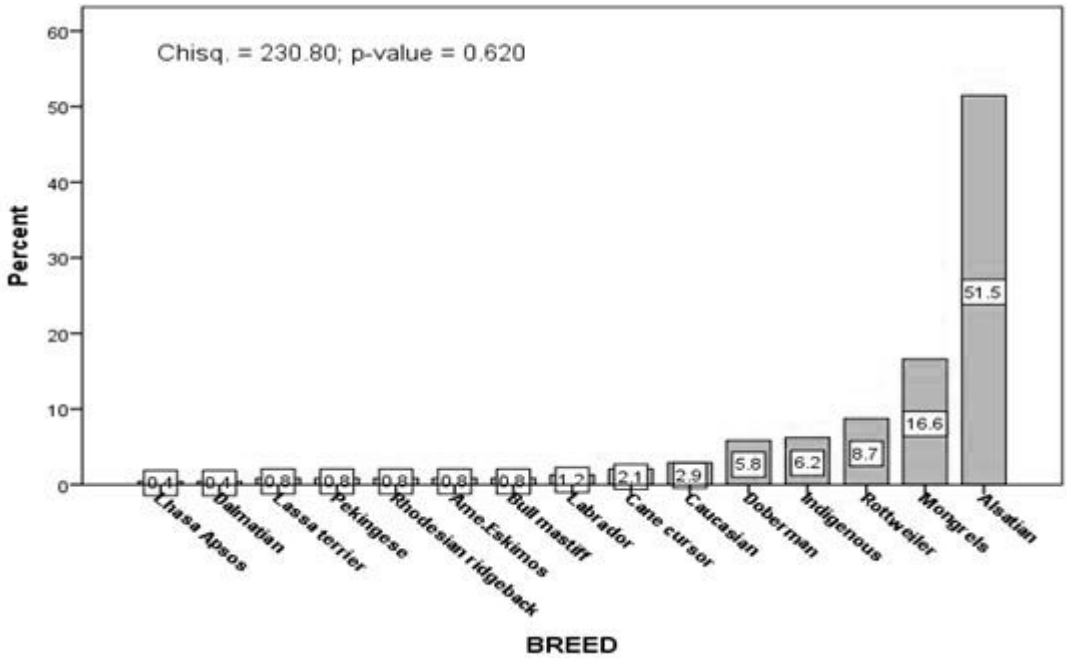

Figure 2: Profile of proportional mortality rate by breed of dogs

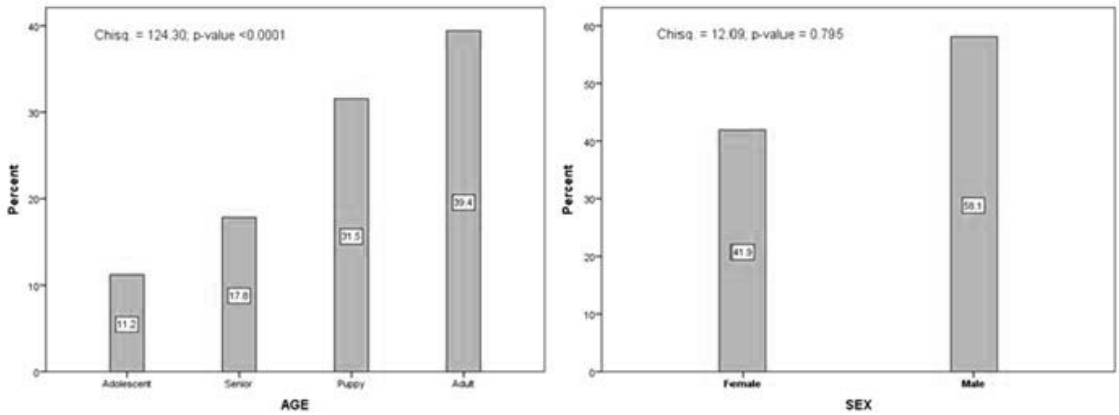

Figure 3: Profile of proportional mortality rate by age and sex of the dogs

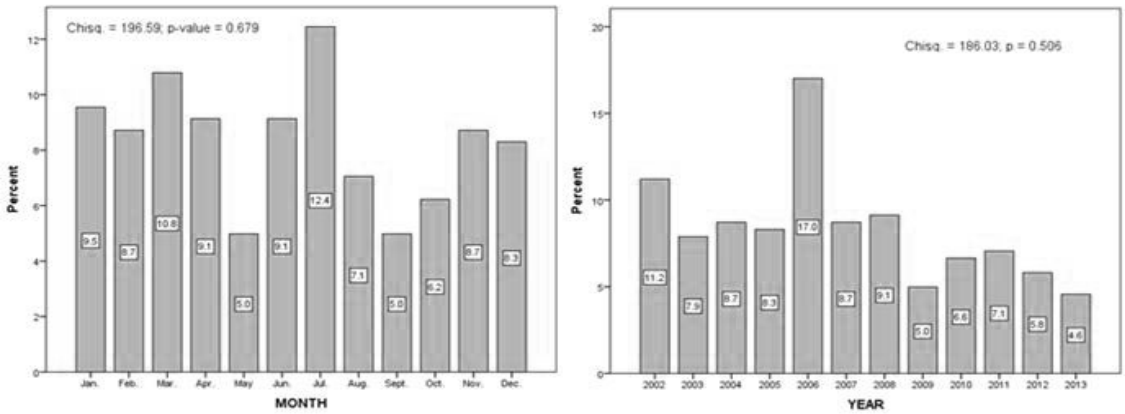

Figure 4: Temporal distribution of mortality by month and year

Figure 4 depicts the temporal distribution of mortality among the dogs by month and year that the deaths had occurred. The highest mortality rate of 41 (17.0%) was recorded in year 2006 while the lowest mortality of 11 (4.6%) was recorded in 2013. There was no statistically significant association (X^2 = 186.03; P = 0.506) between mortality causes and year. Peak mortality 26 (12.4%) was recorded in the months of July while the lowest mortality rates were recorded in the months of May 12(5.0%) and September 12(5.0%), respectively. Again, there was no statistically significant association (X^2 = 196. 59; P = 0.679) between mortality causes and months that the deaths had occurred.

Discussion

Causes of death in dog population are multifactorial ranging from infectious to non-infectious causes as revealed in this study and other similar studies (Bonnett *et al.,* 2005; Michell, 1999; Fleming *et al.,* 2011). The most important prevalent causes of mortality recorded in this study in decreasing order of frequency are canine parvoviral enteritis (19.5%), toxicosis (14.9%), gastroenteritis (12.9%), ascites (10.4%), canine babesiosis (piroplasmosis) (9.5%), trauma (8.3%), cardiovascular causes (5.0%) and snakebite envenomation (3.3%) while euthanasia accounted for 6.2% and "unexplained" death causes constituted 4.1% of the deaths.

As regards temporal distribution of causes of death, mortality causes in pet animals may change over time, and could be influenced by both human interventions and how we care for them. According to Fleming *et al.,* (2011), nutrition, vaccination, neutering, confining pets influences the cause of mortality in pets. The death rate in this study had remained relatively constant over the study period with peak mortality (17.0%) occurring in 2006 while lowest deaths (4.6%) occurred in 2013. The decrease in mortality recorded in 2013 could be probably due to pet health care education received by owners and improved veterinary attention given to pets. Again, monthly records showed that death rates had remained relatively constant throughout the years with slight fluctuations. The highest death rate was recorded in July (13.3%) with the lowest occurring in September (4.1%). Many factors affect the pattern of death and depend on the host, agent, environmental factors and human interventions (Thrusfield, 2005). Most of the cases of deaths were attributed to babesiosis and gastro-intestinal infections. Canine parvoviral enteritis has been reported to have a temporal pattern of distribution (Houston et al., 1996; Mohammed et al., 2005). Most of the deaths which occurred in these pets were probably due to lack of readiness of owners to routinely seek for veterinary attention, thus the temporal distribution of such deaths in pets may vary greatly during each year or month. Also, it is a well-known fact that diseases have different patterns of occurrence, the rates of mortality will greatly vary depending on whether it is endemic or epidemic cause, infectious or non-infectious diseases and how early medical intervention is instituted.

