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1. **KIDNEY LESIONS IN DROMEDARY CAMELS AT SLAUGHTER IN MAIDUGURI, NIGERIA: JANUARY-MARCH, 2017.** *Ali Waziri, Shehu Usman Hassan and Ikechukwu Onyebuchi Igbokwe*..... 7
2. **PREVALENCE OF GASTROINTESTINAL PARASITES IN GOATS SLAUGHTERED IN CHIBOLYA ABATTOIR, LUSAKA, ZAMBIA.** *Bukowa K M, Nyirenda S, Mwanamoonga B, Mbewe J, Hamankolo F, Fandamu P, Mumba M I and Zulu E*..... 17
3. **EFFECT OF REPLACING LOCAL FISH MEAL WITH CRAYFISH DUST ON THE GROWTH PERFORMANCE, BLOOD PROFILE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS.** *Sogunle O M, Abodunrin O J, Adeleye O O, Akinyemi O D and Makanjuola B A*..... 31
4. **EVALUATION OF *FASCIOLA* SPP. INFECTION OF CATTLE AND SHEEP FROM NIGERIAN CITIES OF JOS, GOMBE AND MAIDUGURI.** *Luka J, Ajanusi O J, Chiezey N P, Bale J O O, Tanko J T and Okoro D O*..... 41
5. **CHARACTERISTICS AND MANAGEMENT PRACTICES OF GOAT PRODUCTION SYSTEMS IN ZAMBIA.** *Idowu Kolawole Odubote*..... 53
6. **INTENSITY AND RISK FACTORS ASSOCIATED WITH GASTRO INTESTINAL PARASITE INFECTIONS OF CATTLE IN MATHIRA SUB COUNTY, KENYA.** *Carolyn Nyutu, Maureen Stella Olunga and Donald Siamba*..... 65
7. **STATUS OF THE ANIMAL HEALTHCARE DELIVERY SYSTEMS IN WEST POKOT AND TURKANA DISTRICTS OF KENYA.** *Lewa A K, Mbithi P M F, Nyariki D M, Muchina S J and Wabacha J K*..... 77



## KIDNEY LESIONS IN DROMEDARY CAMELS AT SLAUGHTER IN MAIDUGURI, NIGERIA: JANUARY-MARCH, 2017

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### Abstract

Kidney lesions of dromedary camels were investigated in an observational cross-sectional survey in an abattoir in Maiduguri, Nigeria (January to March, 2017). The kidneys of 82 camels were collected after slaughter for gross and microscopic examination in order to identify lesions. The kidneys of two (2.4%) camels exhibited gross lesions with either pyo-nodular or granular subcapsular lesions which represented localized acute purulent interstitial nephritis or chronic fibrosing lymphoplasmocytic interstitial nephritis, respectively. The kidneys of 80 (97.6%) out of 82 camels with no apparent gross lesions had microscopic lesions in all the kidneys (100%). The microscopic lesions among all the camels (and their frequencies) were renal tubular degeneration and necrosis (100.0%), acute (13.4%) or chronic (6.1%) interstitial nephritis (19.5%), interstitial fibrosis (6.1%), proliferative (4.9%) or membranous (9.8%) glomerulonephritis, membranoproliferative glomerulonephritis (1.2%) and glomerular atrophy (23.2%). In conclusion, kidney lesions were infrequently recognised as gross lesions among the dromedary camels, but microscopic lesions were commonly encountered as nephrosis or nephritides, suggesting that renal function assessment might be necessary in the routine dromedary health evaluations in local veterinary practices.

**Keywords:** Camel, Dromedary, Kidney, Lesions, Nigeria

## LÉSIONS RÉNALES DES DROMADAIRES À L'ABATTOIR DE MAIDUGURI AU NIGERIA : JANVIER-MARS 2017

### Résumé

Des lésions rénales de dromadaires ont été étudiées dans une enquête observationnelle transversale, dans un abattoir de Maiduguri au Nigéria (janvier à mars 2017). Les reins de 82 chameaux ont été prélevés après l'abattage et soumis à un examen macroscopique et microscopique, dans l'objectif d'identifier la nature des lésions. Les reins de deux (2,4%) chameaux présentaient des lésions macroscopiques, avec des lésions sous-capsulaires pyo-nodulaires ou granulaires qui représentaient respectivement une néphrite interstitielle aiguë purulente localisée ou une néphrite interstitielle lymphoplasmocytaire fibreuse chronique. L'ensemble des reins de 80 (97,6%) des 82 chameaux sans lésions macroscopiques apparentes avaient des lésions microscopiques (100%). Les lésions microscopiques chez tous les chameaux (et leurs fréquences) étaient la dégénérescence et la nécrose tubulaires rénales (100,0%), la néphrite interstitielle aiguë (13,4%) ou chronique (6,1%), la néphrite interstitielle (19,5%), la fibrose interstitielle (6,1%), la glomérulonéphrite proliférative (4,9%) ou membraneuse (9,8%), la glomérulonéphrite membranoproliférative (1,2%), et l'atrophie glomérulaire (23,2%). En conclusion, les lésions rénales étaient rarement reconnues comme des lésions macroscopiques chez les dromadaires, mais des lésions microscopiques étaient fréquemment observées sous forme de néphrose ou de néphrite, ce qui porte à croire qu'une évaluation de la fonction rénale pourrait être nécessaire dans les analyses de routine de la santé du dromadaire dans les cabinets vétérinaires locaux.

**Mots-clés :** Chameau, Dromadaire, Rein, Lésions, Nigéria

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## Introduction

The dromedary camels are often imported into northern Nigeria from neighbouring countries by pastoral herders who move with the animals from North and East Africa. The increasing local sedentary and imported population of camels frequently requires veterinary attention, and the veterinary services may not be available in remote inaccessible desert-like environments where the animals are located. As race, pack and work animals, the camels go through stressful periods deprived of adequate feed and water supply but are reported to be hardy with the capacity to withstand extreme desert conditions (Waziri, 2018). The principal mechanism by which the camel survives in the desert is its ability to conserve body water by producing highly concentrated urine (Wilson, 1984), achieved by kidneys that are morphologically adapted for this role (Abdalla and Abdalla, 1979; Abdalla, 2020). Previous reports indicated that dromedary camels in other countries were presented with kidney lesions such as renal capsular pigmentation or thickening, subcapsular and vascular calcification or cysts, glomerular congestion, haemorrhage or atrophy, pyelonephritis, glomerulonephritis, acute tubular necrosis, interstitial nephritis and fibrosis, nephrolithiasis, renal cell adenoma and hydatidosis (Taha *et al.*, 2007; Salem and Hassan, 2011; Rezaie *et al.*, 2014; Kojouri *et al.*, 2014; Saini *et al.*, 2015; Tharwat *et al.*, 2018).

To enhance camel veterinary practice, it is necessary to identify the types and frequencies of lesions which may be affecting renal functions and undermining the health of the dromedary camels in every locality. Preliminary surveys indicated that acute inflammatory conditions of the camel kidneys were rare in Maiduguri, Nigeria, as none was reported among 50 camels examined for kidney lesions, but tubular nephrosis occurred in 62% of the sample population (Hassan *et al.*, 2015). However, nephritides were more common than nephrosis with interstitial nephritis (Saini *et al.*, 2015) or glomerulonephritis (Rezaie *et al.*, 2014) being the commonest kidney lesion

among camels in other study locations. An expanded survey was, therefore, embarked on that increased the sample size to confirm the preponderance of tubular nephrosis over nephritis in the kidneys of camels in Nigeria.

This study was conducted as a postmortem survey of the gross and microscopic lesions in kidneys of dromedary camels presented for slaughter at the abattoir in Maiduguri, Nigeria, with the objective of identifying the various lesions that could be impacting on the renal function and health of the animals.

## Materials and Methods

### *Study design*

The study was an observational, cross-sectional survey of dromedary camels (*Camelus dromedarius*) for gross and microscopic lesions in the kidneys, conducted in an abattoir in Maiduguri (Latitude 11°N and Longitude 13°E), Borno State, Nigeria, where dromedary camels were slaughtered for meat (Baba *et al.*, 1994).

### *Animal Selection*

Eighty two apparently healthy camels were selected for the study by convenient (non-randomized) sampling at the abattoir during the dry season (January-March, 2017). Age and sex were determined using dentition (Ramadan, 1994) and genital observation, respectively. Those selected were adult (> 1.0 year old) male and non-pregnant female camels.

### *Gross Examination of Kidneys*

The pair of kidneys of each camel was examined grossly following routine visual examination, palpation, midsagittal incision and peeling of the renal capsule (Igbokwe, 1989). Lesions were identified, described and photographed.

### *Microscopic Examination of the Kidneys*

Sections of the kidneys were collected and fixed in 10% buffered formalin for at least 48 hours, processed, embedded in paraffin wax, sectioned at 5 µm thickness and stained with Haematoxylin and Eosin (H and E) (Maynard and

El-Nageh, 2003). Tissue sections were examined for microscopic lesions at  $\times 40$ ,  $\times 100$  and  $\times 400$  magnifications, using a light microscope (Amscope® model BNJY 120, United Scope Inc., USA) mounted with a 5-megapixel digital eyepiece camera (Amscope® model MD500, United Scope Inc., USA). Photomicrographs were taken and collated to illustrate the described lesions.

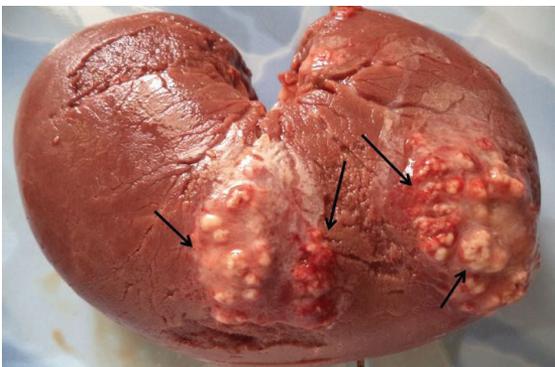
#### Statistical Analysis

The data were descriptively summarized as numbers of occurrences of lesions and their proportions (in percentage) relative to the examined sample size. Comparison of frequencies was done by chi-square analysis using computer software (GraphPad InStat).

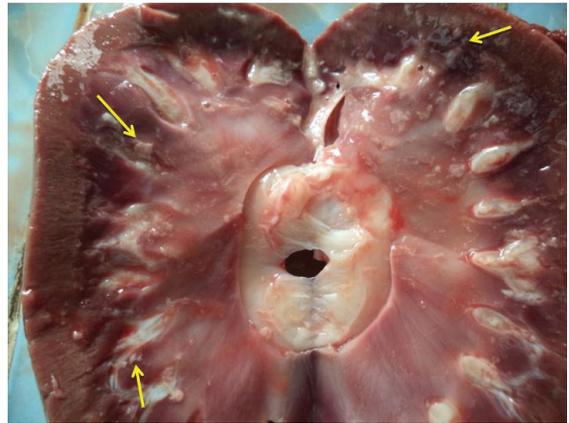
## Results

#### Gross Lesions

The kidneys of two camels (2.4%) out of 82 camels had gross lesions. Both kidneys of one of the camels showed multiple subcapsular haemorrhagic pyo-nodular lesions (Fig. 1). The capsule was partly adherent to the parenchyma and difficult to remove. The cut surface had diffuse whitish to greyish discrete foci extending from the cortex to the renal pelvis (Fig. 2). The kidneys of the second camel showed widely extensive granular subcapsular surfaces with multiple pale linear streaks radiating from the renal hilus to the lateral convex margin (Fig. 3). Kidneys of the other 80 camels (97.6%) examined had no apparent gross lesions.



**Figure 1:** Multiple subcapsular pyo-nodular (short arrows) lesions and haemorrhages (long arrows) of kidneys of the camel

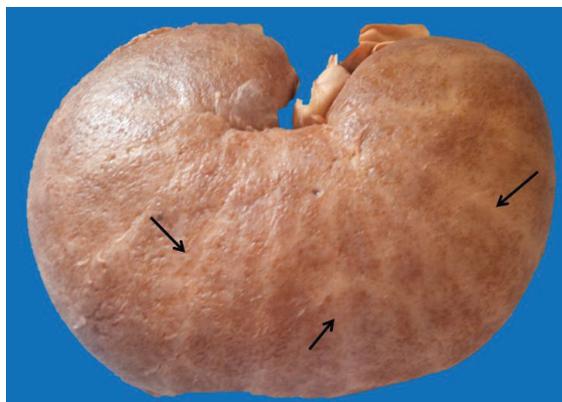


**Figure 2:** Cut surface of camel kidney showing discrete grey foci of pus distributed throughout the cortex and medulla (arrows)

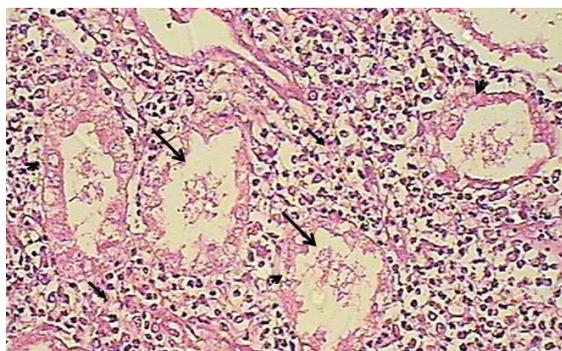
#### Microscopic Lesions

The kidneys from the first camel with gross pyo-nodular lesions were confirmed at histopathology to have acute purulent interstitial nephritis in both the medulla and cortex, characterised by neutrophilic infiltration of the interstitial connective tissue, necrosis of tubular epithelial cells, thickening of glomerular mesangium and the presence of eosinophilic casts in the tubular lumina (Fig. 4-5). The kidneys from the second camel with granular subcapsular parenchyma were microscopically observed to have chronic interstitial nephritis characterised by lymphoplasmacytic infiltration of the interstitium (Fig. 6), interstitial fibrosis, renal tubular atrophy, periglomerular eosinophilic homogenous hyaline deposition, presence of eosinophilic casts in the tubular lumina, expansion of glomerular mesangium, glomerulosclerosis and glomerular atrophy. All the kidneys from the other 80 camels with no apparent gross lesions showed various microscopic lesions such as acute interstitial nephritis, chronic interstitial nephritis, renal tubular degeneration and necrosis with protein (eosinophilic) casts in the lumina, protein casts in Bowman's space, renal congestion and haemorrhage, interstitial fibrosis, periglomerular hyalinization, glomerular atrophy, proliferative glomerulonephritis, membranous glomerulonephritis and membranoproliferative glomerulonephritis. The photomicrographs

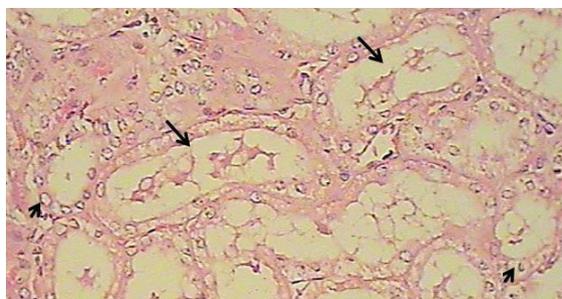
illustrating the lesions in the kidneys without apparent gross lesions are presented in Figures. 7-10.



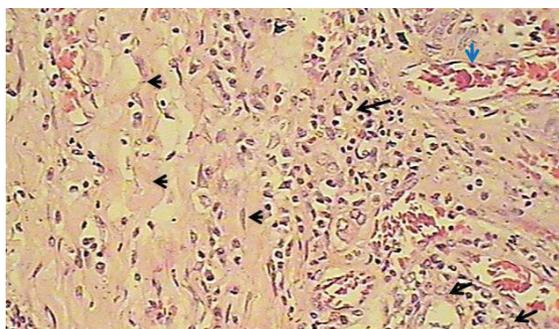
**Figure 3:** Diffuse granular subcapsular surfaces with multiple pale linear streaks radiating out from the renal hilus of kidneys of the camel



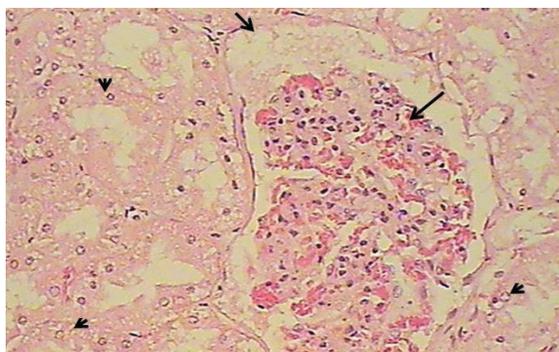
**Figure 4:** Photomicrograph of the kidney showing diffuse neutrophilic infiltration of the interstitium (short arrows) and eosinophilic proteinaceous deposits (long arrows) in the tubular lumina, with degeneration and necrosis of tubular epithelia (arrow heads), H & E, x 400



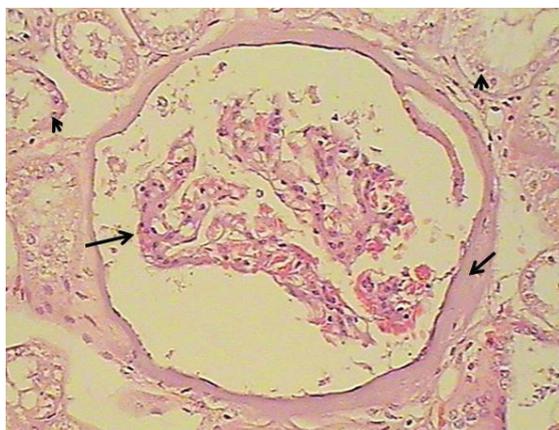
**Figure 5:** Photomicrograph of kidney showing diffuse eosinophilic deposits in tubular lumen (arrows), degenerating and necrotic tubular epithelia (arrow heads), H and E, x 400



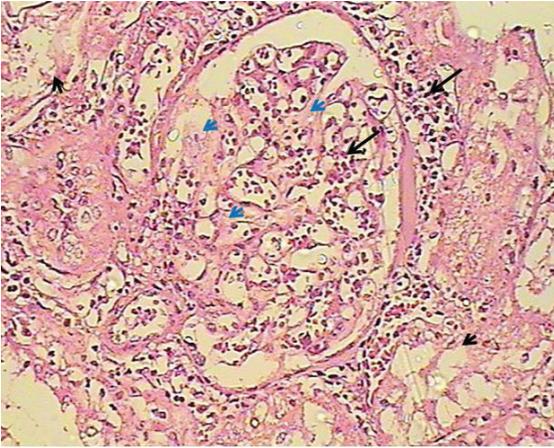
**Figure 6:** Photomicrograph of kidney showing lymphoplasmacytic infiltration of the interstitium (long black arrow), interstitial fibrosis (arrow heads), congestion (blue short arrow) and tubular atrophy (short black arrows), H & E, x 400



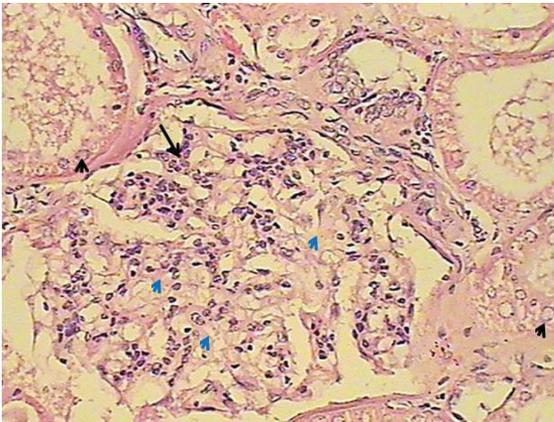
**Figure 7:** Photomicrograph of kidney showing haemorrhages in the glomerulus (long arrow), proteinaceous deposition (short arrow) in Bowman's space and necrotic tubular epithelia (arrow heads), H & E, x 400



**Figure 8:** Photomicrograph of kidney showing glomerular atrophy (long arrow), periglomerular hyalinization (short arrow) and degeneration and necrosis of tubular epithelia (arrow heads), H & E, x 400



**Figure 9:** Photomicrograph of the kidney showing mesangial cells proliferation and neutrophilic infiltration in both interstitium and glomerulus (arrows), thickening of the capillary basement membrane (blue arrow heads) and necrosis of tubular epithelia (black arrow heads), H & E, x 400



**Figure 10:** Photomicrograph of kidney showing neutrophilic infiltration of the glomerulus (arrow), thickening of the capillary basement membrane (blue head arrows) with degeneration and necrosis of tubular epithelia (black arrow heads), H & E, x 400

The frequencies of microscopic kidney lesions among the 82 camels studied are summarized in Table I. The most frequent kidney lesion (100%) was tubular nephrosis (degeneration and necrosis) which occurred in all the camels. Inflammatory conditions of the kidneys occurred as acute (13.4%) and chronic (6.1%) interstitial nephritis (19.5%) or proliferative (4.9%), membranous (9.8%) and membranoproliferative glomerulonephritis

(15.9%). There was no significant ( $p > 0.05$ ) difference between the frequencies of interstitial nephritis and glomerulonephritis (OR = 1.29). The nephritis (35.4%) was less common than tubular nephrosis (100%), with the odds for the occurrence of nephritis at 0.3% (OR = 0.003,  $p < 0.0001$ ). Lesions associated with circulatory disturbance in the interstitium were vascular congestion (12.2%) and interstitial haemorrhage (29.3%). Glomerular atrophy (23.2%), periglomerular hyalinization (35.4%) and protein casts in Bowman's space (62.2%) were also observed.

## Discussion

The kidneys of all the camels (100%) examined had microscopic lesions which manifested grossly in only two camels (2.4%). The lesions were abnormal structures not associated with normal camel kidneys (Safer *et al.*, 1988, 1991; Xu *et al.*, 2009). This is evidence that subclinical kidney pathological conditions may not manifest grossly among the camels at necropsy (Aughey and Frye, 2001). The relative frequencies of kidney lesions were reported as 4.4% in Sudanese camels (Fouad, 2004), 14.0% in Iranian camels (Kojouri *et al.*, 2014), 16.5% in Egyptian camels (Salem and Hassan, 2011) and 66% in Saudi Arabian camels (Barakat *et al.*, 2017). These renal conditions may be caused by infectious and non-infectious conditions (Newman, 2012) with predisposing factors emanating from the arid weather conditions associated with heat stress and water scarcity (Johnson *et al.*, 2016).

Renal tubular degeneration and necrosis (nephrosis), with eosinophilic deposits (protein) in some tubular lumina, were the commonest lesions. Similar reports of high prevalence rates of acute renal tubular necrosis in camels were also reported in other studies (Salem and Hassan, 2011; Kojouri *et al.*, 2014; Hassan *et al.*, 2015). However, a lower prevalence of acute tubular necrosis compared to other lesions was reported in another study (Rezaie *et al.*, 2014). The renal tubular epithelial cells, particularly the proximal convoluted tubules, can be directly damaged by nephrotoxins or

**Table 1:** Frequency of occurrence of microscopic lesions in kidneys of dromedary camels (n = 82)

Type of lesion	Number (%)
Acute interstitial nephritis	11 (13.4)
Chronic interstitial nephritis	5 (6.1)
Renal tubular degeneration and necrosis	82 (100)
Protein casts in Bowman's space	51 (62.2)
Renal congestion	10 (12.2)
Renal haemorrhages	24 (29.3)
Interstitial fibrosis	5 (6.1)
Hyaline degeneration	29 (35.4)
Glomerular atrophy	19 (23.2)
Proliferative glomerulonephritis	4 (4.9)
Membranous glomerulonephritis	8 (9.8)
Membranoproliferative glomerulonephritis	1 (1.2)

indirectly injured by nephrotoxin-induced ischaemia of the renal tubules (Kashgarian, 1998; Newman, 2012). Chronic water deprivation and dehydration in camels may contribute to ischaemic renal injury by alterations in the sodium ion concentrations in the renal tissues, stimulation of the renin-angiotensin mechanism, renal vasoconstriction and reduced perfusion of renal tubules (Newman, 2012). The hyperosmolarity in the kidney during periods of dehydration could induce osmotic nephrosis leading to tubular epithelial vacuolation as the transcytosis of macromolecular solutes take place (Dickenmann *et al.*, 2008; Zhou *et al.*, 2017a). Camels with plasma elevated urea concentrations tend to have metabolic acidosis and the vacuolation of renal tubular epithelial cells during sustained acidosis has been reported. (Zhou *et al.*, 2017b; Waziri, 2018). The vacuolar degenerative process eventually leads to necrosis of the epithelial cells of the kidney. However, reversible vacuolation of renal epithelial tubules may sometimes occur in some animals as incidental findings (Johnson *et al.*, 1998).

This study identified various forms of glomerulonephritis (proliferative, membranous and membranoproliferative) in the kidneys of dromedary camels. Taha *et al.* (2007) and Salem and Hassan (2011) reported glomerulonephritis as the most common renal lesion and indicated

that proliferative glomerulonephritis was characterised by hypercellularity with adhesion to the parietal layer of Bowman's capsule, leukocytic infiltration and periglomerular tubular nephrosis of the surrounding tubules. Membranous glomerulonephritis, similarly reported by Salem and Hassan (2011), was characterised by a thickened basement membrane, which could be as a result of the presence of sub-epithelial immunoglobulin deposits (Newman, 2012). The presence of eosinophilic (protein) casts in the Bowman's space encountered in this study may have been due to glomerulonephropathy causing proteinuria, as was also reported by Taha *et al.* (2007). The glomerular diseases might often be associated with exposure to harsh weather conditions (Johnson *et al.*, 2016). Frequent periods of dehydration could induce persistent vasopressin action to conserve body water, but the adverse consequence of this action is the induction of proteinuria, contraction of mesangial cells and accumulation of mesangial matrix, proliferation of mesangial and epithelial cells and acceleration of glomerulosclerosis (Torres, 2009; Bolignano and Zoccali, 2010)

Interstitial nephritis, which was also reported in other studies (Kojouri *et al.*, 2014; Rezaie *et al.*, 2014; Saini *et al.*, 2015), occurred at a comparable frequency as glomerulonephritis. The inflammatory reaction

was mostly acute and purulent arising from likely pyogenic infections, but could be chronic active with abscess formation or chronic and lymphoplasmocytic (Saini *et al.*, 2015; Tharwat *et al.*, 2018a, b). The purulent (suppurative) inflammation may arise from a bacteraemia or an ascending infection from the lower urinary tract, initiating with infiltrates of neutrophils and subsequently transiting to non-suppurative infiltrates of lymphocytes, plasma cells and macrophages (Newman, 2012).

The renal fibrosis observed in this study might have occurred following the activation of fibroblasts in long standing inflammations as well as primary inflammation of glomeruli and interstitial tissue (Salem and Hassan, 2011; Newman, 2012). Interstitial fibrosis with atrophy of renal tubules and thickening of basement membrane has been reported in camels (Salem and Hassan, 2011). Some of the kidneys showed glomerular atrophy with distended Bowman's space containing eosinophilic (proteinaceous) materials. Atrophy of the glomerular tuft is commonly caused by severe injury following depositions of immune complexes, entrapment of thromboemboli, or bacterial emboli, or direct viral or bacterial infection of glomerular components (Newman, 2012). Salem and Hassan (2011) reported five cases of glomerular atrophy with distension of Bowman's space which was filled with eosinophilic hyaline material.

### Conclusion

This study demonstrated that microscopic kidney lesions (degenerative, necrotic and/or inflammatory) were commonly encountered among dromedary camels in Maiduguri, Nigeria, but these microscopic lesions were frequently not associated with gross lesions, suggesting the likelihood of renal function impairment that necessitates investigation of its role in dromedary health in the local veterinary practice.

### Acknowledgement

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### Conflict of Interest

The authors declare no conflict of interest with respect to the research and publication.

### References

- Abdalla MA, 2020. Anatomical features in the kidney involved in water conservation through urine concentration in dromedaries (*Camelus dromedarius*). *Heliyon* 6(1): e03139
- Abdalla MA, Abdalla O, 1979. Morphometric observations on the kidney of the camel, *Camelus dromedarius*. *Journal of Anatomy*, 12 (9): 45-50
- Aughey E, Frye FL, 2001. *Comparative Histology with Clinical Correlates*. Mason Publishing, the Veterinary Press Ltd., London UK, Pp: 145-146
- Baba SS, Ambali AG, Zaria LT, Kalra S, 1994. Abattoir records of slaughtered camels (*Camelus dromedarius*) in Nigeria. *Bulletin Animal Health and Production in Africa*, 42: 253-257
- Barakat SEM, Hizab FAA, Moqbel MS, 2017. Pathological and serobiochemical studies of naturally occurring kidney affections in camels (*Camelus dromedaries*). *Journal of Camel Practice and Research*, 24 (1): 55-59
- Bolignano D, Zoccali C, 2010. Vasopressin beyond water: implications for renal disease. *Current Opinion in Nephrology and Hypertension* 19 (5): 499-504

- Dickenmann M, Oettl T, Mihatschi MJ, 2008. Osmotic nephrosis: acute kidney injury with accumulation of tubular lysosomes due to administration of exogenous solutes. *American Journal of Kidney Diseases* 51 (3): 491-503
- Fouad AI, 2004. Some studies on renal affections in camels. *Assiut Veterinary Medicine Journal*, 50 (101)
- Hassan SU, Kayumowah FE, Gambo HI, 2015. Gross and microscopic lesions of the kidneys of camels (*Camelus dromedarius*) from the abattoir in Maiduguri, Borno State, Nigeria. In the Proceedings of the International Camel Conference, Al-Hasa, Saudi Arabia, 17-20 February 2013, Gahlot TK (editor), pp 251-254
- Igbokwe IO, 1989. Postmortem examination of carcasses. *Zariya Veterinarian*, 4 (2): 145-152
- Johnson RC, Dovey-Hartman BJ, Syed J, Leach MW, Frank DW, Sinha DP, Mirro EJ, Little JM, Halliwell WH. 1998. Vacuolation in renal tubular epithelium of Cd-I mice: An incidental finding. *Toxicologic Pathology* 26:789-792.
- Johnson RJ, Stenvinkel P, Jensen T, Lanaspá MA, Roncal C, Song Z, Bankir L, Sánchez-Lozada LG, 2016. Metabolic and kidney diseases in the setting of climate change, water shortage, and survival factors. *Journal of American Society of Nephrology* 27: 2247-2256
- Kashgarian, M., 1998. Acute tubular necrosis and ischemic renal injury. In *Heptinstall's pathology of the kidney*. 5th edn, J.C. Jennette, J.L. Olson, M.M. Schwartz and F.G. Silva, Editors, Lippincott-Raven Philadelphia, pp: 872.
- Kojouri GA, Nourani H, Sadeghian S, Imani H, and Raisi A, 2014. Pathological findings of slaughtered camels (*Camelus dromedarius*) kidneys in Najaf-Abad, Iran. *Veterinary Research Forum*, 5 (3): 231-235.
- Maynard J, Elnageh M, 2003. Basic histopathology and anatomical pathology services for developing countries with variable resources. WHO Regional Publications, Eastern Mediterranean, Series 23. World Health Organisation Regional Office for the Eastern Mediterranean, Cairo.
- Newman SJ, 2012. The urinary system. In *Pathologic Basis of Veterinary Diseases*, Fifth ed. Eds., Zachary, JF, McGavin, MD: Elsevier Mosby, Missouri, USA, pp: 589-659.
- Ramadan RO, 1994. *Surgery and Radiology of the Dromedary Camel*, First ed. Al-Jawad Printing Press, Kingdom of Saudi Arabia, 24 – 30.
- Rezaie A, Babak M, Anbari S, Zadeh HK, 2014. Histopathological investigations on renal lesions in slaughtered camel (*Camelus dromedarius*). *Kafkas Universitesi Veterina Fakultesi Dergisi*, 20 (4): 501-506.
- Saini K., Dadhich H, Mathur M, Ashutosh T, 2015. Histopathological studies on renal lesions in dromedary camel (*Camelus dromedaries*). *Journal of Camel Practice and Research* 22: 113-119.
- Safer AM, Abo-Salem KS, 1991. Ultrastructure of the nephron of the young camel *Camelus dromedaries*. *Journal of Morphology* 210 (2): 101-115
- Safer AM, El-Sayed NK, Abo-Salem K, Al-Shaer R, 1988. Ultrastructure of nephron of the one-humped camel, *Camelus dromedarius*. *Journal of Morphology* 198 (3): 287-301
- Salem SI, Hassan AMH, 2011. Clinicopathological, cytological and histopathological studies on liver and kidney affections in camels. *Global Veterinaria*, 7 (6): 557-571.
- Taha K, Shalaby A, Sami MB, Deeb S, 2007. Pathological studies on the association of pneumonia and kidney affections in camels (*Camelus dromedarius*). *Egyptian Journal of Comparative Pathology and Clinical Pathology*, 20 (1): 235-262.
- Tharwat M, Sadan M, El-Shafaey E, Al-Hawas AA and Saeed E, 2018a. Unilateral nephrectomy in a female dromedary camel with pyelonephritis caused by *Staphylococcus lugdunensis*. *Pakistan Veterinary Journal* 38(1): 116-118
- Tharwat M, Sadan M, El-Shafaey E, Saeed E, Al-Hawas A, 2018b. Bilateral renal abscessation and chronic active pyelonephritis in a male camel (*Camelus dromedaries*) caused by *Escherichia coli*. *Journal of Veterinary Medical Science* 80 (5): 778-783.

Torres VE, 2009. Vasopressin in chronic kidney disease: an elephant in the room? *Kidney International* 76 (9): 925-928

Waziri A, 2018. Kidney lesions and their effects on haematology, serum biochemistry and urinalysis in slaughter camels (*Camelus dromedarius*) at the abattoir in Maiduguri, Nigeria. Unpublished MVSc dissertation, Department of Veterinary Pathology, University of Maiduguri, Maiduguri, Nigeria.

Wilson RT, 1984. *The camel*. Longman, London and New York, pp: 69 – 80.

Xu C, Bao H, Qi F-H, Liu Y, Qin J, Gandahi JA, Chen Q, 2009. Morpho-histological investigation of kidney of Bactrian camel (*Camelus bactrianus*). *Journal of Camel Practice and Research* 16 (2): 1-6

Zhou C, Vink R, Byard RW, 2017a. Hyperosmolarity induces Armani-Ebstein-like renal tubular epithelial swelling and cytoplasmic vacuolation. *Journal of Forensic Sciences* 62 (1): 229-232

Zhou C, Yool AJ, Byard RW, 2017b. Basal vacuolation in renal tubular epithelial cells at autopsy and their relation to ketoacidosis. *Journal of Forensic Sciences* 62 (3): 681-685



## PREVALENCE OF GASTROINTESTINAL PARASITES IN GOATS SLAUGHTERED IN CHIBOLYA ABATTOIR, LUSAKA, ZAMBIA

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### Abstract

Gastrointestinal tract infections are among the most important diseases in the goat industry in Zambia. This study was carried out at Chibolya abattoir in Lusaka, where most livestock farmers bring their goats for slaughter because of the great demand for goat meat in Lusaka. Both floatation and sedimentation techniques were used. The study aimed to determine the prevalence and biodiversity of gastrointestinal tract infections in the goats.