Furthermore, according to death specific-causes, disease conditions which are preventable constituted the major cause of mortality recorded in dogs in this study. Death from infections, trauma, toxicosis, cardiovascular causes and snakebite envenomation contributed significantly to causes of mortality in the study population. For instance, Canine babesiosis which accounted for 9.5% of the deaths could be controlled by good environmental sanitation in addition to use of babecidal drugs and ticks control. Due to scarcity of available records of clinical cases of babesiosis-associated-mortalities in Nigeria, it is a common believe that babesia infection in dogs is usually mild or sub-clinical. This study however has revealed a high association of babesiosis with mortality of dogs in Effurun-Warri area. Again, there is a notion that babesiosis occurs more frequently in exotic breeds while indigenous breeds develop the disease in a milder form and usually recover (Leeflang and Ilemobade, 1997; Adamu et al., 2014). This statement may be true but interestingly this study has recorded a single mortality due to babesiosis in local dog breed. Notwithstanding, babesiosis could be complicated or uncomplicated. Uncomplicated

cases are characterized by clinical signs attributed solely to mild or moderate anaemia (Jacobson and Clarke, 1994). Complicated babesiosis is characterized by non-solid-organ failure evidenced by severe anaemia and haemoconcentration or organ dysfunction/ failure (Jacobson, 2006). Nonetheless, breed and genetic susceptibility factors cannot be over-emphasized. Alsatian (German shepherd) was the most affected breed in this study. It should be noted that the introduction of exotic dog breeds into Nigeria without surveillance could introduce more virulent or pathogenic babesia species than the indigenous species already known to exist. Hence, this finding is a reminder to both veterinarians and pet owners on effective control of ticks in dogs.

Gastrointestinal infections (i.e. parvoviral enteritis 19.5% and other gastroenteritis 12.9%) posed the most serious challenge to the survival rates of the dogs in the studied population. Deaths from these infections were recorded mostly in Alsatian, Mongrels and Rottweiler breeds. This finding corroborates the report of previous similar studies (Glickman et al., 1985; Houston et al., 1996). The high mortality recorded due to gastro-enteritis in this study can be ascribed to ignorance on the part of pet owners and failure to seek veterinary care for their pets. Through appropriate vaccination and deworming regimen coupled with early antibiotic prophylaxis, prevention and control of most of the deaths from most of the infectious diseases reported in pets in this study could be achieved.

The high mortality rate observed due to toxicosis (14.9%) most-likely resulted from chemical and food poisoning. From the clinic records, chemical poisonings mostly resulted from the introduction of poisonous substances in the house or dogs kennels. Wrong application of chemicals on dogs (medicated bath), introduction of rat baits, poison, spraying of kennels with acaricides and environmental toxicity were responsible for the chemical toxicities and the related deaths recorded in the dogs. Similarly, food poisoning resulted from feeding dogs with expired pet foods (e.g. canned food) and foods containing chocolate/ chocolate products. Therefore, considering these conditions as preventable by owner will reduce mortality in pets.

Trauma-related mortality in this study was caused mostly by road traffic accidents (RTA), conditions like bites during dogfights and blunt trauma from hit. The low income earning status of some dog owners predispose dogs to straying, food scavenging and other behavioural characteristics like mating, could have most-likely contributed to the traumatic deaths recorded in these pets. The causes and types of trauma may vary by breed. Besides, owners may be less likely to pay for an expensive veterinary care for mongrels or local dog breed that suffered accidents (Bonnett *et al.,* 2005). The 8.3% mortality due to trauma recorded in this study is lower than 17% reported in Sweden (Bonnett et al., 2005) but higher than 3% reported in UK (Michell, 1999) due to car accidents. The differences in the rates could be due to differences in vehicular activities and how well pet movement is restricted especially in developed countries of the world. Again, this data for traumatic deaths should be important when considered most traumatic deaths to be mainly preventable by humans.

Euthanasia accounted for 6.2% of the deaths. The underlying factors in euthanasia in dogs may vary from one dog to another. In practice, dogs may be euthanized for either humane or economic reasons, medical or non-medical conditions such as behavioural problems and for owner convenience in case of elective euthanasia.

Similarly, 10.4% of deaths recorded in this study were attributed to ascites. There are many causes of ascites in dogs (Sood, 2013). Dog breeds prone to ascites in this study were Alsatian, Mongrels and Rottweiler while older dogs were at higher risk than younger dogs. Our finding corroborates the findings of Ihedioha *et al.,* (2013) who reported that ascites accounts for a prevalence of 0.78% in dogs from Enugu State in Nigeria.

Snakebite envenomation accounted for 3.3% of the deaths which could be attributed to the inquisitiveness, in addition to straying and food scavenging activities of dogs.

Cardiovascular causes accounted for 5.6% of the deaths, these findings are

relatively lower than the 8.0% reported in Swedish insured dogs (Bonnett et al., 2005). Fewer cases recorded in this study could be due to the small sample size used. Some of the earlier reports have shown that dog breeds are predisposed to or are at risk of developing heart diseases differently. Häggström *et al.,* (1992) reported higher rates of heart disease in Cavalier King Charles Spaniel. In another study, Irish wolfhounds, Cavalier King Charles Spaniel (Bonnett *et al.,* 2005) and Great Dane were found to be at a higher risk (Eganvall *et al.,* 2006). In this study, German shepherd was at higher risk. This could be probably due to the over representation of German shepherd in this study, which in turn could be owing to its preference over other breeds in the studied area.

Pneumonia accounted for 2.1% of the deaths in the study population with almost all the deaths recorded in larger breeds than in smaller breeds of dogs. Again, Alsatian breed was at a higher risk which may be due to high numbers of this breeds that constituted the study population. Nonetheless, breed susceptible could be responsible for the differences.

Four percent (4%) of the dogs died without any assertion for diagnosis on the cause of death. This may be because the dogs might have died shortly before reaching the veterinary hospital and there was no postmortem examination to ascertain the cause of death, in addition to unclear medical histories.

Other health conditions (Otitis, tumor, Canine distemper, diabetes, hepatitis, pyometritis and rabies) accounted for less than 1.0% each of the total deaths and these conditions may be thought as uncommon in dogs. However, in case of rabies, it is well known that it is endemic in Nigeria (Beard, 2001; Ajayi et al., 2006). Most of the deaths in dogs due to rabies do occur outside the hospital setting, and it is mostly when the owner does not understand the nature of the disease that they seek veterinary advice. Thus, the rabies data obtained from hospital records may not give a true representation of mortality rate due to canine rabies. With the few cases of rabies recorded in study, a rhetoric and innocuous question may be asked, "Why do we still have rabies among dogs in Nigeria despite the availability of safe and effective rabies vaccines?" Probably, it may be due to poverty level, cost of vaccination, lack of awareness, redundant attitude of owners coupled with the lack of support and law enforcement on rabies vaccination by the government and inability to control rabies from the wild reservoirs.

In relation to breed, age and gender-specific mortalities, fifteen (15) breeds of dog were recorded with Alsatian (51.5%), Mongrels (16.6%) and Rottweiler (8.7%), Indigenous dog breed (6.2%) and Doberman (5.8%) been considered as the most susceptible breeds to the various death causes revealed in this study. However, there was no statistically significant association (X^2 = 230.80; P = 0.620) between mortality causes and dog breed. This could suggest that both breeds had equal likelihoods of being susceptible to the death causes when exposed to similar predisposing conditions. Nonetheless, immunodepression is said to be a common finding in German shepherds with parasitic infestation and canine parvovirus enteritis (Toman et al., 1998). Lack of genetic diversity or genetic restriction is also known to accompany immunosuppression in dogs; this is also responsible for the high susceptibility to infections seen in pedigree dogs recorded in this study (Leroy, 2011).