Fecal samples were aseptically collected from randomly selected goats and transported to the Central Veterinary Research Institute Laboratory for analysis. There were 130 goats sampled of which 94 (72.3%) and 36 (27.7%) came from the Southern and Central provinces respectively, representing 87 (66.9%) females and 43 (33.1%) males. The results showed that 117/130 (90%) goats were positive for gastrointestinal tract infections and 17 species of parasites were identified. *Trichostrongylus* spp. (40/130) and *Marshallgia* spp. (1/130) had the highest and the least prevalence respectively. The mixed parasitic infections identified among the goats included cestodes, trematodes, nematodes and protozoa. There were 10/17 (58.8%) zoonotic parasites identified which may put customers and farmers at a high risk of acquiring infection through the consumption of infected meat and contact with infested environments. The results also revealed that there was no significant difference between the location and sex with the positive animals ( $X^2=0.06$ , p-value=0.79;  $X^2=1.17$ , p-value=0.28) respectively. The species of the parasites were biologically diverse but not uniformly distributed [Simpson dominance (D) and Shannon-Weiner index (H)] 0.0867 and 2.571 respectively.

The results of this study suggest that a high prevalence of unevenly distributed gastrointestinal tract infections among goats needs effective control measures to minimize the spread and effects of parasites in small ruminants on livestock farmers and the community. Educational sensitization of the community is of prime importance to educate them on the dangers of such infections.

**Keywords:** Abattoir, Chibolya, Parasites, Goats, gastrointestinal, Zambia.

## PRÉVALENCE DES PARASITES GASTRO-INTESTINAUX CHEZ LES CHÈVRES ABATTUES DANS L'ABATTOIR DE CHIBOLYA À LUSAKA EN ZAMBIE

### Résumé

Les infections du tractus gastro-intestinal sont parmi les maladies les plus importantes dans la filière caprine en Zambie. Cette étude a été réalisée à l'abattoir de Chibolya à Lusaka, où la plupart des éleveurs amènent leurs chèvres pour abattage en raison de la forte demande de viande de chèvre à Lusaka. L'étude a utilisé des techniques de flottation et de sédimentation ; et son objectif était de déterminer la prévalence et la biodiversité des infections du tractus gastro-intestinal chez les chèvres.

Des échantillons de matières fécales ont été prélevés dans des conditions d'asepsie sur des chèvres sélectionnées de manière aléatoire et transportés au Laboratoire vétérinaire central pour analyse. Cent trente (130) chèvres ont été échantillonnées, dont 94 (72,3%) et 36 (27,7%) provenaient respectivement

des provinces du Sud et du Centre, représentant 87 (66,9%) femelles et 43 (33,1%) mâles. Les résultats ont montré que 117 des 130 chèvres (90%) étaient positives pour les infections du tractus gastro-intestinal, avec identification de 17 espèces de parasites. Les infections à *Trichostrongylus* spp. (40/130) et à *Marshallgia* spp. (1/130) avaient respectivement la prévalence la plus élevée et la plus faible. Les infections parasitaires mixtes identifiées chez les chèvres comprenaient des cestodes, des trématodes, des nématodes et des protozoaires. On a identifié 10/17 (58,8%) parasites zoonotiques susceptibles d'exposer les clients et les éleveurs à un risque élevé d'infection à travers la consommation de viande infectée et le contact avec des environnements infestés. Les résultats ont également révélé qu'il n'y avait pas de différence significative entre l'emplacement et le sexe pour les animaux positifs ( $\chi^2 = 0,06$ , valeur  $p = 0,79$  ;  $\chi^2 = 1,17$ , valeur  $p = 0,28$ ). Les espèces des parasites étaient biologiquement diverses mais non réparties de manière uniforme [dominance Simpson (D) et indice Shannon-Weiner (H)], respectivement 0,0867 et 2,571.

Les résultats de cette étude portent à croire qu'une prévalence élevée d'infections gastro-intestinales inégalement réparties chez les chèvres nécessite des mesures de contrôle efficaces pour minimiser la propagation et les effets des parasites des petits ruminants sur les éleveurs et la communauté. La sensibilisation éducative de la communauté est de première importance pour renseigner les membres de la communauté sur les dangers de telles infections.

**Mots-clés :** Abattoir, Chibolya, Parasites, Chèvres, Gastrointestinal, Zambie

### Introduction

Goats, primarily raised for meat and milk are important livestock species all over the world especially in tropical and subtropical regions (Nabi *et al.*, 2014). Goats are reared mainly to provide meat and milk, contributing to the animal protein sources. Goat rearing has a pivotal role in small scale farming and the rural economies of developing societies by generating employment as well as supplementing household incomes in terms of hair, leather and manure production in addition to social and religious ceremonies (Nabi *et al.*, 2014; Owhoeli *et al.*, 2014).

Despite goats being resistant to most livestock diseases as well as adapting easily in drought areas, the intestinal tract of goats can harbor different species of parasites, causing clinical and sub-clinical infections (Amadi *et al.*, 2012; Rafiullah *et al.*, 2011). Gastrointestinal tract parasitic infections have been identified as a major constraint in livestock production in both intensive and semi-intensive management systems resulting in both direct and indirect economic losses (Badran *et al.*, 2012). Despite the major constraints attributed to gastrointestinal tract parasitic infections in goats resulting in loss in productivity and poor quality of goat meat and their products, the impacts are often overlooked as most of these animals are reared by peasant farmers who do not attach much

value to them. Furthermore, gastrointestinal tract parasitic infections in livestock especially goats show little or no obvious clinical signs (Raza *et al.*, 2010). Therefore, due to lack of intervention measures globally, gastrointestinal tract parasitic infections continue to be a major constraint to profitable goat production (Hezam *et al.*, 2016). The transmission success of gastrointestinal tract parasites which occurs almost entirely upon ingestion of the egg/cyst/oocyst through contaminated food or water (Papini *et al.*, 2013), depends on environmental factors such as humidity, temperature, rainfall, vegetation and management practices. The consumption of infective stages by the host followed by excretion of pre-infective stages into the pastures continues the infection of the domestic animals, goats inclusive. In addition, supervision during slaughter and the organization of hygienic precautions concerning food of animal origin is unsatisfactory.

According to numerous reports on gastrointestinal tract parasites, goats have been known to harbour parasites worldwide with infections being trematodes, cestodes, nematodes and protozoa (Sammadar *et al.*, 2015; Kumba *et al.*, 2003). The prevalence of gastrointestinal tract parasitic infections recorded in Europe include 61.1% (Domke *et al.*, 2013), 63.3% (Hassan *et al.*, 2014) and 79.3 % (Vieira *et al.*, 2014). Other documented evidence of gastrointestinal tract parasitic

infections in goats were conducted by Gupta *et al.*, (2016), Hezam *et al.*, (2016), Nabi *et al.*, (2014) and Pestechian *et al.*, (2014) in Europe. Results documented by different researchers in Africa indicate the presence of gastrointestinal tract parasitic infections in goats ranging from 75.5% (Lamrioui *et al.*, 2014) to 100% (Futagbi *et al.*, 2015). Kelemework *et al.*, (2016) and Zvinorova *et al.*, (2016) further revealed the prevalence of gastrointestinal tract parasite infections in goats in Ghana, Ethiopia and Zimbabwe, respectively. The varying prevalence and frequency of occurrence reported from region to region could be due to status of the goats sampled, geographical location, type of management under which the goats are reared and the diagnostic techniques used (Pestechian *et al.*, 2014).

Due to the fact that goats are resistant to most of the livestock diseases (Owhoeli *et al.*, 2014) and can easily thrive in dry areas (Di Cerbo *et al.*, 2010) such as Qwembe and Luangwa Valleys along the Zambezi escarpment in Zambia, the goat population has increased from 758,501 in 2010 to 3,476,790 in 2016 with Southern province and Central province accounting for 35.5% and 16.8% respectively (Central Statistics Office. Preliminary Livestock and Aquaculture Census 2017). This is due to an increased demand for goat meat and its

products both in the rural and urban areas, in addition to providing incomes to both small scale and commercial farmers. With such an increase of the goat population in Zambia, there is need to provide information on gastrointestinal tract parasite infections in order to improve the productivity of goats by small scale farmers. Furthermore, data on the incidence and prevalence of gastrointestinal tract parasitic infections in Zambian goats is not well documented due to abuse of anti-helminthics coupled with poor laboratory diagnosis, surveillance and monitoring. In order to determine the prevalence of gastrointestinal tract parasite infections in goats, a study was carried in goats brought for slaughter at Chibolya abattoir in Lusaka. The results of this study provide the baseline data on gastrointestinal tract parasitic infections in goats in Zambia.

## Materials and Methods

### Study area

The study was conducted at Chibolya abattoir located in the city of Lusaka (15.4411589 S, 28.2614332 E) 1 km west of Lusaka Business Centre in Zambia (fig 1). Chibolya abattoir is a slaughter house for small ruminants from different parts of Zambia.



**Figure 1:** Study site (Source: Google map data@ 2010 Europa Technology)

### *Study population*

All the goats that were brought for slaughter at Chibolya abattoir from July to September 2018 were included in the study. From the total number of goats presented for slaughter, one hundred and thirty (130) were randomly sampled.

### *Sample collection*

The Fecal samples were collected from the abattoir over a period of three (3) months. The average number of samples collected varied depending on the number of goats available for slaughter. Randomly selected goats were sampled after obtaining consent from the chairman of the abattoir and the goat owners. Before slaughter, each selected goat was given an identity. The age, sex and origin of each goat were identified and recorded. The samples were collected in the mornings from 07.00 hours to 12.00 hours.

Fecal samples were collected aseptically from the goats' intestinal contents after slaughter into clean plastic bags. Only samples from the goats' intestinal contents were collected and not Fecal matter found on the floor. The samples were labelled and transported to the Central Veterinary Research Institute parasitology laboratory for analysis. The samples were stored at +4°C overnight before analysis to detect ova, cysts and oocysts.

### *Coprological examination*

Examination and identification of eggs, oocysts and cysts was carried out using the floatation and sedimentation methods.

### *Floatation Method*

The Fecal samples kept at +4°C were removed from the refrigerator and allowed to stand on the bench for 30 minutes. Approximately 3g of Fecal matter was weighed and put in a clean container containing 50ml of concentrated sodium chloride. After mixing thoroughly with a stirring device, the Fecal suspension was sieved using a strainer into another clean container. The Fecal suspension was transferred into a test tube, filled to the brim and covered with a cover slip to allow

the eggs to float for 20 minutes. The cover slip was removed, mounted onto a microscopic glass slide and examined under the microscope using objective of X10 to determine the presence of eggs (ova) or cysts, and objective X40 to determine the morphological structure of the ova. This method was used to examine all the samples collected (Cheesbrough, 2005; Oyerinde, 1999).

### *Sedimentation Method*

Approximately 4g of Fecal matter was weighed into a container containing 50ml of formal saline and mixed thoroughly with a stirring device. The Fecal suspension was filtered through a strainer into another container. The filtered material was transferred into a test tube containing 3 ml of diethyl ether, mixed thoroughly and centrifuged at 2000 rpm for 15 minutes. After centrifugation, the supernatant was removed by using a pipette and discarded. The sediment was added onto a clean microscopic glass slide and stained by adding one drop of lugol's iodine. The preparation was examined as above after mounting a cover slip.

### *Data Analysis*

The data generated was subjected to descriptive statistical analysis using percentages and tables (EPIinfo version 7) and Chi-square analysis was used in determining the prevalence rates in the different gender and ages of the goats studied. A p value ( $p < 0.05$ ) was considered indicative of a statistically significant difference. Diversity and distribution of the parasites in the area was calculated using Simpson's Index and the Shannon-Weiner Index respectively.

## **Results**

A total of 130 goats were sampled at the abattoir and 94 (72.3%) of these came from Southern province (with 66 females and 28 males) while 36 (27.7%) came from Central province comprising of 21 females and 15 males. Goats from Southern province were more infected 85 (65.8%) with gastrointestinal parasites than goats from Central province

with 32 (24.6%) (Table 1a). The prevalence of gastrointestinal parasites in relation to the goats and their location of origin showed no significant difference ( $p=0.79$ ).

The parasites detected fell in the category of nematodes, trematodes, cestodes and protozoa. Most of the infections were due to nematodes followed by trematodes, while protozoa had the least infections in the goats. The results showed that 117 (90%) with 95% confidence interval (95%CI: 84.8-95.2) of the goats were positive for gastrointestinal tract parasites. Among the positive goats, 79 (67.5%) were females and 38 (32.4%) were males. The result of the gastrointestinal tract parasitic infections in relation to the sex of the goats was not statistically significant ( $p=0.28$ ) as shown in table 1b.

Seventeen (17) species of parasites of various genera were identified using both the floatation and sedimentation methods. These included *Avitellina centripunctata*, *Bunostomum spp.*, *Chabertia ovina*, *Coccidia*, *Cooperia spp.*, *Haemonchus contortus*, *Marshallgia spp.*, *Moniezia expansa*, *Nematodirus spp.*, *Oesophagostomum spp.*, *Skrjabinema ovis*, *Strongyloides spp.*, *Teladorsagia circumcincta*, *Trichostrongylus spp.*, *Dicrocoelium dendriticum*, *Fasciola spp.* and *Paramphistomum spp.* *Trichostrongylus spp.* and *Fasciola spp.* were the more abundant 40 (30.8%) 95% CI: 22.9-38.7 and 35 (26.7%) 95% CI 19.1-34.3 respectively while the least abundant were *Coccidia spp.* 2 (1.5%) 95% CI: 0.0-2.3 and *Marshallgia spp.* 1 (0.8%) 95% CI: 0.0-2.3 (Table 2).

**Table 1a:** Prevalence of the gastrointestinal tract parasitic infection

Region of origin	No. sampled	F	M	Positive (%)	Negative (%)	X <sup>2</sup> -value	p-value
Southern	94	66	28	85(65.8)	9 (6.9)	0.06	0.79
Central	36	21	15	32(24.6)	4 (3.1)		
Total	130	87	43	117(90)	13 (10)		
				95% CI	84.8-95.2		

**Table 1b:** Prevalence of the gastrointestinal tract parasitic infection according to sex

No. sampled	No. infected (%)	Sex		X <sup>2</sup> -value	p-value
		F (%)	M (%)		
94	85(65.4)	60 (51.1)	25 (21.4)	1.17	0.28
36	32(23.8)	19 (16.2)	13 (11.1)		
130	117(90)	79 (67.5)	38 (32.4)		
		95% CI 84.8-95.2			

**Table 2:** Prevalence of gastrointestinal tract infestation of goat by Specie of the parasites

Parasite (Ova)	Goats infested			Prevalence (%)	95% CI
	Total	F	M		
<i>Avitellina centripunctata</i>	22	17	5	16.9	10.5-23.3
<i>Bunostomum spp.</i>	11	8	3	8.5	3.7-13.3
<i>Chabertia ovina</i>	27	19	8	20.8	13.8-27.8
<i>Coccidia spp.</i>	2	2	0	1.5	0.0-3.7
<i>Cooperia spp.</i>	5	4	1	3.8	0.5-7.1
<i>Haemonchus contortus</i>	10	8	2	7.7	3.1-12.3
<i>Marshallgia spp.</i>	1	0	1	0.8	0.0-2.3

Parasite (Ova)	Goats infested			Prevalence (%)	95% CI
	Total	F	M		
<i>Moniezia expansa</i>	5	3	2	3.8	0.5-7.1
<i>Nematodirus</i> spp.	14	8	6	10.8	5.5-16.1
<i>Oesophagostomum</i> spp.	14	9	5	10.8	5.5-16.1
<i>Skrjabinema ovis</i>	4	2	2	3.1	0.1-6.1
<i>Strongyloides</i> spp.	27	18	9	20.8	13.8-27.7
<i>Teladorsagia circumcinta</i>	24	14	10	18.5	11.8-25.2
<i>Trichostrongylus</i> spp	40	28	12	30.8	22.9-38.7
<i>Dicrocoelium dendriticum</i>	30	21	9	23.1	15.9-30.3
<i>Fasciola</i> spp	35	24	11	26.7	19.1-34.3
<i>Paramphistomum</i> spp	19	15	4	14.6	8.5-20.7
				90	84.8-95.2

**Table 3:** Diversity and distribution of parasitic species in the study area

Category	Value	x	x <sup>2</sup>	-x ln(x)
<i>Avitellina centripunctata</i>	22	7.6%	0.006	0.196
<i>Bunostomum</i> spp.	11	3.8%	0.001	0.124
<i>Chabertia ovina</i>	27	9.3%	0.009	0.221
<i>Coccidia</i> spp.	5	1.7%	0.000	0.070
<i>Cooperia</i> spp.	2	0.7%	0.000	0.034
<i>Haemonchus contortus</i>	10	3.4%	0.001	0.116
<i>Marshallgia</i> spp	1	0.3%	0.000	0.020
<i>Moniezia expansa</i>	5	1.7%	0.000	0.070
<i>Nematodirus</i> spp.	14	4.8%	0.002	0.146
<i>Oesophagostomum</i> spp.	14	4.8%	0.002	0.146
<i>Skrjabinema ovis</i>	4	1.4%	0.000	0.059
<i>Strongyloides</i> spp.	27	9.3%	0.009	0.221
<i>Teladorsagia circumcinta</i>	24	8.3%	0.007	0.206
<i>Trichostrongylus</i> spp.	40	13.8%	0.019	0.273
<i>Dicrocoelium dendriticum</i>	30	10.3%	0.011	0.235
<i>Fasciola</i> spp.	35	12.1%	0.015	0.255
<i>Paramphistomum</i> spp.	19	6.6%	0.004	0.179
Simpson Dominance (D)			0.0867	
Shannon Entropy or Shannon-Wiener Index (H)				2.5714

x= Proportional abundance (Pi)

Of the 17 species isolated, 10 (58.8%) were zoonotic and these included *Bunostomum* spp., *Chabertia ovina*, *Haemonchus contortus*, *Moniezia expansa*, *Strongyloides* spp., *Teladorsagia circumcincta*, *Trichostrongylus* spp., *Dicrocoelium dendriticum*, *Marshallagia* and *Fasciola* spp.