Among the age groups, mortality record was highest in adults (39.4%), puppies (31.5%), senior (older) dogs (17.8%) and least in adolescents (11.2%). There was a significant ($P < 0.0001$) association between causes of deaths and age group. This implies that age is likely a predisposing factor to causes of deaths in dogs. Furthermore, more male dogs (58.0%) died compared to the females dogs (40.0%) however, there was no statistically significant association (X^2 = 12.09; P = 0.795) between the cause of mortality and sex of dog. This implies that sex could unlikely be a predisposing factor for mortality in dogs. It should be noted that sex of dog can predispose them to certain diseases which are sex-related. For instance, pyometritis is a sex-related disease of female animals. Thus, it can be conclude here that

association of mortality causes with breed, age and gender can only be well appreciated when considered within the limit of specific mortality causes rather than between multiple causes. Egenvall et al., (2005) suggested that it is very important to take into account the age pattern of a disease and possible differences in age distribution across groups when examining competing causes of death. The proportional mortalities within a breed should inform health strategies among dog breeders, helping them to focus on those diseases causing the most deaths at "too early an age" in their breed (Bonnett et al., 2005).

Conclusion

Information on rates and causes of mortality in dog population is very useful as it provides insights into common health problems in breeds, average lifespan, gender susceptibility, the age pattern, and even spatio-temporal distribution of some diseases in dogs. This study has identified preventable diseases and inadequate pet care as the significant causes of mortality in dogs in Effurun/Warri municipality which included parvoviral infection, toxicosis, gastroenteritis, ascites, canine babesiosis, trauma, snakebite envenomation and pneumonias. Dog breeds at higher risk were Alsatians, Mongrels, Rottweiler, Indigenous dogs and Doberman. Considering data used here as merely hospital records, we still strongly believe it is a close representation of what may be tenable in the general dog population. Slight differences, however, might exist in that the particular causes of mortality may not accurately represent those of the general dog population even if the patterns are the same. Despite all odds, this information can be valuable to epidemiologists, veterinarians, researchers, current and prospective owners and dog breeders. We therefore highly advocated for improved dog management.

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A SURVEY ON SOME DROMEDARY CAMEL DISEASES AT TUMBOOL SLAUGHTERHOUSE, GEZIRA STATE, SUDAN

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Abstarct

Large sector of population in the area depend on camel meat and frequently consume raw camel meat and liver. A Four-year retrospective study (2007–2010) of camel slaughtered at Tumbool slaughterhouse in Butana area, Gazira State, was carried out to determine the prevalence of diseases encountered in slaughtered camels. A total of 8220 camels were examined anti-mortem and postmortem during the period of study. Records were analyzed at Tumbool Camel Research center (TCRC). Of these animals 2220 (27%) were males and 6000 (73%) were females out of them (30%) were pregnant. The major diseases examined at pre-mortem were recorded. Maior pathological conditions recorded included hydated cyst (19.7%), pneumonia (27.5%) and udder infections (41%), whereas, serological examination showed brucellosis (51.2%), Toxoplasmosis (44%) and trypanosomosis (3%). The results highlight on the awareness for puplic health in the areas with serious zoonatic diseases.

Key words: dromedary camel, slaughterhouse, parasitic & infectious diseases

ETUDE DE CERTAINES MALADIES DES DROMADAIRES À L'ABATTOIR DE TUMBOOL DE L'ÉTAT DE GEZIRA AU SOUDAN

Résumé

Un grande partie de la population de la région dépend de la viande de chameau, et consomme fréquemment de la viande et du foie de chameau crus. Une étude quadriennale rétrospective (2007-2010) de chameaux abattus à l'abattoir Tumbool dans la zone de Butana dans l'État de Gazira a été effectuée dans le but de déterminer la prévalence des maladies observées chez les chameaux abattus. Au total, 8.220 chameaux ont été soumis à un examen anti-mortem et post-mortem au cours de la période de l'étude. Les données ont été analysées au Centre de recherche sur le chameau de Tumbool (CFTC). Deux milles deux cents vingt (2220) de ces animaux (27%) étaient des mâles, et 6000 (73%) étaient des femelles dont 30% gestantes. Les principales maladies examinées pré-mortem ont été enregistrées. Les principales affections pathologiques notées comprennent les kystes hydatiques (19,7%), la pneumonie (27,5%) et les infections de la mamelle (41%), tandis que l'examen sérologique a révélé la brucellose (51,2%), la toxoplasmose (44%) et la trypanosomiase (3%). Les résultats soulignent le besoin de sensibilisation à la santé publique dans les zones où prévalent des zoonoses graves.

Mots-clés : Dromadaire ; Abattoir ; Maladies parasitaires & infectieuses

Introduction

Meat inspection records are among important sources of data on prevalence of diseases (Kambarage *et al.,* 1995) and can be used in back-tracking to farm's management, in order to detect disease incidence and implement plans for control programmes. In Sudan they usually slaughtered cull animals whereas productive animals were slaughtered only for financial purposes. Slaughterhouses provide excellent opportunities for detecting diseases of both economic and public health importance (Ojo, 1994), especially in estimating the public health when exposed to certain zoonotic diseases in addition to estimate the financial implications of carcass condemnations to butchers (Asaaava *et al.,* 2009).

This study was carried out to provide information on the disease conditions encountered in camels slaughtered at Tumbool slaughterhouse as a possible indication of diseases conditions and consequently, in planning disease control.

Materials and methods

This study was conducted at Tumbool slaughterhouse and Tumbool Camel Research Centre (TCRC) in Butana plains, Gezira State. Tumbool is the major or central market for camel's meat in the state where camels are usually purchased from different regions of Sudan.Records and description of pathological conditions kept by the staff of the TCRC between 2007- 2010 were collected twice a week. Slaughtered animals were recorded as male and female, their age group, and their major location (Butana, Saeed," Southern-west Butana", Kassala "Eastern Sudan" and Western Sudan "mainly darfur"). camels were examined pre-mortem for any visually detected disease such as dermal infections, ticks infestations, injuries, fractions, dis-configuration, eye infections etc. Upon slaughtering, the post-mortem examinations include liver and lungs diseases and examination of gastrointestinal cestodes. Pregnancy was detected by examination of the uteri. In addition, blood samples were taken from the jugular vein of camels and examined serologically for brucellosis using Rose Bengal Test and for anti-toxoplasma antibodies by Latex agglutination test (LAT) using commercial kits (Toxo-Latex, Spinreact, Sant Esteve De Bas Spain). During the last two months of the collection period the pathological conditions of camel udder from (390 female camels) were recorded.

Analysis of data:

Data obtained were analysed to generate means, percentages and comperisons using the computerized programme Statistical Packages for Social Science (SPSS, 10.0). significance was considered at P<.0.05.

Results

The number of slaughtered camels during 2007- 2010 was estimated as (21180). Anti-mortem and post- mortem examinations were done to 8220 camels 72% of them are female camels. Their distribution according to their locations as follows: total number of Butana camels in this study is 4573 comprising 55.6% of the slaughtered camels; camels from Western Sudan is 1449 (17.6%); from Saeed area (Southern-west Butana) the examined camels are 1235 (15%) while 963 (11.7%) camels from Kassala (Eastern Sudan).

An increasing (P<0.05) trend of annual percentages of female camels slaughtered during the study period was represented in Figure (1) which outnumbered (57%-83%) the males (17%-43%). The overall pregnant she camels were 1779 with 30% pregnancy rate. However, highest (P<0.05) pregnancy rate (45%) was reported during 2007 as shown in Figure (2). On the other hand, Figure (3) showed that female camels brought from Western Sudan had the highest (P<0.05) percentage of pregnant camels (45%) among the slaughtered ones, followed by the Saeed camels (30%) while the Butana camels recorded (24%) and the Kassala camels represented the lowest pregnant animals (21%), Figure (3).

Table (1) showed the estimated annual incidence of some diseases during the survey period as detected in anti mortem examinations. It showed that 100% of the camels examined

were infested with large numbers of ticks. Two types of ticks were identified, Hyalomma dromederii and Hyalomma anatolicum. Ticks are present on all parts of the camel's body, the predilection sites were perennial, inguinal and axial regions, between the toes and around the ears, eyes and lips. Sarcoptic mange, due to Sarcoptes spp., diagnosed in 0.5% of the slaughtered camels other visual diseases are representing in Table (1).

The annual incidence of hydated cyst reported during post mortem examinations showed a mean of 19.7% , ranging between 18-25%per year, (Figure 4) with a non significant variation (P>0.05) between male (14%) and female camels (25%). The cysts were of variable sizes and 95% were found in the lung alone, and 5.0%% in the lung and liver. On the other hand, 27.5% (18- 37%) of the examined camels showed pneumonia with no significant variations (P>0.05) due to their sex (24.6% males; 30.5% females). However, higher incidence (P<0.05) of pneumonia 37% was reported during 2007.

The incidence of hydated cyst among camels ranged between 14-24% with insignificant variations (P>0.05) according to their locations. On the other hand, incidence of pneumonia was higher (P<0.05) in Western camels (36%) compared to other localities (22-27%) Figure (5).

Infection with hydated showed higher (P<0.05) incidence in old animals than younger ones in both sexes Table (3) however, infection with pneumonia showed no relation (P>0.05) to animal age in both sexes Table (3).

Examination of intestinal contents during 2009 revealed high percentages 63% and 69% of parasitic infection with nematodes and cestode , respectively. Liver abscesses recorded in 30-35% of the examined camels. On the other hand lower diseases incidence were recorded for tuberculosis, thyroids and trypanosomosis. Seriological examination of the animals showed 44% sero positive to anti-Toxoplasma gondii antibodies and 51% were positive brucellosis.

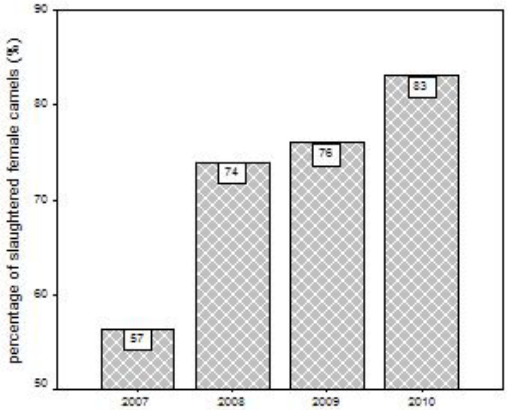

Figure 1: The percentages of slaughtered female camels during the survey period (2007-2010)

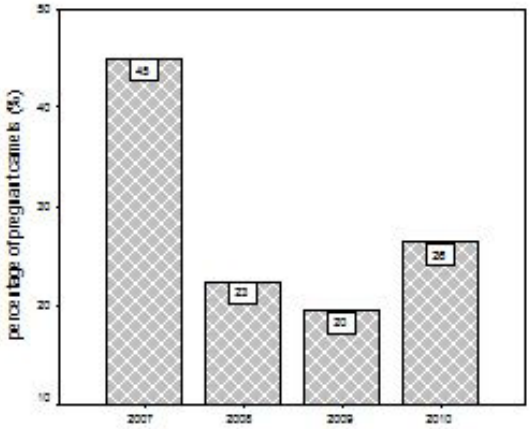

Figure 2: The percentages of pregnant camels slaughtered during the survey period (2007-2010)

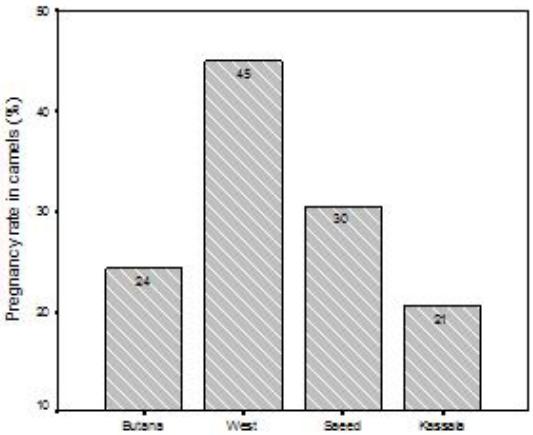

Figure (3): The percentages of slaughtered pregnant camels according to their location

Table 1: Anti-mortem prevalence of some camel diseases recorded during 2008-2010 at Tumbool slaughterhouse

Diseases	2009	2008	2007	2010
Tick infestation	100%	100%	100%	100%
Mange	2.2%	0.5%	0.19%	20.%
Ring worm	0.24%	0.05%	0.04%	2.4%
Abscess	2.20%	0.4%	0.04%	1.8%
Injuries	0.50%	0.00%	0.00%	1.9%
Fractions	0.85%	00.7%	0.27%	2.3%
S- nick syndrome	0.00%	%0.00	0.15%	0.6%
Contagious skin necrosis	0.00%	%0.00	0.04%	0.57%
Eye infection	0.91%	0 0.5%	0.11%	1.4%
Vaginal prolapsed	0.00%	00.2%	%0.00	1.00%
Eczyma	0.00%	0.05%	0.04%	0.18%
Foot rut	NR	%0.00	0.08%	0.22%
Blindness	NR	00.2%	0.08%	0.66%
Cornial opacity	NR	0.15%	0.04%	0.18%
Testis tumefaction	NR	%0.00	0.00%	0.09%
Udder infections	NR	86.67 %	NR	NR

**NR: not recorded*

Table 2: Post-mortem prevalence of some camel diseases recorded during 2007-2010 at Tumbool slaughterhouse

Diseases	2009	2008	2007	2010
Hydatosis	24.4%	24.8%	20%	17.6%
Pneumonia	37.3%	17.5%	29%	33%
Intestinal nematodes	NR	NR	63%	NR
Intestinal cestodes	NR	NR	69%	NR
Liver abscesses	NR	NR	30%	35%
Tuberculosis	0.3%	0.038%	0.0%	0.0%
Thyroids	0.01%	0.02%	0.04%	0.0%
Trypanosomosis	3.0%	NR	NR	NR
Toxoplasmosis	NR	NR	44%	NR
Brucellosis	NR	NR	NR	51.2%

**NR: not recorded*

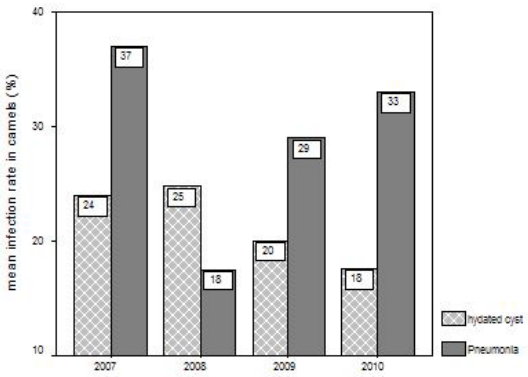

Figure 4: The annual infection rates of slaughtered camels with hydated cyst and pneumonia.

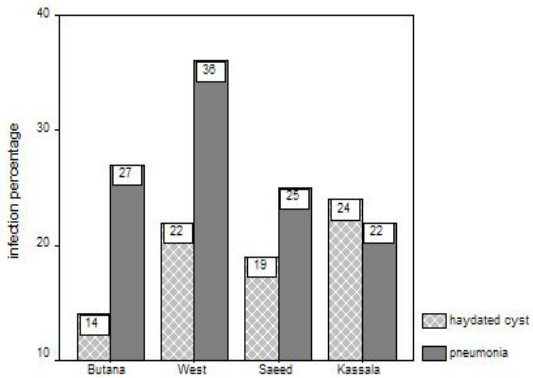

Figure 5: The infection rates of slaughtered camels with hydated cyst and pneumonia according to their locations during 2007-2010

Table 3: Infection rate of camels with pneumonia and hydated cyst according to their sex and age groups during 2007 - 2010

Disease	Sex	Age group 1-3 years	Age group 4-6 years	Age group 7-9 years	Age group 10->	Total
Pneumonia	males	23%	24.9%	32%	26.4%	23.3%
	female	27.4%	29%	30.8%	33.4%	30.6%
Hydated cyst	males	4.2%*	14%*	21%	28.4%	10%
	females	11.6%*	19.3%	24.2%	28.5%	22.4%

**significant at 0.05 (chi ^{2}- test).*

Discussion

Camels at Tumbool slaughterhouse were brought from different localities within and outside Butana area such as kassala, Western Sudan and Saeed area (Southern-east Butana).In this study a total of 6000 and 2220 females and males camels were examined about 55.6% of them were from Butana type where local marking is available.camels brought from western sudan (17.6%), saeed (15%) and kassala region (11.7%) were exposed to extra stress of long journy and the increasing possibility of viral and bacterial infections as well as mechanical injuries.