Among the 117 goats that were positive for gastrointestinal tract parasites, 43 (36.8%) had single parasitic infections while 74 (63.2%) had multiple infections. The prevalence of gastrointestinal tract parasites infection recorded was higher in goats of 5 years of age 65 (55.6%), followed by those of 6 years 27 (23.1%) and least in those of 4 years with 25 (21.4%). The data further revealed species diversity and distribution. The species of the parasites detected were diverse according to the Simpson's dominance index (D) 0.0867 and were unevenly distributed according to the Shannon-Weiner index (H) of 2.571 in the study area (table 3).

## Discussions

Domestic animals are often affected by endo and ecto parasites. These infections cause health problems and economic losses. Health problems may be acute, mild or chronic and may lead to the death of an animal while economic losses occur in a variety of ways which include losses through infertility, reduced work capacity, a reduction in food intake and lower weight gains, treatment costs and mortality in heavily parasitized animals (Waller, 2006). Gastrointestinal tract parasites, affecting domestic animals both on small and large scale farms present similar problems in livestock including goats (Raza *et al.*, 2010).

The coproscopical examination of 130 samples collected from goats brought for slaughter at Chibolya abattoir revealed a high prevalence (90%) of gastrointestinal tract parasites. This finding was in agreement with those of Futagbi *et al.*, (2015) who recorded the prevalence of gastrointestinal tract parasites at 100%. Furthermore, our finding was similar to those of Solomon-Wisdom *et al.*, (2014), Nwigwe *et al.*, (2013) and Amadi *et al.*, (2012) who reported high prevalences

of gastrointestinal tract parasites in goats. The goats in this study were reared under a traditional management system where goats are always left to wander about scavenging and feeding indiscriminately on anything they come in contact with resulting in exposure to massive parasitic infections before returning to their unhygienic poorly kept sheds. This is in agreement with Adejinmi *et al.*, (2015) and Forse (1999) who observed that animals kept in poor ranches/conditions and also fed with contaminated food and water are exposed to massive parasitic infections. Most goats harbor gastrointestinal tract parasites and may therefore act as silent carriers contaminating pastures. They become re-infected mainly due to lack of knowledge by the farmers on modern and good management systems, illiteracy and the lack of anthelmintic drugs. Additionally, anthelmintic drug resistance could have contributed to the high prevalence of gastrointestinal tract parasites infection in the goats in this study. High prevalence of goat gastrointestinal tract parasites in different regions is probably due to the tropical environments and high humidity (Papini *et al.*, 2013) with persistent infections throughout the year. Low gastrointestinal tract parasites infection rates are mainly due to lower environmental temperatures which are not conducive for larval development. The samples in this study were collected during the warm period of the year hence the high rate of gastrointestinal tract parasites infections in the goats. This is in agreement with Umur *et al.*, (2005) who reported a continuous increase in infection rates in autumn until the onset of winter.

This study detected nematodes, trematodes, cestodes and protozoa with nematodes as the most identified parasites. This is in agreement with the earlier report by Amadi *et al.*, (2012), where nematodes were more prevalent than trematodes and cestodes in small ruminants. The reasons are that nematodes do not require intermediate hosts and both the larval and adult stages are infective stages of the parasites. Trematodes recorded the second most prevalent class of helminths detected in goats. Trematodes

require intermediate hosts to complete their life cycles and therefore transmission is dependent on the availability of intermediate hosts. The availability of intermediate hosts is dependent on seasons for survival. This study did not examine seasonal variations of gastrointestinal tract parasites. The class of cestodes was the least detected in this study. This finding is in agreement with other studies that found that trematodes are more prevalent than cestodes (Futagbi *et al.*, 2015; Kusiluka *et al.*, 1998). The only protozoan identified was *Coccidia* which was in agreement with Anene *et al.*, (1994) who detected *Coccidia* in goats and sheep.

The species detected during in this study covered all the three classes of helminths including protozoa. Seventeen (17) species of parasitic infections were recorded. The results show that *Trichostrongylus* spp. and *Fasciola* spp. were more abundant while the least abundant were *Coccidia* spp. and *Marshalligia* spp. These findings are in agreement with previous studies carried out both in Europe and Africa indicating a variety of species that parasitize small ruminants (Hassan *et al.*, 2019; Kelemework *et al.*, 2016; Zvinorova *et al.*, 2016; Futagbi *et al.*, 2015; Stadaliene *et al.*, 2015; Hassan *et al.*, 2014; Owhoeli *et al.*, 2014; Vieira *et al.*, 2014; Domke *et al.*, 2013 and Anene *et al.*, 1994). *Trichostrongylus* spp. is a common parasite of herbivorous animals including cattle, sheep, donkeys, goats, deer and rabbits. Our finding is in agreement with Kelemework *et al.*, (2016) where *Trichostrongylus* spp. was the highest in prevalence from coproculture results. The high prevalence of *Fasciola* spp. in goats observed in this study was similar to the finding by Futagbi *et al.*, (2015) where 80.5% of goats examined were infected with *Fasciola* spp.

This study also highlighted the multiple infections in goats brought for slaughter at Chibolya abattoir. This could be attributed to the management system employed by farmers, nutrition and the limited knowledge of the farmers on the medications required to control the infections. In the current study, *Coccidia* were the only protozoan detected. The presence of *Coccidia* in our study agrees

with the study by Hassan *et al.*, (2019) where *Coccidia* accounted for 76.89% of the detected parasites in goats. Other reports indicating the presence of *Coccidia* were by Verma *et al.*, (2018), Singh *et al.*, (2015), Jatau *et al.*, (2011) and, Obijiaku and Agbede (2007) who reported high incidences of *Coccidian* infections in goats. However, our finding differs from those of the previous studies as only low levels of *Coccidia* were detected in goats brought for slaughter at Chibolya abattoir.

The study revealed a higher prevalence (67.5%) of gastrointestinal tract parasitic infections in the female goats than in their male counterparts (32.4%) although this was not significantly different. This is in agreement with the observation of Dagnachew *et al.*, (2011) who reported a higher prevalence of gastrointestinal tract parasitic infections in females. The epidemiology and distribution of gastrointestinal tract parasitic infections in goats is not directly influenced by sex (Adua and Hassan, 2016). However, the higher prevalence of infections in females is supported by the general understanding that female animals are more susceptible to helminth infections. This is attributed to a decreased immune status especially during the peri-parturient period as a result of hormonal changes (Valcarcel and Romero, 1999; Urquhart *et al.*, 1996). Our result showing no significant difference in infections between the sexes of the goats is consistent with other findings by Hassan *et al.*, (2013b), Ghanem *et al.*, (2009) and Regassa *et al.*, (2006).

With respect to the age of the goats, most infections were recorded in goats of approximately 5 years. This finding is in agreement with Ntonifor *et al.*, (2013) and Nwosu *et al.*, (2007) who reported that adult animals could be harbouring mature worms. Adult animals can withstand higher infection without much adverse effects leading to chronic infection hence acting as reservoirs. The results of this study indicated that there was no statistical significance between infections in the different ages of goats even though age is considered an important risk factor in gastrointestinal tract infection (Raza *et al.*, 2007). The infection rate between (kids,

yearlings and adults was not considered in the present study and therefore the results only showed parasitic infections in adult goats brought for slaughter at the abattoir.

The zoonotic nematodes identified in the goats brought for slaughter at Chibolya abattoir included *Chabertia ovina*, *Teladorsagia circumcincta*, *Haemonchus contortus*, *Trichostrongylus* spp., *Strongyloides* spp., *Bunostomum* spp. and *Marshallagia* spp., that infect millions of people worldwide (Pestechian *et al.*, 2014; Dhaliwal and Juyal, 2013; Joe, 1947). The other zoonotic species detected in the study were *Moniezia expansa* belonging to the Cestodes and the Trematode group of *Dicrocoelium dendriticum* and *Fasciola* spp. *Dicrocoelium dendriticum* is a rare food-borne zoonosis causing human biliary tract infection, dicrocoeliasis and low prevalence in human infection has been reported (Jeandron *et al.*, 2011). Most of the zoonotic parasites diagnosed in sheep and goats are transmitted by close contact between man and animals. These are often, occupational diseases principally affecting breeders, veterinarians and/or slaughterhouse workers. Our findings are in agreement with Pestechian *et al.*, (2014) and Joe (1947) who reported the presence of zoonotic helminths in livestock. The detection of zoonotic helminths in the present study is an indicator that these can be transmitted to man probably via ingestion or through the skin.

In this study, there were more goats originating from Southern province as compared to Central province. This is reflected in the report of the animal census by the Central Statistics Office (2017) indicating that Southern and Central provinces contributed about 36% and 17% of the total goat population in Zambia respectively. The high goat population in Southern province was probably due to farmers opting to rear goats instead of cattle which died of diseases namely tick borne diseases, contagious bovine Pleuropneumonia, and foot and mouth disease in the recent past. Furthermore, dry areas such as Qwembe valley of Southern province have higher numbers of goats population as a result of poor rainfall patterns. The helminth infection rates in both

provinces were not statistically significant because farmers had taken much interest in the rearing of goats which are resistant to most diseases. The higher percentage of female goats brought for slaughter was probably due to being non-productive hence culled to buy young female goats to increase the production in the herds. This principle is mostly used in livestock production by culling older female stocks in preference for young females which would increase the herd size.

The value of 2.51 Shannon-Weiner Index (H) and 0.0867 Simpson Dominance (D) suggest that the gastrointestinal parasite species were of medium diversity and unevenly distributed in the areas. The high diversity of the species of public health importance such as *Fasciola* spp suggests that snail vectors were probably not controlled in these areas and could serve as an index of pollution of the environment where these animals graze (Ikepeze and Obikwelu, 2016; Dida *et al.*, 2014). This suggests that control measures should be intensified to minimize the risk of infection for humans. The escalation of the snail-borne infection, which affects the liver, results in condemnation of the organ. This reduces the income of the farmer because all contaminated livers would be discarded reducing the total price of the carcass (Nyirenda *et al.*, 2019).

## Conclusion

More than two-thirds of the goats examined in this study were positive for gastrointestinal tract infections and 17 species of parasites were identified of which *Trichostrongylus* spp., had the highest prevalence. The results also revealed that there were no significant differences in infection with gastrointestinal parasites between the locations or sexes of the goats. There was biodiversity in the species of the parasites but they were not uniformly distributed.

## Recommendation

1. The data suggest considerable gastrointestinal parasitic problems for goat

farmers and the need to strengthen existing control measures in using anthelmintics in the control of gastrointestinal parasites.

2. Extension workers need to advise farmers on the appropriate anthelmintic drugs to use and the correct dosages in order to reduce the chances of development of anthelmintic resistance by the parasites.
3. Adequate control and preventative measures could be initiated through collaborative efforts by the government assisted by relevant agencies through mass enlightenment and education of goat breeders on the importance of environmental sanitation, personal hygiene and the risk of acquiring gastrointestinal parasite infections.
4. There should be legislative control over the slaughtering of goats and the distribution of abattoirs. Abattoir workers should be properly trained on meat handling and zoonotic infections.

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### References

Adejinmi O O, Adejinmi J O, Falohun O O, Aderoju O R, Dauda W J, 2015. Prevalence of Gastrointestinal Parasites of Goats in Ibadan, Southwest, Nigeria. *World Journal of Agricultural Research*, 3 (2): 49-51.

Adua M M, Hassan D I, 2016. Prevalence of Nematode Infestation in Goats reared in Nasarawa State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 12 (3): 79-84.

Amadi A, Avoaja D, Essien E, 2012. Epidemiology of Helminth Parasites of West African Dwarf Goat (*Capra Hircus*) in Umuariaga in Ikwuano LGA, Abia State. *Journal of Applied Sciences and Environmental Management*, 16 (4): 359-362.

Anene B M, Onyekwodiri E O, Chime A B, Anika S M, 1994. Gastrointestinal parasites in sheep and goats of South eastern, Nigeria. *Small Ruminants Research*, 13 (2): 187-192.

Badran I, Abuamsha R, Aref R, Alqisi W, Alumor J, 2012. Prevalence and diversity of gastrointestinal parasites in small ruminants under two different rearing systems in Jenin district of Palestine. *An-Najah University Journal of Research* 26:1-18.

Central Statistics Office. Preliminary Livestock and Aquaculture Census Results in Zambia, 2017.

Cheesbrough M, 2005. *District Laboratory Practice for Tropical Countries. Part 2.* Cambridge University Press, UK. pp 434.

Dagnachew S, Amamute A, Temegen W, 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondar zone, Northwest Ethiopia. *Ethiopian Veterinary Journal*, 15 (2): 57-68.

Di Cerbo A R, Manfredi M, Zanzani S, Stradiotto K, 2010. Gastrointestinal infection in goat farm in Lombardy (Northern Italy): analysis on community and spatial distribution of parasites. *Small Ruminants Research* 88:102-112.

Dhaliwal B S, Juyal P D, 2013. Nematode Zoonoses. *Parasitic Zoonoses* pp 83-122.

Dida G O, Gelder F B, Anyona D N, Matano S, Abuom P O, Adoka S O, Ouma C, Kanangire C K, Owuor P O, Ofulla A V, 2014. Distribution and abundance of schistosomiasis and fascioliasis host snails along the Mara River in Kenya and Tanzania. *Infectious Ecology and Epidemiology*. 10:34-42.

Domke A V M, Chartier C, Gjerde B, Leine N, Vatn S, Stuen S, 2013. Prevalence of gastrointestinal helminths, lungworms and liver fluke in sheep and goats in Norway. *Veterinary parasitology*, 194: 40-48.

Forse A M, 1999. *Where there is no vet.* 1st ed. Macmillian press Ltd, London and Oxford Publisher.

pp 380.

Futagbi G, Abankwa J, Agbale P, Aboagye I, 2015. Assessment of Helminth Infections in Goats Slaughtered in an Abattoir in a suburb of Accra, Ghana. *West African Journal of Applied Ecology*, 23: 35-42.

Ghanem Y M, Naser M H, Abdelkader A H, Heybe A, 2009. An epidemiocoprolological study of protozoan and nematode parasites of ruminants in tropical semi-arid district of Somalilan D (North of Somalia). *Veterinary Medical Journal*. pp 768-787.

Gupta M, Rao M, Dixit P, Shukla P, Dixit A, 2016. Prevalence of Gastrointestinal Nematodes in Goats in and around Jabalpur. *Environment and Ecology*, 34: 2495-2497.

Hassan D I, Musa-Azara I S, Mohammed J, Zanwa I A, 2013b. Influence of age, sex and season on haematology and serum chemistry of Red Sokoto goats in Lafia, Nasarawa State Nigeria. *International Journal of Agricultural Science and Veterinary Medicine*, 1(4): 57-63.

Hassan M, Hoque M, Islam S, Khan S, Roy K, Banu Q, 2014. A prevalence of parasites in Black Bengal goats in Chittagong, Bangladesh. *Global Journal of Poultry Farming and vaccination*, 2 (1): 111-115.

Hassan N, M. F., Farag T, K., Abu El Ezz M. T., Abou-Zeina H, A. A., 2019. Prevalence assessment of gastrointestinal parasitic infections among goats in Giza Governorate, Egypt. *Bulletin of the National Research Centre*. 43: 127

Hezam K, Morshed A F, Hassan A, Abbas A B, Ghaleb H, Zhang J, Qahtan A S A, 2016. Prevalence of Parasitic Helminthes among Slaughtered Animals in slaughterhouses in Taiz, Yemen. *International Journal Current Microbiology Applied Science*, 5: 80-88.

Ikpeze O O, Obikwelu M E, 2016. Factors affecting seasonal abundance of gastropods of public health importance found at Agulu Lake shorelines in Nigeria. *International Journal Pure Applied. Bioscience*; 4(2): 91-102.

Jatau I D, Abdulganiyu A, Lawal A L, Okubanjo O O, Yusuf K H, 2011. Gastrointestinal and haemoparasitism of sheep and goats at slaughter in Kano, northern-Nigeria. *Sokoto Journal of Veterinary Sciences*, 9 (1):7-11.

Jeandron A, Rinaldi L, Abdylidaeva G, Usubalieva J, Steinmann P, Cringoli G, Utzinger J, 2011. Human infections with *Dicrocoelium dendriticum* in Kyrgyzstan: the tip of the iceberg? *Journal of Parasitology*, 97 (6):1170-1172.

Joe L K, 1947. *Trichostrongylus* Infection in Man and Domestic Animals in Java. *The Journal of Parasitology*, 33, (4): 359-362.

Kelemework S, Tilahun A, Benalfew E, Getachew A, 2016. A study on prevalence of gastrointestinal helminthiasis of sheep and goats in and around Dire Dawa, Eastern Ethiopia. *Journal of Parasitology and Vector Biology*, 8: 107-113.