Tick infestation is common 100% throughout the year. Commonly found ticks on dromedaries are Hyalomma ssp, Rhipicephalus ssp and Amblyomma ssp (Schwartz and Dioli, 1992). Butana camels commonly infested by Amblyommlus spp., Boophilus spp., Hyalomma spp. and Rhipicephalus spp., (Maha, 2010). Ticks are present on all parts of the camel's body, the predilection sites were perennial, inguinal and axial region, between the toes and around the ears, eyes and lips. Sarcoptic mange, due to Sarcoptes spp.,diagnosed in 0.5% of the slaughtered camels and most infections appeared during the winter season. Ringworm's infection varied (0.04- 2.4%) although Al-Ani, 1997 reported that it is considered rearly in camels however, ringworm due to T. dankaliense, T.verrucosum, T.schoenleinii, T.mentagrophytes, Microsporum canis and M. gypseum has been reported in camels from Iraq, Egypt, Somalia, and Saudi Arabia (Al-Ani et al., 1995).

Injuries of varying degree of severity are a common problem in camel management (Schwartz and Dioli, 1992). During the rutting season fighting wounds among male camels is a common problem. Common sites for bite wounds are the withers, hump, front legs and scrotum. In this survey low percentages of injuies (1.90%) and fractions (2.3%) were reported, although the long travelling of camels across harsh environment are the main causes

of leg fractions and eye injuries leading to cornial opacity and blindness in some cases.

Helminthic infections are highly concern to camels in different parts of the world (El-Bihari, 1980; Al-Ani, et al., 1990; Al-Ani and Al-Shareefi, 1995). Our study showed that camels in Tumbool slaughterhouse are highly infested with gastrointestinal parasites. About 67 % and 90% of the camels examined were found to be infected by different species of gastrointestinal cestodes and nematodes, respectively. These findings were in agreement with the findings of Selim and Rahman (1972) in Egypt, Altaif (1974) in Iraq, Fadl (1988) in Sudan-Butana planes. Inas (2003) reported cestodes from camels in different regions of the Sudan. Moreover, mixed infestations with two or even three intestinal cestodes spp. in the same camels were diagnosed (Sijoud, 2013).

In this study an unexcepted high percentages (30%) of pregnant female camels may be due to their higher incidence of brucellosis and pathological udder disorder which eventually enhance their owners for culling these animals The incidence of brucellosis in slaughtered camels (51.2%) was higher than what has been reported elsewhere from farm surveys in Chad (26%), Kenya (14%), Saudi Arabia (12%), Iraq (7%) and United Arab Emirates (1.5%) (Al-Ani and Al-Shareefi, 1990; Afzal and Sakkir, 1994).

Infertility has been commonly reported in camels (Al-Ani, et al., 1992). Inactive ovaries, luteal and follicular cysts and uterine infection were reported in camels in different parts of the world (Shalash and Nawite, 1963; Abdo et al., 1969; Musa, 1984; Al-Ani, et al., 1992). These conditions are responsible for early slaughtering of the she camels due to conception failure (Al-Ani, et al., 1992), thus culling reasons in female camels are higher than male ones and this may partially explain the increasing trends in slaughtering female camels at Tumbool slaughterhouse.

Pneumonia is the most important predisposing factors for respiratory disease in this survey a mean of 27.5% of camels were found to have penumonia with varying levels of pathological damadge irrespective ($P>0.05$) to animal sex or age. However, camels coming from Western Sudan showed the higher infection rate 36% compare to others (22-27%) supporting the findings that pneumonia outbreaks among camels caused by sudden climatic changes, stress, poor management, low level of health status and bad nutrition (Schwartz and Dioli, 1992).

Infection with hydated cyst showed an increasing rate with respect to animal age where higher ($P<0.05$) incidence recorded in old animals than younger ones in both sexes. This observation is expected as most parasitic infection increased with increasing exposure time. On the other hand, hydated cyst infection was found to vary considerably according to the camel localities with significantly lower infection rate being reported for Butana camels (14%).

Conclusions

The result of this study showed high incidence of parasitic and infectious diseases of slaughtered camels which highlight on the expected field diseases of camels. and discuss the possible reasons for culling of pregnant females.

Recommendations

The study recommend that an intensive care and attention should be taken to aviod cases of serious losses in production due to slaughter of pregnant and productive animals. More data collection from the abattoir as well as from field and farms are needed in order to detect diseases outbreaks, plan control programmes, vaccination and other socio-economic studies.

Impact of the research

Such research study at the slaughterhouses along with standard abattoir records of various animal diseases encountered for finding out trends of animal diseases, outbreak of particular diseases at the various farms and locations from which animals were purchased for human consumption.

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URBAN AGRICULTURE AND POVERTY ALLEVIATION IN DEVELOPING COUNTRIES

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Abstract

Urban agriculture has served for a long time as a vital asset in the livelihood strategies of urban households in developing countries. It has been considered since then as a relevant input in responding to the embryonic economic situation of developing countries resulting to the structural adjustment programs and increasing migrations. Urban agriculture has expanded rapidly during the last two decades. And practicing it, will upgrade the income generation for the abundant unqualified workforce in urban cities in developing countries. It is therefore, the role of political leaders to regulate that fruitful sector, with (i) the provision of land regulation policies, meaning the legalization of urban agriculture as a step towards securing lands for the urban poor. Its illegal consideration status has left a governance vacuum, which should be filled through policy formulation and regular institutionalized management in a participatory manner including all relevant stakeholders, if food security has to be increased and environment improved in an urban development context, (ii) the supply of fertilizers and seeds for cereals and tubers in order to improve the expected harvest capacities and monitor the process with a free of charge availability and supply of agronomy technicians staff (iii) and finally with training programs related to the same. This article also gives an overview of the advantage of planning a city, a definition and pros of urban economy in country development. Finally, as a social sciences paper, it aims at giving pathways for political leaders in how to reconsider the abundant unqualified work force in urban cities in developing countries.

AGRICULTURE URBAINE ET ALLÈGEMENT DE LA PAUVRETÉ DANS LES PAYS EN DÉVELOPPEMENT

Résumé

L'agriculture urbaine est depuis longtemps un atout vital des stratégies de subsistance des ménages urbains dans les pays en développement. Elle est considérée comme une contribution pertinente qui permet de répondre à la situation économique embryonnaire des pays en développement résultant des programmes d'ajustement structurel et de l'augmentation des migrations. L'agriculture urbaine s'est développée rapidement au cours des deux dernières décennies, et sa pratique renforce la génération des revenus de la main-d'œuvre non qualifiée abondante dans les centres urbains des pays en développement. Il appartient donc aux dirigeants politiques de réglementer ce secteur fructueux par la mise à disposition de politiques de règlementation foncière, signifiant une légalisation de l'agriculture urbaine comme étape vers l'acquisition de terres pour les citadins pauvres. Le fait de considérer l'agriculture urbaine d'illégale a laissé un vide de gouvernance, qui doit être comblé par une formulation de politiques et une gestion institutionnalisée régulière et participative incluant toutes les parties prenantes, pour que la sécurité alimentaire puisse être renforcée et l'environnement amélioré dans un contexte de développement urbain. De plus, les dirigeants doivent assurer la fourniture d'engrais et de semences de céréales et de tubercules afin d'améliorer les capacités de récolte attendues et surveiller le processus à travers la mise à disposition gratuite de techniciens agronomes et de programmes de formation connexes. Cet article donne également un aperçu des vertus de l'urbanisme, la définition et les avantages de l'économie urbaine dans le développement d'un pays. Enfin, en tant que document des sciences sociales, il vise à donner aux dirigeants politiques un cheminement leur permettant de se pencher à nouveau sur la main d'œuvre non qualifiée qui est abondante dans les centres urbains des pays en développement.

Introduction

By the turn of 2020, almost half of the world population will be urban and there will be a move from towns to huge cities where the growth of the population in urban areas will be the backbone of national economy (Brundtland report 1988, chapter 4). Third world countries have suffered from rural exodus consecutively by following that strategic expectation of development from urban to rural areas. However, for both areas (urban to rural and vice versa), development policies have not proven themselves; consequences, they have been very questioned and criticized. The rural exodus is defined as the departure of the population from campaigns to cities in order to search for a better life. This has had many consequences: the loss of the labour force, a growing number of an ageing population in villages, hunger, reduction of agriculture production, food and livestock practices in villages and increase in crime rate, Slumps' creation because of the insufficient earn to rent decent houses, the phenomenon of pick pocket and of anarchy in urban areas. The reason behind those questions and critiques is that, the majority of the work force which comes from rural areas does not have any qualification and at time does not meet the level of education required in higher education system and they are mainly found in cities, reason why they are mostly founded practicing clerical jobs (house help, personal drivers, and maneuvers in yards), for their survival. From the above explanations, there is a serious need to develop strategies in order to plan economy growth from urban to rural areas. One of the key assets on which strategic planning can be relied on is Agriculture through crops and livestock practice. First of all, livestock contributes about 40% to the agricultural gross domestic product (GDP) and constitutes about 30% to the agricultural GDP in the developing world (World Bank, 2009). With the growing populations, the increasing urbanization raises the demand for easily cooked nutritious food. Also, the rising incomes in the middle classes of developing countries allow people to express their food preferences. The demand for livestock products for example is the fastest growing in agricultural markets, especially for the products in which smallholders can be competitive such as milk, meat and eggs. There is in fact a consensus that, developing the livestock sector can contribute to poverty reduction and economic growth. About 60% of rural households in developing countries are estimated to depend on livestock for their livelihoods. The population, urbanization and gains growth in real per capita income are fuelling a growing demand for high-value foods, including meat and dairy products (FAO, 2009). Secondly, the majority of the world's estimated 1.3 billion poor people living in developing countries depend directly or indirectly on livestock for their livelihoods (World Bank, 2008 and FAO, 2009). These estimates highlight the important contribution of livestock to sustainable agricultural development. Thirdly, animals are sources of food. Specifically, they are rich in proteins for human diets and can also become an income, employment and possibly foreign exchanges generator for low income producers. Livestock can serve as wealth store; can provide draught powers, organic fertilizers for crops productions and can be used as means of conveyance. This provides good business opportunities for livestock producers mainly in developing countries. The contribution of livestock to the world's food supply, family nutrition, incomes, employment, soil fertility, livelihoods, transport and sustainable agricultural production continues to be a subject of significant review and debate (LID, 1999). Based on this, for developing countries, practicing urban agriculture (crops and livestock) can be a response in alleviating poverty in urban areas, through (i) jobs creation and income generation, (ii) the reduction of the cost of life and urban community sanitary situation with the provision of fresh food at a relative lower cost, (iii) the creation of stand-alone cities.

Understanding the concept of urban planning and its usage

Urban planning refers to the process of improving the welfare of people and their communities by creating more convenient, equitable, healthful, efficient, and attractive

places for present and future generations. The urban area is known to be part of the biopolitic construction of the country meaning that, urban planning helps in creating communities that offer better choices for where and how people live. Planning helps communities to envision their future. It helps them in finding the right balance of new development and essential services, environmental protection, and innovative change. That means, planning a city supposes a good command of the population's variations, identification of its strengths and its weaknesses in terms of the work force quality. It refers also to the construction of adequate infrastructures; they could be for entertainment (stadia), socialization (schools, markets), for humanization (hospital, clean water). Adding to the above social actions, we have the construction of decent settlements in order to avoid communicable diseases, promiscuity and criminal behaviours. From a strategic perspective of urban planning, there will be a need for including cities' designers and civilians in order to come up with a well-defined vision and clear objectives so that every citizen is aware of where political leaders, city authorities are heading the town or the urban settlement to.

Urban Economy in a country development

The problem of urban economy has been at the centre of many discussions. The urban economy is mostly built around resourcefulness. Cities in both developed and undeveloped countries are built on inequities, whereby a good percentage of dwellers are hustlers, but are the most to participate in the building of national economies, with tax payments, renting and good consumptions. They can be ranked in few groups: taxi drivers, vendors, shops owners, moto-taxi drivers, hawkers, call box owners, cyber café workers, transporters of rickshaws, maneuvers in yards, house helps, night vigils, barbers... and so on. These proliferations of small businesses constitute a development lever on which political authorities could be based on for the economy recovery.

The regulation and supervision of small trades

Many urban planners nowadays think that, with the regulation of the small jobs sector by the use of a legal framework environment, the link to customs and tax policies, the increase of the minimal salary amount and the reduction of corruption can lead those engaged in such activities to operate safely. For example, in many countries like Kenya, a qualified house help earns 110 usd, whereas in Cameroon, qualified or not, a house help has less than 80 usd per month (Commission on Revenue Allocation in Cameroon and Kenya, 2014).

From that, how do we expect such Social Corporation for example, to rent a decent house, to buy a land on an appropriate tenure instead of swampy areas if their level of incomes unable them in achieving their monthly needs? How do we want them to have access to decent schools and hospitals with such living standards? Activities like driving cars and bikes should be allowed after a successful attendance for examination in order to be given a driving license; this will reduce death rate caused by road accidents. A flexible policy and facilitation should also be considered for the creation and bank facilities for smaller and medium size enterprises and start-ups.

Lastly, it will be useful to gather or encourage those small traders to be constituted in groups according to their nature in order to make their assistance easier. They can be gathered in cooperatives, trade unions or simple associations where the government will be able to monitor and solve their daily difficulties as a corporation, not as an individual.

Promoting urban Agriculture as a relevant alternative

One of the issues with urban area is that, city dwellers depend on rural agriculture production coming from the countryside. Considering citizens' level of income in urban areas, it is obvious that village products including transport fees become expensive then not so quite accessible for all. Government should seek for ways to develop urban agriculture as a response to that. In simple words, urban agriculture can be defined as the one taking

place in swampy areas in shantytowns, or plots of land surrounding the city. Nevertheless, most definitions embrace agricultural production for both self consumption and some trade (sale, barter, gifts, etc.). Both destinations are usually found to be targeted to varying degrees by the producers or households studied in urban areas. Economic research recently has been aimed at specific (export) market-oriented production and has helped us to better understand the economic performance of Urban Agriculture and its comparative pros over other supply sources, both at the producer and consumer level. On the self consumption level, relatively more attention should be given to the economics of animal assets and the utility of supplemental food self consumption afforded by Urban Agriculture to households, whereas in Accra, there was not a real consideration of the asset value of small livestock. A study in Cairo, a city thrice as densely peopled as Accra and with only 3% of its precipitation, revealed that almost 30% of low income households in informal housing had livestock worth on average nearly a full month of income (GTZ, 1999. Today, Smit et al., (1996b). The study also claimed that an estimated 800 million people are engaged in Urban Agriculture across the world; of these, 200 million are market producers, employing 150 million people full time (Smit et al., 1996b). Denninger et al., (1998) estimates among the 65 million people living in urban areas of Eritrea, Ethiopia, Kenya, Tanzania, Uganda and Zambia, 25 of them currently obtain part of their food from Urban Agriculture and that, by 2020, at least 35 to 40 million urban residents will depend on UA to feed Themselves. Data on several production systems draw dramatic growth in numbers of producers, production systems at work, area used, production and yields in several cities. Both production capacity and yields have increased, despite area reduction in market vegetable gardening in Dakar (Mbaye 1999, de Bon et al., 1997). Similar trends can be observed in Kumasi (Abutiate 1995), Lomé (Kouvonou et al., 1998) and in local and export specialty crops in Bissau (Lourenço Lindell 1995). Related to the urban food supply side, crop choices, agricultural credit programs and incentives, technical extension and research, and distribution networks often have been imposed by export and hard currency earning policies, high transaction costs may discourage rural producers from supplying critical markets; institutional frameworks may not be in place for markets to operate effectively. The production of food in cities provides nutritious food otherwise unaffordable (Self production represents anywhere from 18% (East Jakarta) to 60% (Kampala) of total food consumption in low income households, with sample percentages depending solely on self production reaching 50% (Nairobi) (Mougeot 1994). In Harare, savings of low income farmers are equivalent to as much as several months of earnings (ENDA-ZW 1997). In Havana, urban gardens have significantly increased the quality and quantity of food available to the producers' households and their neighborhood, improved the financial welfare of the households and enhanced the environmental quality of the community (Altieri et al.,1999).