Kusiluka L J M, Kambarage D M, Harrison L J S, Daborn C J, Matthewman R W, 1998. Causes of morbidity and mortality in goats in Morogoro district, Tanzania: the influence of management 29:167-172.

Kumba F, Katjivena H, Kauta G, Lutaaya E, 2003. Seasonal evolution of Fecal egg output by gastrointestinal worms in goats on communal farms in eastern Namibia. *Onderstepoort Journal of Veterinary Research*, 70: 265-271.

Lamrioui D, Hassouni T, Belghyti D, Mostafi J, Madhi Y E, Lamri D, 2014. Prevalence and intensity of intestinal nematodes in goat (*Capra hircus*) from oriental region, Province of Figuig, Morocco *International Journal of Agricultural Science Research*, 2(9): 279-282.

Nabi H, Saeed K, Shah S R, Rashid M I, Akbar H, Shehzad W, 2014. Epidemiological study of gastrointestinal nematodes of goats in district Swat, Khyber Pakhtunkhwa, Pakistan. *Science International*, 26:283-286.

Ntonifor H N, Shei S J, Ndale N W, Mbunkur G N, 2013. Epidemiological studies of parasitic infections in ruminants in Jakiri, Bui Division, North-West Region of Cameroon. *Journals of Veterinary Medicine and Animal Health*, 5(12): 344-352.

Nwigwe J O, Njoku O, Odikamnor O O, Uhwo A C, 2013. Comparative study of intestinal helminths and protozoa of cattle and goats in Abakaliki metropolis of Ebonyi State, Nigeria. *Advances in Applied Science Research*, 4 (2): 223-227.

- Nwosu C O, Madu P, Richards W S, 2007. Prevalence and seasonal changes in the population of gastrointestinal nematodes of small ruminants in the semi-arid zone of north-eastern Nigeria. *Veterinary Parasitology*, 144 (1-2): 118-124.
- Nyirenda S S , Sakala M, Moonde L, Kayesa E, Fandamu P, Banda F, Sinkala Y, 2019. Prevalence of bovine fascioliasis and economic impact associated with liver condemnation in abattoirs in Mongu district of Zambia. *BMC Veterinary Research*, 15:33
- Obijiaku I N, Agbede R I S, 2007. Prevalence of coccidiosis and associated pathology in lambs and kids from three contrasting management systems. In: *Proceedings of the 44th Annual Congress of the Nigerian Veterinary Medical Association (NVMA), Delta 2007*. pp 229–232.
- Owhoeli, O, Elele K, Gboeloh L B, 2014. Prevalence of Gastrointestinal Helminths in Exotic and Indigenous Goats Slaughtered in Selected Abattoirs in Port Harcourt, South Nigeria.
- Chinese Journal of Biology. <http://dx.doi.org/10.1155/2014/435913>.
- Oyerinde J P O, 1999. *Essential of Tropical Medical Parasitology*. University of Lagos press, Akoka, Lagos, Nigeria. pp 347-358.
- Papini R, Cecchi V, Capocchi O, Mancianti F, 2013. Small ruminant *Gongylonema pulchrum* infection in the South West Algerian desert: prevalence of a sporadic zoonosis. *Medycyna Weterynaryjna*, 69 (3): 161-164.
- Pestechian N, Kalani H, Faridnia R, Yousefi H A, 2014. Zoonotic gastrointestinal nematodes (*Trichostrongylidae*) from sheep and goat in Isfahan, Iran. *Acta Scientiae Veterinariae*, 42: 1-6.
- Rafiullah A A, Turi A S, Sayyed R S, Shabbi A, Muhammad S, 2011. Prevalence of gastrointestinal tract parasites in Cattle of khyber pakhtunkhwa. *ARPN Journal of Agricultural and Biological Science*, 6: 9.
- Raza A M, Murtaza S, Bachaya H A, Qayyum A, Zama M A, 2010. Point prevalence of *Toxocara vitulorum* in Large Ruminants Slaughtered at Multan Abattoir. *Pakistan Veterinary Journal*, 30: 242-244.
- Regassa F, Sori T, Dhuguma R, Kiros Y, 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. *Journal of Applied Research in Veterinary Medicine*, 4 (1): 51-57.
- Sammadar K, Haque M H, Ashfia K M, Nahar S F, Boby F, Saha S S, 2015. Prevalence of gastrointestinal parasitic infestation of ruminants at Rajbari, Bangladesh. *International Journal of National Social science*, 2: 27-34.
- Solomon-Wisdom G O, Matur B M, Ibe K C, 2014. Prevalence of intestinal helminth infection among sheep and goats raised for slaughtering in Gwagwalada Abattoir, Abuja, Nigeria. *Journal of Global Pharmaceutical Sciences*, 2(1): 12- 19.
- Stadaliene I, Höglund J, Petkevičius S, 2015. Seasonal patterns of gastrointestinal nematode infection in goats on two Lithuanian farms. *Acta Veterinaria Scandinavica*, 57: 16-21.
- Singh A K, Das G, Roy B, Nath S, Naresh R, Kumar S, 2015. Prevalence of gastrointestinal parasitic infections in goat of Madhya Pradesh, India. *Journal of Parasitic Disease*. 39 (4): 716–719.
- Singh S, 2002. Human strongyloidiasis in AIDS era: its zoonotic importance. *Journal of Association for Physicians India*. 50:415-422.
- Umur S, Yukari B A, 2005. Seasonal Activity of Gastro- Intestinal Nematodes in Goats in Burdur Region, Turkey. *Turkey Journal of Veterinary Animal Science*, 29:441-448.
- Urquhart G M, Armour J, Duncan J L, Dunn A M, Jennings F W, 1996. *Veterinary Parasitology*. Second edition, Blackwell Science. pp 356.
- Valcarcel F, Romero C G, 1999. Prevalence and seasonal pattern of caprine trichostrongyles in a dry area of central Spain. *Journal Veterinary Medical Sciences*, 46(10): 673- 681.
- Verma R, Sharma D K, Paul S, Gururaj K, Dige M, Saxena V K, Rout P K, Bhusan S, Banerjee P S, 2018. Epidemiology of common gastrointestinal parasitic infections in goats reared in semi-arid region of India. *Journal of Animal Research* 8 (1):39–45.

Vieira V D, Feitosa T F, Vilela V L R, Azevedo S S, De Almeida Neto J L, De Moraes D F, Ribeiro A R C, Athayde A C R, 2014. Prevalence and risk factors associated with goat gastrointestinal helminthiasis in the Sertão region of Paraíba State, Brazil. *Tropical animal health and production*, 46: 355-361.

Waller P J, 2006. From discovery to development: current industry perspectives for the development of novel methods of helminth control in livestock. *Veterinary Parasitology*, 139 (1-3): 1-14.

Zvinorova P, Halimani T, Muchadeyi F, Matika O, Riggio V, Dzama K, 2016. Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research*, 143: 75-83.



## EFFECT OF REPLACING LOCAL FISH MEAL WITH CRAYFISH DUST ON THE GROWTH PERFORMANCE, BLOOD PROFILE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS

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### Abstract

This study determined the effect of replacing local fish meal with crayfish dust on the growth performance, blood profile and carcass characteristics of broiler chickens. One hundred and sixty, day-old Marshall® strain of broiler chickens were purchased from a reputable hatchery. On arrival, the chicks were tagged individually with identification numbers and their initial weights were taken. The chicks were randomly assigned to five treatment groups based on the levels of replacement of fishmeal with crayfish dust. The treatment groups were 0, 25%, 50%, 75% and 100% replacement of fishmeal with crayfish dust. Each of the treatment groups consisting of 32 birds were further sub-divided into 4 replicates of 8 birds each. Data generated were subjected to Analysis of variance in a Completely Randomized Design. The results showed that the average feed intake of birds at the starter phase was significantly highest (44.89 g/bird/day) in treatment group 1 (control) and lowest (37.43 g/bird/day) in treatment group 2. White blood cell counts were significantly ( $p < 0.05$ ) highest (21.25 and 21.21  $\times 10^3/\mu\text{l}$ ) in birds on treatments 4 and 5, respectively and lowest (19.55  $\times 10^3/\mu\text{l}$ ) in the control group. The total protein was also significantly ( $p < 0.05$ ) highest (6.61 g/dl) in birds on treatment 4 and lowest (6.15, 6.12 and 6.11 g/dl) in birds on treatments 1, 3 and 5. The total cholesterol was significantly ( $p < 0.05$ ) highest (90.31 g/dl) in birds on treatment 4 and lowest (88.89 g/dl) in the control group. Thigh weight as a percentage of dressed weight was significantly ( $p < 0.05$ ) highest (10.12%) in birds on treatment 4 and lowest (7.85%) in the control. In addition, the empty gizzard weight was significantly ( $p < 0.05$ ) highest (2.35 and 2.38, %) in birds on treatments 4 and 5, respectively and lowest (1.76%) in birds on treatment 2. The study concluded that replacement of fishmeal with crayfish dust at 75% could be adopted for heavier thigh and gizzard portions without any deleterious effects on the blood parameters of the birds.

**Keywords:** Cray fish dust, growth performance, blood profile, carcass, broiler chickens

## EFFET DU REMPLACEMENT DE LA FARINE DE POISSON LOCAL PAR LA POUSSIÈRE D'ÉCREVISSSES SUR LA PERFORMANCE DE CROISSANCE, LE PROFIL SANGUIN ET LES CARACTÉRISTIQUES DES CARCASSES DES POULETS DE CHAIR

### Résumé

Cette étude a déterminé l'effet du remplacement de la farine de poisson local par de la poussière d'écrevisses sur les performances de croissance, le profil sanguin et les caractéristiques de carcasse des poulets de chair. Cent soixante poussins de chair d'un jour, de souche Marshall®, ont été achetés dans un couvoir réputé. À l'arrivée, les poussins ont été étiquetés individuellement avec des numéros d'identification et leur poids initial a été mesuré. Les poussins ont été répartis de manière aléatoire dans cinq groupes de traitement en fonction des niveaux de remplacement de la farine de poisson par de la poussière d'écrevisses. Les groupes de traitement étaient 0, 25%, 50%, 75% et 100% de remplacement de la farine de poisson par de la poussière d'écrevisses. Chacun des groupes de traitement composé de 32 oiseaux a été subdivisé en 4 répétitions de 8 oiseaux chacune. Les données générées ont été soumises à une analyse de variance

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dans un plan complètement aléatoire. Les résultats ont montré que la consommation moyenne des oiseaux à la phase de démarrage était significativement la plus élevée (44,89 g / oiseau / jour) dans le groupe de traitement 1 (témoin) et la plus faible (37,43 g / oiseau / jour) dans le groupe de traitement 2. Le nombre de globules blancs était significativement ( $p < 0,05$ ) le plus élevé (21,25 et  $21,21 \times 10^3 / \mu\text{l}$ ) respectivement chez les oiseaux soumis aux traitements 4 et 5 et la plus faible ( $19,55 \times 10^3 / \mu\text{l}$ ) dans le groupe témoin. De plus, la protéine totale était significativement ( $p < 0,05$ ) la plus élevée (6,61 g / dl) chez les oiseaux sous traitement 4 et la plus faible (6,15, 6,12 et 6,11 g / dl) chez les oiseaux soumis aux traitements 1, 3 et 5. Le cholestérol total était significativement ( $p < 0,05$ ) le plus élevé (90,31 g / dl) chez les oiseaux sous traitement 4 et le plus faible (88,89 g / dl) dans le groupe témoin. Le poids des cuisses en pourcentage du poids paré était significativement ( $p < 0,05$ ) le plus élevé (10,12%) chez les oiseaux sous traitement 4 et le plus bas (7,85%) chez le groupe témoin. De plus, le poids du gésier à vide était significativement ( $p < 0,05$ ) le plus élevé (2,35 et 2,38%) chez les oiseaux respectivement sous les traitements 4 et 5, et le plus faible (1,76%) chez les oiseaux sous le traitement 2. L'étude a conclu que le remplacement de la farine de poisson par la poussière d'écrevisses à 75% pourrait être adopté pour des portions de cuisse et de gésier plus lourdes sans aucun effet néfaste sur les paramètres sanguins des oiseaux.

**Mots-clés :** poussière d'écrevisse, performance de croissance, profil sanguin, carcasse, poulets de chair

## Introduction

The poultry sector is possibly the fastest growing and most flexible of all the sectors in the Nigerian livestock industry. This is as a result of the very strong demand for its product and has thus expanded, consolidated and globalized over the years in countries of all income levels (FAO, 2013). The total consumption of poultry meat and eggs has also increased dramatically and continues to increase ahead of human population growth (Hossain *et al.*, 2003). The broiler industry, therefore, demands fast-growing chicks and good quality feed with high levels of energy, proteins, vitamins and essential minerals to support maximum growth. In Nigeria, the poultry industry has however been confronted with the challenges of high cost and scarcity of feed inputs with an associated problem of dwindling quality. According to Ojewola and Annah (2006), poultry feeds cost about 60-65% of the total cost of poultry production while protein costs about 13% of the total feed cost. This situation, therefore, calls for solutions that can urgently check the steadily increasing prices of feeds so as to encourage more poultry production and thus increase animal protein supply.

The quality and quantity of dietary protein are primary factors influencing growth and feed costs. Consequently, considerable

research has been conducted to evaluate protein requirements (Guillaume, 1997) and the acceptability of various feedstuffs as protein sources (Tacon and Akiyama, 1997). Feedstuffs containing at least 20% crude protein are often considered to be suitable protein sources. Fishmeal is one of the acceptable sources of protein for poultry feeds because of its adequacy in the composition of amino acids. However, the downturn in the economy of developing nations especially Nigeria has led to the rising cost of fish, owing to the high demand by the human increasing population. As such, fishmeal has become less available with its attendant exorbitant price value. It is against this backdrop that the crayfish waste/dust was investigated as a replacement for fishmeal.

Crayfish dust is a by-product of crayfish production. There is no use for it in the diet of humans, and thus it can be much better utilised for feed formulation. Crayfish dust has a crude protein value as high as 35-60% and an energy value of about 1454 Kcal/Kg thus making it an excellent source of protein (Asafa *et al.*, 2012). Being of marine origin, crayfish is relatively rich in calcium and phosphorous, minor inorganic elements, fatty acids, methionine and lysine, vitamins and unidentified growth factors such as phytochemicals (Okoye, 1998). Research efforts were geared towards using crayfish dust that may bring about the expected growth rate and reduction in feed costs. The study aimed to

examine the effect of replacing local fish meal with crayfish dust on growth performance, blood profile and carcass characteristics of broiler chickens.

### Materials and Methods

#### Experimental Site

The experiment was carried out at the Research Poultry Unit of the Institute of Agricultural Research and Training, Ibadan, Oyo State. It is located on latitude 7°23'N, longitude 3°51'E and Altitude 650 mm, it lies in the humid zone of the rainforest belt 07°3'25" of South Western Nigeria with a mean annual rainfall of 1220 mm and a mean temperature of 26°C.

#### Experimental Birds and Management

One hundred and sixty day-old Marshall® strain of broiler chickens were purchased from a reputable hatchery in Oyo

State. On arrival, the chicks were tagged individually with identification numbers and their initial weights were taken. The chicks were randomly assigned to five treatment groups based on the levels of replacement of fishmeal with crayfish dust. The experimental treatments were 0, 25%, 50%, 75% and 100% replacement of fishmeal with crayfish dust in 100 kg of diet. Each of the treatment groups consisting of 32 birds were further sub-divided into 4 replicates of 8 birds each. The chicks were brooded on treatment basis for 2 weeks and were fed ad-libitum and water was supplied daily throughout an experimental period of 8 weeks. One basal diet (Table 1) was compounded to meet the nutritional requirements of broilers as recommended by NRC (1994). The dietary treatments included: T1 (control), T2 (0.625kg of crayfish dust), T3 (1.25kg of crayfish dust), T4 (1.875kg of crayfish dust) and T5 (2.5kg of crayfish dust) in 100 kg of the diets.

**Table 1:** Composition of the experimental diets

Ingredient	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Maize	53.00	53.00	53.00	53.00	53.00
Soyabean Meal	35.00	35.00	35.00	35.00	35.00
Wheat Offal	5.00	5.00	5.00	5.00	5.00
Fish Meal	2.50	1.875	1.25	0.625	0.00
Crayfish Dust	0.00	0.625	1.25	1.875	2.50
Limestone	1.50	1.50	1.50	1.50	1.50
Di-calcium Phosphate	2.00	2.00	2.00	2.00	2.00
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20
Salt (NaCl)	0.35	0.35	0.35	0.35	0.35
Premix	0.25	0.25	0.25	0.25	0.25
Toxin Binder	0.10	0.10	0.10	0.10	0.10
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

### Data collection

#### Growth performance

Growth performance parameters were collected at starter (days 1 to 28) and finisher (days 29 to 56) phases. The initial body weights and subsequent weekly weights of the birds were measured with a digital

balance. The daily feed intake was obtained by deducting the quantity of feed left over from the quantity of feed given. The feed conversion ratio was deduced by dividing the quantity of feed consumed by weight gained.

### Blood Parameters

On the last day of the study (8 week old broilers), 5 ml of blood were collected into heparinised tubes from the brachial veins of 2 selected birds per replicate. All the samples were collected in the morning before feeding (between 07:00 am and 09:00 am) transported to the laboratory in cool containers within 2 hours of collection. The haematological parameters were determined and analysed according to the procedures described by Sood (2016). Packed Cell Volume (PCV) was determined using microhaematocrit capillaries. Haemoglobin concentration (Hb) was determined using the cyanmethaemoglobin method which involves mixing 5 ml of Drabkin's solution (1000 ml of deionised water mixed with 400 mg of Potassium ferricyanide, 280 mg of Potassium dihydrogen phosphate, 100 mg of Potassium cyanide and 1 ml of non-ionic detergent) with 20  $\mu$ l of blood sample. The mixture was read in a photocolourimeter at 540 nm (green filter). Blood counts and differential blood counts were determined using the improved Neubauer's chamber (area of 9 sq/mm and depth of 0.1 mm).

Serum biochemical parameters (Total protein, globulin, albumin, creatinine, uric acid, cholesterol, triglycerides, Aspartate transaminase (AST), Alanine transaminase (ALT), Alkaline Phosphate (ALP), glucose, calcium and phosphorous) were analyzed using commercially available test kits (Randox laboratories, United Kingdom, Model BT294QY).

### Carcass Yield Evaluation

On the last day of the study, two birds per replicate were selected for carcass analysis. The selected birds were starved overnight and slaughtered by severing the carotid artery and the jugular vein. The birds were allowed to bleed completely followed by removal of the skin. The dressed weights of the carcasses were recorded after evisceration and the dressing percentages were estimated by dividing the dressed weights of carcasses by the live weights and multiplied by 100. The weights of cut-up parts (breasts, backs, drumsticks, thighs,

wings and necks), organs (spleen, gizzard, proventriculus, pancreas, liver, heart, thymus and bursa) and intestines (duodenum, jejunum, ileum, caecum and colon) were determined using an electronic scale and the values were recorded in grams and further expressed as a percentage of the respective live weights.

### Statistical Analysis

Data generated were subjected to Analysis of variance in a Completely Randomized Design. Significantly ( $p < 0.05$ ) different means were separated using the Tukey Test as contained in Minitab® version 17.1.0 (Minitab, 2013).

## Results and Discussion

The effects of replacing local fish meal with crayfish dust on the growth performance of broiler chickens are shown in Table 2. The average feed intake in the starter phase was significantly highest (44.89 g/bird/day) in birds on the control diet and lowest (37.43 g/bird/day) in birds on treatment 2. The reduced consumption of feed in broilers fed diets replacing crayfish dust with fish meal compared to the control group in the starter phase indicated that crayfish dust possesses anorectic properties. This is consistent with earlier reports by Aktar *et al.* (2011) and Rahman and Koh (2016) who reported reduction in the feed intakes of broilers fed shrimp and marine wastes when compared with the control. Asafa *et al.* (2012) also observed differences in the mean feed intakes of broilers fed diets replacing fishmeal with poultry offal meal and crayfish waste. On the contrary, the findings of Ojewola and Annah (2006) revealed no differences in the feed intake of broilers fed diets containing danish fish meal, crayfish dust and shrimp waste. Ijaiya and Eko (2009) also reported no impact of replacing dietary fish meal with silkworm (*Anaphe infracta*) caterpillar meal on the feed consumption of starter broilers.

The effects of replacing local fish meal with crayfish dust on the haematology of broiler chicken are presented in Table 3. Significant differences ( $p < 0.05$ ) were observed in all the

**Table 2:** Effects of replacing local fish meal with crayfish dust on growth performance of broiler chicken

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	P value
<b>Starter phase</b>							
Initial weight (g/bird)	38.03	37.19	37.50	37.41	38.69	0.44	0.17
Average final weight (g/bird)	674.80	609.90	652.70	641.00	645.30	32.90	0.73
Average weight gain (g/bird/day)	22.74	20.45	21.97	21.56	21.66	1.18	0.74
Average feed intake (g/bird/day)	44.89 <sup>a</sup>	37.43 <sup>b</sup>	39.41 <sup>ab</sup>	42.40 <sup>ab</sup>	42.37 <sup>ab</sup>	1.59	0.04
FCR	1.97	1.83	1.79	1.97	1.96	0.08	0.40
<b>Finisher phase</b>							
Initial weight (g/bird)	674.80	609.90	652.70	641.00	645.30	32.90	0.73
Average final weight (g/bird)	1654.00	1476.00	1718.00	1630.00	1534.00	100.00	0.47
Average weight gain (g/bird/day)	34.97	30.92	38.05	35.32	31.73	2.82	0.41
Average feed intake (g/bird/day)	103.26	90.00	106.54	104.03	101.03	5.69	0.12
FCR	2.95	2.91	3.04	2.95	3.18	0.20	0.57

<sup>ab</sup> Means on the same row having different superscript are significantly ( $p < 0.05$ ) different.

**Table 3:** Effects of replacing local fish meal with crayfish dust on haematological parameters of broiler chicken

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	P value
Packed Cell Volume (%)	30.95 <sup>e</sup>	31.35 <sup>d</sup>	33.99 <sup>c</sup>	34.51 <sup>a</sup>	34.09 <sup>b</sup>	0.01	<0.001
Haemoglobin concentration (g/dl)	10.35 <sup>c</sup>	11.55 <sup>a</sup>	10.99 <sup>b</sup>	11.59 <sup>a</sup>	11.05 <sup>b</sup>	0.02	<0.001
Red blood cell counts ( $\times 10^{12}/l$ )	2.11 <sup>e</sup>	2.22 <sup>d</sup>	2.33 <sup>c</sup>	2.55 <sup>a</sup>	2.45 <sup>b</sup>	0.01	<0.001
White blood cell counts ( $\times 10^3/\mu l$ )	19.55 <sup>d</sup>	20.75 <sup>c</sup>	21.07 <sup>b</sup>	21.25 <sup>a</sup>	21.21 <sup>a</sup>	0.01	<0.001
Heterophil ( $\times 10^3/\mu l$ )	10.05 <sup>e</sup>	10.39 <sup>d</sup>	10.88 <sup>c</sup>	11.19 <sup>a</sup>	11.06 <sup>b</sup>	0.01	<0.001
Eosinophil ( $\times 10^3/\mu l$ )	0.41 <sup>c</sup>	0.63 <sup>a</sup>	0.47 <sup>c</sup>	0.60 <sup>ab</sup>	0.55 <sup>b</sup>	0.01	<0.001
Lymphocytes ( $\times 10^3/\mu l$ )	78.51 <sup>d</sup>	78.71 <sup>c</sup>	78.95 <sup>b</sup>	79.39 <sup>a</sup>	78.95 <sup>b</sup>	0.01	<0.001
Monocytes ( $\times 10^3/\mu l$ )	0.64 <sup>c</sup>	0.81 <sup>b</sup>	0.71 <sup>b</sup>	0.76 <sup>ab</sup>	0.82 <sup>a</sup>	0.01	<0.001
Basophils ( $\times 10^3/\mu l$ )	0.21 <sup>b</sup>	0.34 <sup>a</sup>	0.16 <sup>c</sup>	0.05 <sup>d</sup>	0.00 <sup>e</sup>	0.01	<0.001

<sup>abcde</sup> Means on the same row having different superscript are significantly ( $p < 0.05$ ) different.

parameters measured across treatments. The PCV, RBC, heterophils and lymphocytes were significantly ( $p < 0.05$ ) highest (34.51%,  $2.55 \times 10^{12}/\mu\text{l}$ , 11.19% and 79.39%, respectively) in birds on treatment 4 and lowest (30.95%,  $2.11 \times 10^{12}/\mu\text{l}$ , 10.05% and 78.51%, respectively) in the control group. These values were within the ranges reported by Tehrani *et al.* (2012) in broilers fed different levels of brine shrimp (*Artemia urmiana*). Significantly ( $p < 0.05$ ) highest values (11.55 and 11.59 g/dl) for Hb were recorded in birds on treatments 2 and 4, respectively while the lowest Hb value (10.35 g/dl) was recorded in the control group. The White blood cell counts were significantly ( $p < 0.05$ ) highest ( $21.25$  and  $21.21 \times 10^3/\mu\text{l}$ ) in birds on treatments 4 and 5, respectively and lowest ( $19.55 \times 10^3/\mu\text{l}$ ) in the control group. Eosinophil counts were significantly ( $p < 0.05$ ) highest (0.63%) in birds on treatment 2 and lowest (0.41 and 0.47%) in birds on treatments 1 and 3, respectively. Birds on treatment 5 recorded significantly ( $p < 0.05$ ) highest (0.82%) monocyte counts while the lowest (0.64%) was recorded in the control group. Basophils were significantly ( $p < 0.05$ ) highest (0.34%) in birds on treatment 2 and lowest (0.00%) in birds on

treatment 5.

The haemoglobin concentration and red blood cell counts fell within the values recorded in the findings of Muhammad and Oloyede (2009) and Tewe and Egbunike (2009). However, these results contradicted the findings of Agboola *et al.* (2013) who reported higher Hb concentrations, RBC and WBC counts in the control group than in birds fed graded levels of frog (*Rana esculata*) meal as replacement to fish meal. The differences in test ingredients and the age of the birds during blood collection could be responsible for this disparity in the results.

The serum biochemical parameters measured were significantly ( $p < 0.05$ ) different among the treatments (Table 4). The total protein was significantly ( $p < 0.05$ ) highest (6.61 g/dl) in birds on treatment 4 and lowest (6.15, 6.12 and 6.11 g/dl) in birds on treatments 1, 3 and 5, respectively. The globulin was also significantly ( $p < 0.05$ ) highest (3.31 g/dl) in treatment 4 and lowest (3.06, 3.12 and 3.10 g/dl) in birds in birds in treatments 1, 3 and 5, respectively. Albumin was significantly ( $p < 0.05$ ) higher (3.21 and 3.30 g/dl) in birds on treatments 2 and 4, respectively and lower (3.09, 3.00 and

**Table 4:** Effects of replacing local fish meal with crayfish dust on serum biochemical parameters of broiler chickens

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	P value
Total Protein (g/dl)	6.15 <sup>c</sup>	6.41 <sup>b</sup>	6.12 <sup>c</sup>	6.61 <sup>a</sup>	6.11 <sup>c</sup>	0.03	<0.001
Globulin (g/dl)	3.06 <sup>c</sup>	3.20 <sup>b</sup>	3.12 <sup>c</sup>	3.31 <sup>a</sup>	3.10 <sup>c</sup>	0.02	<0.001
Albumin (g/dl)	3.09 <sup>b</sup>	3.21 <sup>a</sup>	3.00 <sup>b</sup>	3.30 <sup>a</sup>	3.00 <sup>b</sup>	0.02	<0.001
Creatinine (g/dl)	1.40 <sup>c</sup>	1.50 <sup>b</sup>	1.45 <sup>bc</sup>	1.57 <sup>a</sup>	1.57 <sup>a</sup>	0.01	<0.001
Uric acid (g/d)	13.49 <sup>d</sup>	13.77 <sup>c</sup>	13.93 <sup>b</sup>	14.25 <sup>a</sup>	14.05 <sup>b</sup>	0.03	<0.001
ALP (g/dl)	32.07 <sup>d</sup>	32.30 <sup>c</sup>	33.04 <sup>b</sup>	33.30 <sup>a</sup>	33.21 <sup>a</sup>	0.02	<0.001
AST (g/dl)	21.13 <sup>e</sup>	21.61 <sup>d</sup>	22.05 <sup>c</sup>	22.44 <sup>a</sup>	22.21 <sup>b</sup>	0.01	<0.001
ALT (g/dl)	17.19 <sup>e</sup>	17.45 <sup>d</sup>	17.63 <sup>c</sup>	17.83 <sup>a</sup>	17.76 <sup>b</sup>	0.01	<0.001
Glucose (g/dl)	90.05 <sup>e</sup>	90.91 <sup>d</sup>	92.05 <sup>c</sup>	92.69 <sup>a</sup>	92.18 <sup>b</sup>	0.01	<0.001
Calcium (g/dl)	13.05 <sup>e</sup>	13.31 <sup>d</sup>	14.13 <sup>c</sup>	14.34 <sup>a</sup>	14.22 <sup>b</sup>	0.01	<0.001
Phosphorus (g/dl)	3.71 <sup>e</sup>	3.86 <sup>d</sup>	4.06 <sup>c</sup>	4.35 <sup>a</sup>	4.25 <sup>b</sup>	0.01	<0.001
Total cholesterol (g/dl)	88.89 <sup>e</sup>	89.54 <sup>d</sup>	89.92 <sup>c</sup>	90.31 <sup>a</sup>	90.14 <sup>b</sup>	0.02	<0.001
Triglyceride (g/dl)	168.88 <sup>a</sup>	167.75 <sup>c</sup>	159.23 <sup>d</sup>	168.48 <sup>b</sup>	159.18 <sup>d</sup>	0.08	<0.001

<sup>abcde</sup> Means on the same row having different superscript are significantly ( $p < 0.05$ ) different.

AST = Aspartate transaminase; ALT = Alanine transaminase; ALP = Alkaline Phosphate

**Table 5:** Effects of replacing local fish meal with crayfish dust on carcass characteristics of broiler chicken

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)	SEM	P value
Live weight	1662.50	1615.00	1826.50	1612.25	1491.00	102	0.28
Dressing percentage	66.21	63.36	65.74	69.50	65.85	1.55	0.14
<b>Cut-up parts<sup>1</sup></b>							
Breast	15.30	16.36	17.48	17.86	15.48	1.12	0.42
Back	12.18	11.97	12.81	13.45	13.22	1.51	0.00
Drumsticks	8.49	9.20	9.39	9.84	8.63	0.49	0.00
Thighs	7.85 <sup>b</sup>	9.37 <sup>ab</sup>	9.57 <sup>ab</sup>	10.12 <sup>a</sup>	8.87 <sup>ab</sup>	0.45	0.03
Wings	5.94	6.05	6.59	6.79	6.96	0.43	0.00
Neck	3.27	3.12	2.96	4.11	3.60	0.29	0.00
<b>Organs<sup>2</sup></b>							
Spleen	0.16	0.12	0.12	0.11	0.11	0.03	0.00
Gizzard	2.13 <sup>ab</sup>	1.76 <sup>b</sup>	2.02 <sup>ab</sup>	2.35 <sup>a</sup>	2.38 <sup>a</sup>	0.13	0.00
Proventriculus	0.44	0.41	0.48	0.42	0.57	0.05	0.00
Pancreas	0.24	0.18	0.28	0.24	0.25	0.03	0.36
Liver	2.49	2.60	2.69	2.65	2.30	0.25	0.00
Heart	0.71	0.59	0.65	0.78	0.51	0.08	0.00
Thymus	0.41	0.29	0.31	0.28	0.31	0.11	0.00
Bursa	0.08	0.06	0.08	0.05	0.06	0.02	0.00
<b>Intestines<sup>3</sup></b>							
Duodenum	0.67	0.53	0.83	0.74	0.77	0.13	0.57
Jejunum	1.37	1.35	1.51	1.57	1.71	0.18	0.63
Ileum	1.07	1.24	1.51	1.23	1.26	0.17	0.47
Caecum	0.83	1.03	0.90	0.69	0.89	0.10	0.26
Colon	0.22	0.13	0.19	0.08	0.17	0.04	0.16

<sup>ab</sup> Means on the same row having different superscript are significantly ( $p < 0.05$ ) different.

<sup>1,2,3</sup>: values are expressed as percentages of the live weight.

3.00 g/dl) in birds on treatments 1, 3 and 5, respectively. The reports are in line with the findings of Subbarayudu (2015) who observed higher serum protein levels in broilers fed varying levels of shrimp waste when compared with the control group. Agbede and Aletor (2003) however, reported that the total serum protein, albumin and globulin syntheses were not affected by the sources of dietary protein.

The highest creatinine values (1.57 g/dl) were recorded in birds on treatments 4 and 5, respectively while the lowest value (3.09 g/dl) was recorded in the control group. Uric acid, AST, ALT, glucose, calcium and phosphorus

values were significantly ( $p < 0.05$ ) highest (14.25, 22.44, 17.83, 92.69, 14.34 and 4.35 g/dl, respectively) in birds on treatment 4 and lowest (13.49, 21.13, 17.19, 90.05, 13.05 and 3.71 g/dl, respectively) in the control group. According to Agboola *et al.* (2013), the concentration of uric acid depends on the diet especially those with high protein content. Thus, the differences in the uric acid values in this study suggest better digestion, utilization and absorption of the protein in the crayfish dust used. ALP was significantly ( $p < 0.05$ ) highest (33.30 and 33.21 g/dl) in birds on treatments 4 and 5, respectively and lowest (32.07 g/dl) in the control group.

Total cholesterol was significantly ( $p < 0.05$ ) highest (90.31 g/dl) in birds on treatment 4 and lowest (88.89 g/dl) in the control group. The values recorded fall within the range for plasma cholesterol recorded by Daneshyar *et al.* (2011). Furthermore, triglyceride was significantly ( $p < 0.05$ ) highest (168.88 g/dl) in birds on treatment 1 and lowest (159.23 and 159.18 g/dl) in birds on treatments 3 and 5, respectively.

Table 5 shows the effects of replacing local fish meal with crayfish dust on the carcass characteristics of the broiler chickens. Thigh weights as a percentage of the live weights were significantly ( $p < 0.05$ ) highest (10.12%) in birds on treatment 4 and lowest (7.85%) in the control group. This is consistent with the findings of Asafa *et al.* (2012) who reported differences in the cut-up parts and organ weights of broiler carcasses fed a combination of poultry offal meal and crayfish waste meal as a replacement for fish meal. Aktar *et al.* (2011) also observed differences in thigh meat weights of broilers on diets where fish meal was replaced by shrimp waste and marine waste at various levels. Gizzard weights were significantly ( $p < 0.05$ ) highest (2.35 and 2.38, %) in birds on treatments 4 and 5, respectively and lowest (1.76%) in birds on treatment 2. The values obtained for gizzard weights as a percentage of the live weights were consistent with earlier reports (Fanimó *et al.*, 1996; Mohammed *et al.*, 2009). However, the results of the study differed from those obtained by Mahata *et al.* (2008) where the effect of substituting fish meal with shrimp waste had no impact on the weights of the digestive organs measured.