Urban agriculture as a source of income generation and community welfare

As expressed earlier in this document, the practice of agriculture in urban area can become a real solution for poverty alleviation. Those involved in the practice will be able with the harvest from their farms to earn their daily lives decently, mainly if the practice is around cereals like maize and tubers like sweet potato whose life cycle is not extending 3 or 6 months. It has been shown that, with modern agriculture techniques, a Ha of sweet potato can provide 15 tones (CIP document on the Importance of Sweet potato, 2014). Adding to this, we have the livestock sector with poultry and small scale breeding whereby: eggs, lived chickens or slaughtered and fresh milk could be very interesting for income generation and reduction of lives expenditure in both self consumption or market driven. The approximate cost of a 1 month and half chicken is USD 5, since it is a wide consumption food, practicing poultry can be with certainty and income source of generation. We can also cite breeding with fresh milk production, for sailing or family consumption, can either bring income

generation or money savings, an average 500 kgs cow produce close to USD 300 dollars daily (Oxfam project in Kenya, 2005).)

The impact of Urban Agriculture on urban community welfare is more documented than the impact on the rural counterparts. In low income urban districts of Bissau, Brazzaville and Nairobi, for example, urban farmers contribute to community welfare and funeral groups and to formal and informal channels of food acquisition. They generate employment and additional or seasonal income for other basic needs (processed food), link up with the food trade, produce food products otherwise unaffordable, reduce dependence on purchased food, enhance their own exchange entitlement and provide food gifts and meal sharing (Laurenço Lindell 1996, Moustier 1996, Dennery 1996). In Bissau and Port au Prince, the frequent gifting of food by home producers strengthens reciprocity within assistance networks and reduces incidence of theft. Open space producers also unwillingly contribute to curbing food insecurity through loss of crops, animals and other assets to theft, commonly reported in surveys (Lourenço Lindell 1995, Régis 1999).

Urban Agriculture practice for a free diseases urban community

Apart from being a real source of income generation, agriculture in urban area can help in ameliorating the health condition of urban population, with the consumption of fresh product whose are healthy. Developing countries are known to face various infrastructure problems such as lack of road and a poor electricity supply and so on... sometimes, goods from countryside like vegetables, plantain or other cereals will spend more than two or three days before reaching the town and therefore will lost all their freshness and some relevant nutriments useful for Health. Promoting urban agriculture will enable urban communities to consume fresh food directly from farms in neighborhoods around cities. The practice of livestock in urban area will also help urban dwellers in consuming fresh meat and eggs. In a city like Yaoundé in Cameroon for example, there is not any cold or slaughterhouse which exists to provide fresh animal products. The supply in animal direct and processed products at time is from the eastern and northern regions of Cameroon respectively, hundreds kilometers far from the capital after long distance of transportation under doubtful conservation methods or techniques. The provision of milk, meat and eggs at time is from the eastern and northern regions of Cameroon respectively hundreds kilometers far from the capital. Suppliers need long distance to transport those foods under doubtful conservation methods and techniques. Also, practicing urban agriculture can reduce the higher risky to malnutrition diseases. Globally, an estimated 165 million children under five years meaning 26% in the world have become stunted in 2011 - a decrease of 35%, instead of 253 million in 1990. 36% of African children under the age of 5 have stunted growth. Stunting is used as an indicator of chronic malnutrition. One third of the death of children less than five years is caused by malnutrition and Vitamin A deficiency (Demographic and National Health Surveys, 2008, 2010, Mozambique). Consequently, iron deficiency limits the mental capacity of 2 billion children in the world and is linked to about: (i) 25% of maternal deaths in developing countries, due to Iodine deficiency causes brain damage in newborns, nearly 18 million per year and is the leading preventable cause of mental retardation, (ii) the vitamin A deficiency causes blindness or visual impair illness to nearly 500,000 children and kills nearly 670,000 of them under 5 years, (iii) approximately 150,000 newborns have severe birth defects every year due to deficiency of folic acid, (iv) only 1/3 of the world population is estimated living in areas at high risk of zinc deficiency, which can lead to decreased immunity and increased mortality of infections resulting from infections such as diarrhea, especially among children.

More than one third of the world population meaning more than 3 billion people in 2013 is affected by deficiencies in essential micronutrients such as iron, iodine, vitamin A acid folic and zinc. (Demographic and National Health Surveys, 2008, 2010, Mozambique)

To tackle this, promoting urban agriculture

could be an efficient approach in supplying the urban population with healthy, fresh, good food at a very competitive price. With tubers like orange flesh sweet potato very rich in Vitamin A or other nutriments containing Beta-carotene (Vitamin A) like vegetables, seed crops (maize, millet, rice, sorghum) could be considered as responses to the fight against vitamin A deficiency in urban areas.

Reconsidering the work force capacity in urban area

It is obvious that the major workforce in urban areas is unqualified and therefore underestimated even wrongly ranked and paid. This could be an opportunity for governments and decision-makers to create infrastructure in proportion to populations needs.

Some professional schools specialized in small trades can be opened and free of charge, to help this abundant work force upgrading its quality to meet the exigencies of the labour-market force and professional management for those who are self-employed, meaning owners of start-ups and small and medium size enterprises. The advantages of this, will be their reconsideration after those trainings sessions depending on their sector of activity and level of education, a professional certification should be awarded to a house help or car washer so that his/her intrinsic value is no longer questionable and therefore will be paid, based on his/her professional capacities and experiences. It will be obvious that, this qualified workforce will no longer be paid as unqualified jobless work force ready to do anything in order to survive, but as professional workers seeking for decent jobs.

Conclusion

In summary, this article argues that, agriculture in urban area is relevant for national economy. With the increasing number of poor people in the world, 1.2 billion people survive on less than $1 a day, economic growth is important for poverty reduction, on its own, but such growth is not enough. To reduce poverty, growth must occur in a sector in which the poor are already actively participating in, for them to benefit directly from it. Agriculture (crops and livestock) can make a major contribution to poverty reduction as about 50-75 percent of the world's poor depend on it as part of their livelihood. Apart from having a direct impact on farm incomes and rural employment, agricultural growth also stimulates other forms of growth through demand for non tradable and consumption linkages. Agricultural growth has a much greater impact on poverty reduction than the equivalent level of urban, industrial growth. Practicing urban agriculture, will definitely upgrade the income generation for the abundant unqualified workforce in urban cities in developing countries. It is therefore, the role of political leaders to regulate that fruitful sector, with (i) the provision of land regulation policies, meaning the legalization of urban agriculture as a step towards securing lands for the urban poor since its illegal status consideration has left a governance vacuum, which could be filled through policy formulation and regular institutionalized management in a participatory manner including all relevant stakeholders if food security has to be increased and environment improved in an urban development context., (ii) the supply of fertilizers and seeds for cereals, and tubers in order to improve the expected harvest capacities and monitor the process with a free of charge availability and supply of agronomy technicians staff (iii) and finally with training programs related to the same.