### Conclusion and Recommendations

From this study, the replacement of fishmeal with crayfish dust at 75% should be adopted for heavier thigh and gizzard portions without any deleterious effects on the blood parameters.

### References

- Agbede, J.O. and Aletor, V.A. 2003. Evaluation of Fish Meal Replaced with Leaf Protein Concentrate from *Glyricidia* in Diets for Broiler - Chicks: Effect on Performance, Muscle Growth, Haematology and Serum Metabolites. *International Journal Poultry Science*, 2: 242-250.
- Agboola A.F., Ajayi, H.I., Ogunbode, S.M., Majolagbe, O.H., Adenekan, O.O., Oguntuyo, C.T. and Opaleye, R.O. 2013. Serum biochemistry and haematological indices of broiler chickens fed graded levels of frog (*Rana esculata*) meal as replacement to fish meal. *International Journal of Agriculture and Biosciences*, 2(5): 260-265.
- Aktar, M., Rashid, M., Azam, M.G., Howlider, M.A.R. and Hoque, M.A. 2011. Shrimp waste and marine waste as substitutes of fish meal in broiler diet. *Bangladesh Journal of Animal Science*, 40 (1 & 2): 18-22
- Asafa, A.R., Ologhobo, A.D., and Adejumo, I.O. 2012a. Performance and Carcass Characteristics of Broiler Finishers Fed Different Levels of Poultry Offal Meal and Crayfish Waste Meal as Replacement for Fishmeal. *American Journal of Experimental Agriculture* 2(4): 690-699
- Daneshyar, M., Alizadeh Ghandkanlo, M., Sabzi Bayeghra, F., Farhangpajhoh, F. and Aghaei, M. 2011. Effects of dietary turmeric supplementation on plasma lipoproteins, meat quality and fatty acid composition in broilers. *South African Journal of Animal Science* 41(4): 420-427
- Fanimó, A.O., Mudama, E., Umukorol, T.B. and Oduguwa, O.O. 1996. Substitution of shrimp waste meal for fish meal in broiler chick rations. *Tropical Agric. (Trinidad)*. 73(2), 201 – 205.
- FAO. 2013. FAOSTAT data. Food and Agriculture Organization, Rome: [www.fao.org](http://www.fao.org).
- Guillaume, J. 1997. Protein and amino acids. In D'Abramo, L.R., Conklin, D.E; Akiyamo, D.M. (eds), *Crustacean Nutrition*. *Adu. World aquaculture*. Vol. 6. World Aquaculture Society, Baton rouge, LA, USA. PP: 26-50.
- Hossain, M.H., Ahammad, M.U. and Howlider, M.A.R. 2003. Replacement of fish by broiler offal in broiler diet. *International Journal of Poultry Science*,

2: 159-163.

Ijaiya, A.T. and Eko, E.O. 2009. Effect of Replacing Dietary Fish Meal with Silkworm (*Anapheinfracta*) Caterpillar Meal on Growth, Digestibility and Economics of Production of Starter Broiler Chickens. *Pakistan Journal of Nutrition* 8 (6): 845-849.

Mahata, M.E., Dharma, A., Irsan Ryanto, H. and Rizal, Y. 2008. Effect of Substituting Shrimp Waste Hydrolysate of *Penaeus merguensis* for Fish Meal in Broiler Performance. *Pakistan Journal of Nutrition* 7 (6): 806-810

Mohammed, G., Igwebuike, J. U., Adamu, S.B., Dibal, E. and Ayewe, F. 2009. Haematological indices and carcass characteristics of broiler chicken fed graded levels of yam peel as partial replacement for maize. *Proceedings of 14th Annual conference of Animal Science Association of Nigeria*. 475-477.

Muhammad, N.O. and Oloyede, O.B. 2009. Haematological Parameters of Broiler Chicks Fed *Aspergillus niger* - Fermented *Terminalia catappa* Seed Meal-Based Diet. *Global Journal of Biotechnology and Biochemistry* 4 (2) : 179-183.

NRC, 1994. National Research Council. Nutrient requirement of poultry. 9th revised edition. National Academic Press, Washington D.C.

Ojewola, G.S. and Annah S.I. 2006. Nutritive and Economic Value of Danish Fish Meal, Crayfish Dust Meal and Shrimp Waste Meal Inclusion in Broiler Diets. *International Journal of Poultry Science* 5 (4): 390-394.

Okoye, F.C. 1998. The replacement value of Shrimp waste meal (SWM) for local fish meal (LFM) in the diet of broiler chicken. *Proceeding of the Anniversary Conference. NSAP*, P: 261.

Rahman, M. and Koh, K. 2016. Effects of Formic Acid-Treated Shrimp Meal on Growth Performance and Nutrient Digestibility in Broilers. *Journal of Poultry Science*, 53(3): 208-212

Sood, R. 2016. *Medical Laboratory Technology: Methods and Interpretations*. Sixth edition. Jaypee Brothers Medical Publishers Ltd. New Delhi, India.

Subbarayudu, M. 2015. Utilization of Shrimp Waste in Broiler Diets. Masters of Veterinary Science (Animal Nutrition) Thesis submitted to the Department of Animal Nutrition, College of Veterinary Science, Tirupati Sri Venkateswara Veterinary University.

Tacon, A.G.J. and Akiyama, D.M. 1997. Feed Ingredients. In D'Abraham, L.R., Conklin, D.E., Akiyama, D. M. (Eds) *Crustacean Nutrition*. *Adv World Aquacult. Vol.6*. World Aquaculture Society. Baton Rouge, L.A., USA, PP: 411-472.

Tehrani A, Javanbakht J, Askari S, Hassan M.A. and Solati A. 2012. Haematological Studies on Broiler Chickens Fed with Different Levels of *Artemia urmiana*. *Journal of Biotechnology Biomater* 2:138.

Tewe .O.O, and Egbunike, G.N. 1992. Utilization of cassava in non ruminant feeding. In : *cassava as livestock feed in Africa*. (S.K. Hahn., L. Reynolds and G.N. Egbunike (eds.). IITA Ibadan and ILCA, addisababa. Pp 28-38



## EVALUATION OF *FASCIOLA* SPP. INFECTION OF CATTLE AND SHEEP FROM NIGERIAN CITIES OF JOS, GOMBE AND MAIDUGURI

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### Abstract

Fasciolosis is a hepatic parasitic disease, mainly of ruminants caused by *Fasciola hepatica* and *Fasciola gigantica* which is responsible for serious economic losses in the farming industry, although humans may be infected. The objective of this study was to determine the prevalence and risk factors for infection with *Fasciola* spp. in cattle and sheep from the Nigerian North-central city of Jos (Plateau State) and the Northeastern cities of Gombe (Gombe State) and Maiduguri (Borno State), using bile and Fecal sedimentation methods. The effects of age, breed, sex and months of sampling were similarly determined. A total of 2,376 samples of Feces and bile were collected from 1,188 cattle, while 2,354 samples were from 1,177 sheep, giving an overall prevalence of 27.53% and 11.98% respectively in cattle and sheep. Sex, age and breed had no significant ( $p \geq 0.05$ ) impact on the prevalence rate in cattle, while months of sample collection and sample type had significant ( $p < 0.0001$ ) impacts. Similarly, cattle from Jos had a significantly ( $p < 0.05$ ) higher prevalence of 35.43% followed by those from Gombe (26.99%), while those from Maiduguri had the lowest (19.63%) among the sampled cattle. There was a negative association between the number of positive cattle and eggs per gram (EPG), with those from Maiduguri having a mean EPG of  $65.85 \pm 13.2$  followed by those from Gombe  $45.48 \pm 10.8$  and those from Jos had the least ( $14.4 \pm 1.34$ ). In sheep, age, months of sample collection and sample type had impacts, as significant variations ( $p < 0.05$ ) were observed among the results. Furthermore, sheep from Jos had significantly ( $p < 0.010$ ) higher prevalence rate (24.35%) than those from both Maiduguri (6.16%) and Gombe (5.52%). The results obtained from the different locations showed significant ( $p < 0.05$ ) variations based on age, breed, sex and sample types, while within locations, the results differed significantly ( $p < 0.0001$ ) based on months of sample collection and the sample type in both cattle and sheep. The results obtained reflect the agro-climatic patterns of the study locations.

**Key words:** *Fasciola*, Prevalence, Nigeria, Fecal egg count, risk factors, Bile egg count, sedimentation, Fasciolosis

## ÉVALUATION DE L'INFECTION À *FASCIOLA* SPP. DE BOVINS ET D'OVINS DES VILLES NIGÉRIANES DE JOS, GOMBE ET MAIDUGURI

### Résumé

La fasciolose est une maladie parasitaire hépatique principalement des ruminants, causée par *Fasciola hepatica* et *Fasciola gigantica*. Elle est responsable de graves pertes économiques dans le secteur de l'élevage, bien que les humains puissent être infectés. L'objectif de cette étude était de déterminer la prévalence et les facteurs de risque d'infection par *Fasciola* spp chez les bovins et les ovins de la ville nigériane de Jos dans le centre-nord (État du Plateau) et des villes du nord-est à savoir Gombe (État de Gombe) et Maiduguri (État de Borno), en utilisant des méthodes de sédimentation biliaire et fécale. Les effets de l'âge, de la race, du sexe et des mois d'échantillonnage ont été déterminés de la même manière.

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Au total, 2 376 échantillons de matières fécales et de bile ont été prélevés sur 1 188 bovins, tandis que 2 354 échantillons provenaient de 1 177 ovins, ce qui donne une prévalence globale de 27,53% et 11,98% respectivement chez les bovins et les ovins. Le sexe, l'âge et la race n'ont pas eu d'impact significatif ( $p \geq 0,05$ ) sur le taux de prévalence chez les bovins, tandis que les mois de collecte et le type d'échantillon ont eu des impacts significatifs ( $p < 0,0001$ ). De même, les bovins de Jos avaient une prévalence significativement ( $p < 0,05$ ) plus élevée de 35,43%, suivis de ceux de Gombe (26,99%), tandis que ceux de Maiduguri avaient la plus faible (19,63%) prévalence parmi les bovins échantillonnés. Il y a eu une association négative entre le nombre de bovins positifs et d'œufs par gramme (EPG), ceux de Maiduguri ayant un EPG moyen de  $65,85 \pm 13,2$  suivi de ceux de Gombe ( $45,48 \pm 10,8$ ), tandis que ceux de Jos en avaient le plus faible ( $14,4 \pm 1,34$ ). Chez les moutons, l'âge, les mois de prélèvement et le type d'échantillon ont eu des impacts, car des variations significatives ( $p < 0,05$ ) ont été observées dans les résultats. De plus, les moutons de Jos avaient un taux de prévalence significativement ( $p < 0,010$ ) plus élevé (24,35%) que ceux de Maiduguri (6,16%) et de Gombe (5,52%). Les résultats obtenus dans les différents sites ont montré des variations significatives ( $p < 0,05$ ) basées sur l'âge, la race, le sexe et les types d'échantillons, tandis qu'à l'intérieur des sites, les résultats différaient considérablement ( $p < 0,0001$ ) en fonction des mois de collecte des échantillons et du type d'échantillon chez les bovins et les ovins. Les résultats obtenus reflètent les schémas agro-climatiques des lieux d'étude.

**Mots-clés :** *Fasciola*, Prévalence, Nigéria, Numération d'œufs fécaux, facteurs de risque, Numération d'œufs biliaires, sédimentation, Fasciolose

## Introduction

Fasciolosis, a disease of economic and public health significance, is caused by two species; *Fasciola hepatica* and *Fasciola gigantica*. Previous reports have shown the existence of an intermediate form, particularly from countries like Vietnam and Pakistan (Itagaki *et al.*, 2009, Mufti *et al.*, 2014). Along with other important parasitic diseases such as trypanosomosis, fasciolosis remains an important impediment to optimal production due to the associated decrease in productivity and the high costs of treatment of the growing ruminant population in Nigeria. Although fasciolosis is more important in cattle than other domestic animals (Jean-Richard *et al.*, 2014), there have been reports of its occurrence with varied prevalence in sheep (Martinez-Valladares *et al.*, 2013), goats (Tasawar *et al.*, 2007), horses (Badawy *et al.*, 2014) and buffaloes (Magbool *et al.*, 2002). Similarly, there have been occurrences in unusual hosts such as dogs (Salib *et al.*, 2013), humans (Incani *et al.*, 2003) and even in vegetables put up for sale (Esonu, 2014). Past reports from Turkey (Yildirim *et al.*, 2007), Mexico (Cruz-Mendoza *et al.*, 2005), Kenya (Kithuka *et al.*, 2002), Iran (Khanjari *et al.*, 2014) and Nigeria (Adedokun *et al.*, 2008a) on the incidence of fasciolosis in different animal species demonstrated the

cosmopolitan nature of this disease, which spans countries and continents. In fact, no continent is free from fasciolosis, and it is likely that where animal cases are reported, human cases also exist (WHO, 2016).

A prevalence of 30-50% is normally found among animals in endemic regions, but this may sometimes reach 70% (Gupta, 2014). From different ruminants, prevalence rates of 17.0%, 25.90%, 45.70% and 33.50% have been respectively reported from the Nigerian cities of Zaria, Gombe, Port-Harcourt and Ibadan (Adedokun *et al.*, 2008a; Gboeloh, 2012; Aliyu *et al.*, 2014; Adang *et al.*, 2015), emphasizing the importance of fasciolosis across the country. The variations in prevalence across regions are often linked to a variety of factors, including climatic factors, cattle trade, cattle rustling, population numbers and the presence of the snail intermediate host (Kithuka *et al.*, 2002). Furthermore, a prediction of the disease pattern is possible, where the seasonal dynamics of the snail intermediate host are known (Radostits *et al.*, 2006). Similarly, Mascoma *et al.* (2009a) reported that higher temperatures might enhance cercarial production due to increased host metabolic activity and the greater energy available to the parasite, in addition to markedly increased physiological processes associated with increasing temperatures in ectothermic

animals like snails.

Our current knowledge of fasciolosis based on coprological examinations from the study locations is based on data generated more than a decade or two ago, thus rendering such reports, perhaps not useful for current policy formulation and epidemiological works. In addition, the exact relationship between egg counts from bile and Feces largely remains unknown. We therefore present findings on the updated status of fasciolosis prevalence, egg counts and some risk factors for the acquisition of infection in both cattle and sheep from three Nigerian cities.

## Materials and Methods

### Study Areas

Maiduguri is the capital and largest city of Borno State, northeastern Nigeria. It is located on the north bank of the seasonal Ngadda (Alau) river, between latitude 11°50' N and longitude 13°50' E. Maiduguri sits at 325 meters above sea level (Figure 1). Gombe town

is the capital of Gombe State, Nigeria. The town is situated between latitude 10°08' N and 11°24' E and longitude 11°02' E and 11°18' E. The town experiences two seasons, the rainy season, from April to October and the dry season, from November to March (Adang *et al.*, 2015). The town is situated at 460 meters above sea level (Figure 1). Jos is located at 9°48' 00" N and 8°52' 00" E and has a landscape of Guinea Savannah (Pam *et al.*, 2013). It is situated at an elevation of 1186 meters above sea level (Figure 1).

### Study Design

This study was designed as a cross-sectional study and involved cattle and sheep slaughtered at the major abattoirs of Jos, Gombe and Maiduguri, Nigeria. Due to lack of previous data on the combined prevalence of fasciolosis in the bile and Feces of cattle and sheep from the study locations, the number of samples collected was determined using the formula of Thrusfield (2005).



**Figure 1:** Map of Nigeria showing the Distribution of the Sampling Locations (Abattoirs)

Source: Modified from the Administrative Map of Nigeria

## Sample Collection and Transportation

A total of 4,730 samples consisting of two thousand, three hundred and sixty five (2,365) samples of each bile and Feces, were collected in the study. A total of 2,376 samples of Feces and bile were collected from 1,188 cattle, while 2,354 samples were from 1,177 sheep. Based on the study sites, 412 samples each of bile and Feces were collected from cattle in Jos, while 390 samples were similarly collected from sheep. Three hundred and eighty nine (389) samples each of bile and Feces were collected from cattle, while 398 were similarly collected from sheep in Gombe. From Maiduguri abattoir, 387 and 389 samples of each bile and Feces were collected from cattle and sheep respectively. The samples were collected as described by Magaji *et al.* (2014). All samples not intended for immediate examination were preserved in 10% buffered formalin.

## Sample Processing

### Sample Processing

Both Feces and bile samples were subjected to the sedimentation technique as described by Magaji *et al.* (2014). Briefly, four grams (4 g) of Feces or 4 ml of bile were placed in labeled test tubes containing 6 ml of distilled water (Feces), and then strained to give a suspension, which was then strained through a tea strainer into a clean labeled Petri dish. 1 ml of diethyl-ether was added to the resulting filtrate before centrifuging. The entire sediment was examined for *Fasciola* eggs and then counted for determination of the prevalence and eggs per gram.

Prevalence was determined by expressing the number of positive samples as a % of the total samples tested. The number of eggs counted was expressed per gram/ml of Feces/bile (Ortiz *et al.*, 2000).