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SHORT COMMUNICATION:

FATAL HYPERLIPAEMIA SYNDROME IN A DONKEY (*Equus asinus*) IN IBADAN, OYO STATE, NIGERIA

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Introduction

Hyperlipaemia is a severe clinical syndrome characterised by fatty infiltration of the liver (hepatic lipidosis) and elevations of blood lipids sufficient to cause grossly visible changes in the blood (Mair, 1995). Hyperlipaemia occurs most commonly in fat ponies in late pregnancy and is rarely seen in larger horses (Jeffcott and Field, 1985). There have also been a few reports of this syndrome in donkeys (Mair, 1995; Tarrant et al., 1998). Although pregnancy and lactation are widely acknowledged as risk factors for hyperlipaemia, other factors such as age, sex, and body condition have been associated with the risk of developing this disease in donkeys. Reid and Mohammed (1996) reported that female donkeys and donkeys of obese body condition are more at risk of developing hyperlipaemia than males or those of moderate or poor body condition, respectively. They also reported that older animals were at higher risk than younger animals. The pathogenesis of the hepatic lipidosis observed in hyperlipaemia syndrome is associated with negative energy balance usually due to pregnancy, parturition, high milk production, or anorexia from other disease states such as mastitis, displaced abomasum, and ketosis. As a result, excessive lipid is mobilized from body reservoirs, and fatty acids are transported to the liver, kidney, and muscle. The ability of the liver to process triglycerides for export as lipoproteins is limited; therefore, excess lipid is deposited as intracellular droplets of triglycerides (Mair, 1995; Palmer and Olsen, 2002; Seifi et al., 2002). Initially, affected animals are lethargic and anorexic. As the disease progresses, diarrhoea, colic, ventral oedema, signs of central nervous system dysfunction (e.g. ataxia, head-pressing) and recumbency may develop (Hughes, Hodgson and Dart 2004). Haematological findings are nonspecific and may include haemoconcentration, stress leukogram, neutrophilia or neutropenia. Clinical chemistry findings may include azotaemia, increased concentrations of hepatocellular leakage and cholestatic enzymes (e.g AST, GLDH, GGT) bilirubin and bile acids, hypoglycaemia, electrolyte derangements, hyperlactataemia and metabolic acidosis (Hughes, Hodgson & Dart 2004). Postmortem findings in hyperlipaemia syndrome are usually those of lipid deposition in body tissues (especially liver and kidneys), (Hughes, 2012). There is no published report of the occurrence of this syndrome in donkeys in Nigeria. Most of the previous reports of this syndrome in donkeys have been from the Northern hemisphere and Australia (Mair, 1995; Reid and Mohammed, 1996; Tarrant et al., 1998). Here, we present a case of fatal hyperlipaemia syndrome in a donkey in Ibadan, Nigeria.

Case History, Diagnosis and Discussion

The carcass of an adult female donkey owned by the Zoological Gardens, University of Ibadan was presented for necropsy in the Department of Veterinary Pathology, University of Ibadan. The donkey was acquired as an adult from Borno state, Nigeria, and was housed in the Zoological Garden, University of Ibadan for about four months prior to death. Ever since the animal was acquired, it had been progressively losing weight in spite of feeding. The donkey subsequently became anorexic, weak and recumbent, five days prior to death. Clinical examination five days prior to death revealed a rectal temperature of 36.4^{0}C, respiratory rate of 48 breaths/min (reference range: 16-66 breaths per minute) and a capillary refill time of less than 2 seconds (reference range: 1-2 seconds).

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Five days prior to death, the animal was bled via venipuncture of the jugular vein for haematology and clinical chemistry. Haematology was unremarkable, however the plasma was cloudy (lipaemic). Clinical chemistry revealed moderate azotaemia (Blood urea nitrogen-34mg/dl, Creatinine-2.5mg/dl), (reference values-creatinine: 0.6-1.5mg/dl; BUN: 7-27mg/dl). The values of other analytes evaluated (albumin, alanine transaminase, aspartate transaminase, glucose and bilirubin-T), were within their respective normal reference range.

At necropsy the liver was markedly enlarged, diffusely pale, greasy on cut surface and friable (Fig. 1). Samples of the liver floated in formalin. Other lesions observed included, severe emaciation, dehydration, markedly pale mucous membranes and kidneys. The uterus contained three litres of yellowish watery fluid and a fully formed foetus. Histologically, all the hepatocytes in the liver were markedly enlarged and each had a single, large cytoplasmic vacuole. The nuclei of the enlarged hepatocytes were flattened and displaced to the periphery (Fig.2).

The present case was diagnosed as hyperlipaemia syndrome due to the findings of lipaemic plasma, diffuse hepatic lipidosis and moderate azotaemia. The lesions observed in this case are similar to those reported in previous cases of hyperlipaemia syndrome in ponies, American miniature horses and donkeys (Gay et al., 1978; Moore et al., 1994; Mogg and Palmer, 1995). Hyperlipaemia is caused by decreased caloric intake, which causes fat mobilization and fat accumulation in the liver and accumulation in the plasma (Maas and Pearson, 2009). It is possible that the disease was initiated in this donkey by a falling nutritional plane in the face of high nutritional requirements associated with the jenny's pregnancy status. Pregnancy and lactation are widely acknowledged as risk factors for hyperlipaemia in donkeys (Jeffcott and Field, 1985). The cause of the moderate azotemia observed in this case could not be determined. However, the azotaemia observed is most likely prerenal as a result of dehydration occasioned by the donkey's refusal to feed or drink water for five days. Azotaemia has been reported as a common finding in hyperlipaemic horses (Maas and Pearson, 2009; Hughes, 2012). Hughes (2012) also reported that azotaemia could exacerbate hyperlipaemia by inhibiting the hydrolysis of very low density lipoproteins in peripheral tissues to free fatty acids and glycerol, resulting in increased serum levels of triglycerides. Hyperlipaemia is usually fatal in donkeys, thus improvement of body condition, reduction of stress, close monitoring of high-risk donkeys, early detection and treatment may improve survival (Mogg and Palmer, 1995; Reid and Mohammed, 1996).

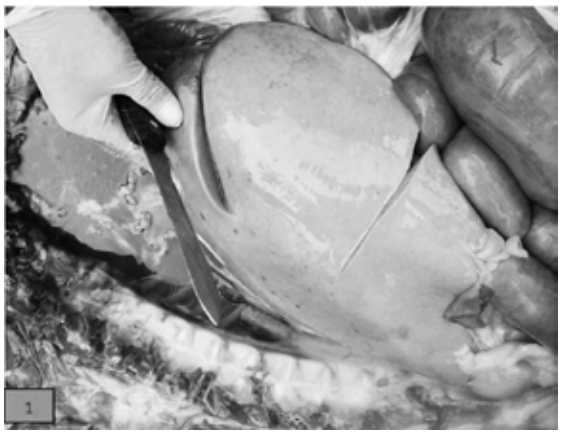

Plate 1: Markedly enlarged, diffusely pale, greasy liver.

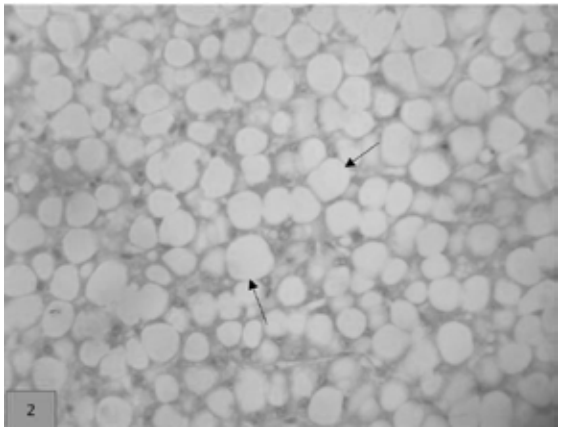

Plate 2: Liver of donkey showing severe, diffuse hepatocellular vacuolation (arrows) with displacement of nuclei to the periphery. (X400), H&E.

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AFRICAN UNION - INTERAFRICAN BUREAU FOR ANIMAL RESOURCES (AU-IBAR)

Bulletin of Animal Health and Production in Africa
Guide for Preparation of Papers
Notes to Authors

The Editor in Chief
January 2013

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The Bulletin of Animal Health and Production in Africa (BAHPA) of the African Union Interafrican Bureau for Animal Resources (AU-IBAR) is a scientific journal which publishes articles on research relevant to animal health and production including wildlife and fisheries contributing to the human wellbeing, food security, poverty alleviation and sustainable development in Africa. The bulletin disseminates technical recommendations on animal health and production to stakeholders, including policy makers, researchers and scientists in member states. The Bulletin is the African voice on animal resources issues specific to Africa.

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6. Materials and Methods should describe materials, methods, apparatus, experimental procedure and statistical methods (experimental design, data collection and data analysis) in sufficient detail to allow other authors to reproduce the results. This part may have subheadings. The experimental methods and treatments applied shall conform to the most recent guidelines on the animal's treatment and care. For manuscripts that report complex statistics, the Editor recommends statistical consultation (or at least expertise); a biostatistician may review such manuscripts during the review process. Cite only textbooks and published article references to support your choices of tests. Indicate any statistics software used.
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