### Data Analyses

The statistical package for social science (SPSS version 20.0) was used to calculate percentages and summarized into tables. Chi square was used to test for

association between the sampled animals and the different variables. Values of ( $P \leq 0.05$  were defined as significant).

## Results

### Overall Prevalence of *Fasciola* spp

In cattle and sheep, an overall prevalence of 327/1188 (27.53%) and 141/1177 (11.98%) respectively was obtained in the study. In cattle, the highest prevalence was in animals from Jos 146/412 (35.44%), followed by Gombe 105/389 (26.99%) and Maiduguri 76/387 (19.64%). These results differed significantly ( $P < 0.01$ ) from each other. There was a negative association between the number of positive animals and eggs per gram (EPG) of Feces and bile, with Maiduguri having a mean EPG of  $65.85 \pm 13.2$  followed by Gombe  $45.48 \pm 10.8$  and Jos the least ( $14.4 \pm 1.34$ ). Similarly, sheep from Jos had the highest prevalence (24.35%), followed by Maiduguri (6.16%), while the least prevalence of (5.52%) was in samples from Gombe. The prevalence in samples from Jos differed significantly ( $P < 0.0001$ ) from the other locations. Actual mean EPGs of 19.71, 36.34 and 14.47 were obtained for sheep from Jos, Gombe and Maiduguri, respectively.

### Prevalence in Cattle

The results from the study locations showed that there was no significant variation ( $P < 0.05$ ) based on the sex, age and breed of the cattle examined. However, there was a significant ( $P < 0.0001$ ) variation in the prevalence based on the months of sample collection. Similar to the prevalence, the eggs per gram (EPG) for the respective months of sampling showed significant ( $P < 0.0001$ ) differences (Table 1). Furthermore, the recovery of eggs through bile sedimentation was significantly ( $P < 0.0001$ ) higher (23.90%) compared to fecal sedimentation (11.02%). The results of the EPG based on the techniques applied corroborated the prevalence as bile sedimentation had a higher EPG count ( $41.12 \pm 5.78$ ) than fecal sedimentation (0.0056) (Table 1).

**Table 1:** Prevalence of *Fasciola* spp. of Cattle in Jos, Gombe and Maiduguri

Parameter	No. Sampled	No.(%) <sup>+</sup> ve	Mean egg per gram (EPG) (Mean±SEM)
<b>Sex</b>			
Male	241	65 (26.97) <sup>a</sup>	23.81±4.12 <sup>a</sup>
Female	947	262 (27.66) <sup>a</sup>	36.27±5.35 <sup>a</sup>
Total	1188	327 (27.52) <sup>a</sup>	33.67±4.33 <sup>a</sup>
		<b>0.8292</b>	<b>0.243</b>
<b>Age</b>			
Young	235	58 (24.68) <sup>a</sup>	30.64±6.99 <sup>a</sup>
Adult	953	269 (28.22) <sup>a</sup>	33.39±4.85 <sup>a</sup>
Total	1188	327 (27.52)	33.67±4.33 <sup>a</sup>
		<b>0.2757</b>	<b>0.8091</b>
<b>Breed</b>			
Rahaji	416	105(25.24) <sup>a</sup>	40.60±9.67
Bunaji	630	185(29.36) <sup>a</sup>	12.33±3.10
Crosses	45	18(40.00) <sup>a</sup>	14.44±2.56
Sokoto Gudali	7	2(28.57) <sup>a</sup>	1.50±1.50
Wadara	81	15(18.51) <sup>a</sup>	117.30±49.58
Kuri	8	2(25.00) <sup>a</sup>	117.7±59.12
Ambala	1	0(0.00) <sup>a</sup>	0.00±0.00
Total	1188	327(27.52) <sup>a</sup>	33.67±4.33
		<b>0.1538</b>	<b>NA</b>
<b>Month</b>			
January	339	114(33.62) <sup>a</sup>	12.14±1.17 <sup>a</sup>
February	127	50(39.37) <sup>b</sup>	32.37±13.24 <sup>b</sup>
March	67	22(32.83) <sup>a</sup>	59.68±33.17 <sup>c</sup>
April	103	19(18.44) <sup>c</sup>	126.80±43.58 <sup>d</sup>
May	284	57(20.07) <sup>c</sup>	38.65±5.95 <sup>ab</sup>
June	268	65(24.25) <sup>d</sup>	37.47±7.23 <sup>ab</sup>
Total	1188	327(27.52) <sup>a</sup>	33.67±4.33 <sup>b</sup>
		<b>P&lt;0.0001</b>	<b>P&lt;0.0001</b>
<b>Technique</b>			
Bile sedimentation	1188	284(23.90) <sup>a</sup>	41.12±5.78 <sup>a</sup>
Fecal sedimentation	1188	131(11.02) <sup>b</sup>	15.72±3.75 <sup>b</sup>
		<b>P&lt;0.0001</b>	<b>0.0056</b>

Different superscripts in columns differed significantly ( $P<0.05$ )

**Table 2:** Prevalence of *Fasciola* spp. of Sheep in Jos, Gombe and Maiduguri

Parameter	No. Sampled	No.(%) <sup>+</sup> ve	Mean egg per gram (EPG) (Mean±SEM)
<b>Sex</b>			
Male	175	23(13.14) <sup>a</sup>	12.78±3.64 <sup>a</sup>
Female	1002	118(11.77) <sup>a</sup>	29.45±7.91 <sup>a</sup>
Total	1177	141(11.97) <sup>a</sup>	26.71±6.65 <sup>a</sup>
		<b>0.6075</b>	<b>0.3538</b>
<b>Age</b>			
Young	76	2(2.63) <sup>a</sup>	2.00±1.00 <sup>a</sup>
Adult	1101	139(12.62) <sup>b</sup>	26.31±6.58 <sup>a</sup>
Total	1177	141(11.97) <sup>b</sup>	26.71±6.65 <sup>a</sup>
		<b>0.0055</b>	<b>0.6388</b>
<b>Breed</b>			
Yankasa	1021	126(12.34) <sup>a</sup>	23.17±6.55
Balami	152	13(8.55) <sup>a</sup>	53.88±36.93
WAD	4	0(0.00) <sup>a</sup>	0.00±0.00
Total	1177	141(11.97) <sup>a</sup>	26.71±6.65
		<b>0.3072</b>	<b>NA</b>
<b>Month</b>			
January	14	4(28.57) <sup>a</sup>	6.00±1.70 <sup>a</sup>
February	90	4(4.44) <sup>b</sup>	169.30±166.10 <sup>b</sup>
March	161	10(6.21) <sup>b</sup>	12.80±4.52 <sup>a</sup>
April	194	12(6.18) <sup>b</sup>	13.00±5.27 <sup>a</sup>
May	195	12(6.15) <sup>b</sup>	65.38±45.16 <sup>ab</sup>
June	156	10(6.41) <sup>b</sup>	11.50±7.49 <sup>a</sup>
July	167	45(26.94) <sup>a</sup>	21.30±3.90 <sup>a</sup>
August	200	44(22.00) <sup>a</sup>	21.04±5.25 <sup>a</sup>
Total	1177	141(11.97) <sup>c</sup>	26.71±6.65 <sup>a</sup>
		<b>P&lt;0.0001</b>	<b>P=0.032</b>
<b>Technique</b>			
Bile sedimentation	1,177	72(6.11) <sup>a</sup>	50.88±15.11 <sup>a</sup>
Fecal sedimentation	1,177	103(8.75) <sup>b</sup>	26.55±6.72 <sup>b</sup>
		<b>0.0149</b>	<b>0.043</b>

Different superscripts in columns differed significantly ( $P<0.05$ )

### Prevalence in Sheep

Similar to the results found in cattle, the prevalence of *Fasciola* spp. In samples of sheep from Jos, Gombe and Maiduguri showed that age and breed had no effect ( $P>0.05$ ) on the prevalence, while adult sheep (12.62%) had

a significantly ( $P=0.0055$ ) higher prevalence compared to young sheep (2.63%) (Table 2). In addition, the EPG of the infected sheep did not vary significantly ( $P>0.05$ ) based on the age, sex and breed of the sheep sampled during the study.

On the effect of months of sampling on the prevalence, January (28.57%), July (26.94%) and August (22.00%) had significantly ( $P<0.0001$ ) higher counts compared to the rest of the months, in contrast to the EPG for which the highest counts were recorded in the month of February ( $169.30\pm 166.10$ ) and the lowest in January ( $6.00\pm 1.70$ ) ( $P= P=0.032$ ). Furthermore, there was a negative relationship between the prevalence and the EPG detected from bile and fecal samples. While the prevalence in bile was significantly ( $P=0.0149$ ) lower (6.11% vs 8.75%), the EPG in bile was significantly ( $P=0.043$ ) higher ( $50.88\pm 15.11$  vs  $26.55\pm 6.72$ ) than the corresponding results from fecal analysis.

*Distribution of prevalence based on sample types from the three study locations*

An inverse relationship which was significant ( $P<0.05$ ) was detected between prevalence and EPG results obtained from the Feces and bile of sheep sampled from Jos. Detection by bile sedimentation among samples from Jos was significantly ( $P=0.0312$ ) lower (13.07%) than by bile sedimentation (18.71%), while EPG detected in bile was higher ( $P=0.0003$ ) than that from Feces ( $32.70\pm 5.59$  vs  $9.66\pm 2.68$ ). In cattle however, only the prevalence and not the EPG showed significant variations at ( $P=0.0001$ ) (Table 3).

**Table 3:** Prevalence of *Fasciola* spp. in cattle and sheep from Jos, Gombe and Maiduguri in relation to sample type

Location	Species	Technique	No. Examined	No. (%) Infected	Mean egg per gram (EPG) (Mean $\pm$ SEM)
Jos	Sheep	Bile sedimentation	390	51(13.07) <sup>a</sup>	32.70 $\pm$ 5.59 <sup>a</sup>
		Fecal sedimentation	390	73(18.71) <sup>b</sup>	9.66 $\pm$ 2.68 <sup>b</sup>
				<b>0.0312</b>	<b>0.0003</b>
	Cattle	Bile sedimentation	412	125(30.33) <sup>a</sup>	16.33 $\pm$ 1.87 <sup>a</sup>
		Fecal sedimentation	412	78(18.93) <sup>b</sup>	11.66 $\pm$ 1.79 <sup>a</sup>
				<b>0.0001</b>	<b>0.098</b>
Gombe	Sheep	Bile sedimentation	398	10(2.51) <sup>a</sup>	109.33 $\pm$ 89.33 <sup>a</sup>
		Fecal sedimentation	398	13(3.15) <sup>a</sup>	3.69 $\pm$ 1.70 <sup>a</sup>
				<b>0.5256</b>	<b>0.211</b>
	Cattle	Bile sedimentation	389	89(22.87) <sup>a</sup>	60.49 $\pm$ 15.31 <sup>a</sup>
		Fecal sedimentation	389	43(11.05) <sup>b</sup>	12.15 $\pm$ 3.53 <sup>a</sup>
				<b>P&lt;0.0001</b>	<b>0.037</b>
Maiduguri	Sheep	Bile sedimentation	389	11(2.82) <sup>a</sup>	79.33 $\pm$ 48.03 <sup>a</sup>
		Fecal sedimentation	389	17(4.37) <sup>a</sup>	6.35 $\pm$ 2.62 <sup>a</sup>
				<b>0.2481</b>	<b>0.08</b>
	Cattle	Bile sedimentation	387	70(18.08) <sup>a</sup>	67.87 $\pm$ 14.03 <sup>a</sup>
		Fecal sedimentation	387	10(2.58) <sup>b</sup>	54.82 $\pm$ 39.20 <sup>a</sup>
				<b>P&lt;0.0001</b>	<b>0.723</b>

Different superscripts in columns differed significantly ( $P<0.05$ ).

Among samples collected from Gombe, those from cattle and not sheep showed significant changes with respect to both prevalence and EPG. Both the prevalence and the EPG from the results of bile sedimentation were higher at ( $P < 0.0001$ ) and ( $P = 0.037$ ) respectively than the corresponding findings from Feces (Table 3). From Maiduguri and for both cattle and sheep, there were no significant variations among the results obtained except for the prevalence in cattle, where findings from the bile were very highly significant ( $P < 0.0001$ ) than that from Feces (18.08% compared to 2.58%)

### Discussion

The 27.52% prevalence of infection obtained in cattle examined in this study is similar to what was generally reported for endemic regions by Gupta (2014) and Hussein and Khalifa (2010) in Egypt, but lower than that reported by Greter *et al.* (2016) from the eastern shores of Lake Chad (41.9%). In contrast, the overall prevalence of 11.97% found in sheep from the three locations (Maiduguri, Gombe and Jos) is far less than the (59.3%) reported by Martinez-Valladares *et al.* (2013) in Spain. The higher prevalence in cattle than sheep in this study is corroborated by the results of the mean EPG, where the overall egg count in cattle was higher than was found in sheep from the three locations. The EPG count for both cattle and sheep was lower than previously reported by Adedokun *et al.* (2008b) in cattle from Nigeria and by Affroze *et al.* (2013) in cattle from Bangladesh. However, it was higher than the previous findings of Kleiman *et al.* (2005) among cattle in Argentina and Ortiz *et al.* (2000) among human subjects in Peru. The high egg counts in the previous studies (Adedokun *et al.*, 2008b; Affroze *et al.*, 2013) compared to the present study may be linked to the higher percentage of animals in this study having low levels of infection with egg counts of (1-2 eggs/gram/ml) of Feces/bile.

Kusiluka and Kamarage (1996) asserted that the climate, management system, parasites and the definitive and intermediate

hosts of trematodes, each play an important role in the epidemiology of the diseases caused by trematodes, fasciolosis inclusive. Similarly, the higher overall EPG in cattle ( $33.67 \pm 4.33$ ) and sheep ( $26.71 \pm 6.65$ ) in this study than previously shown in cattle from Argentina (Kleiman *et al.*, 2005) and Cambodia (Sothoeun *et al.*, 2006) was not surprising because of the different management systems found in the different geographical regions. The results of the prevalence of infection in cattle sampled in this study may be a reflection of the interplay of different climatic, management, host and parasite factors in the three agro-climatic regions, typified by the study locations. Jos, located in the northern Guinea Savannah and at an altitude of 1186 meters above sea level had the highest infection rate, followed by Gombe, which is located in the Sudan Savannah at an altitude of 460 meters. Maiduguri located at an altitude of 325 meters above sea level in Sahel Savannah had the least infection rate. The increased prevalence of the infection in colder locations like Jos contrary to previous reports may be partly explained by the effects of climate change. As suggested by Mascoma *et al.* (2009a) who affirmed that higher temperature might enhance cercarial production due to increased host metabolic activity and the greater energy available to the parasite.

The higher prevalence in cattle than in sheep in this study corroborates the previous findings of Mungube *et al.* (2017), where similar results were reported, and this may be due to the occurrence mainly of acute fasciolosis in sheep than in cattle. Acute fasciolosis limits the possibility of infected animals reaching the abattoir for slaughter, since death often ensues before any sign can be noticed (Radostits *et al.*, 2006). On the other hand, the larger size of the cattle liver has been proposed as a likely reason for the chronicity of the infection in the species compared to the rather small liver of the sheep. In addition, the widely practiced system of rearing cattle in the study areas under extensive systems of management compared to sheep that are kept under semi-intensive and intensive systems might also have contributed to the higher prevalence in cattle

than in sheep, since extensively reared animals have an increased likelihood of coming into contact with the infective stages of *Fasciola* spp. on pastures. Mai *et al.* (2012) reported that 95% of the population of cattle in Nigeria is reared under pastoralist or semi pastoralist systems of management. This scenario may not have changed significantly over the years.

The reported common findings of higher infection levels in female animals (Biu *et al.*, 2013) than males, was not the case in this study. The prevalence of *Fasciola* spp in the cattle and sheep in this study did not show any statistically significant variation based on the sex of the animals in the three locations. However, male animals (cattle and sheep) from Gombe had a higher likelihood of acquiring *Fasciola* infection than the females. This report agrees with the report of Olupinyo and Ajanusi (2005) in sheep in Zaria, Nigeria. The overall significantly higher infection ( $p < 0.005$ ) among adult sheep, and not cattle may be explained by the continued exposure of adult animals to contaminated pastures, which invariably increases their chances of acquiring the metacercariae of *Fasciola* spp. Young animals, however, especially during pre-weaning times, are normally confined, thereby reducing the likelihood of acquiring infection.

Contrary to the earlier reports of Ahmed *et al.* (2007) in sheep, Yatswako and Alhaji (2017) in cattle in Nigeria, our study showed no statistically significant variation ( $P < 0.05$ ) across the breeds of cattle and sheep examined. This may have been due to exposure of the different breeds to similar or the same climatic, management and nutritional conditions which are important in the determination of the epidemiology of the disease. Furthermore, the months of sampling showed very significant ( $p < 0.0001$ ) variations in both species, with increased likelihood of the acquisition of infection in the months of February (cattle) and January (sheep). Similar observations were made in the cool dry period among sheep in Ethiopia (Ahmed *et al.*, 2007), in winter and spring among cattle in Egypt (Nossair and Abdella, 2014) and in the dry season (November-April) in sheep in Yola,

Nigeria (Ardo and Aliyara, 2014), and may be justified by the period of abundance of the snail intermediate hosts and the timing of release of the cercariae. It was previously shown that increased temperature causes an increase in metabolic and physiologic activities of ectothermic animals like snails (Mascoma *et al.*, 2009b), and this may coincidewith the period of increased activity of the snail. The cool dry period of November to March coincides with a period of absence of rain in the study areas and may be responsible for pastoralists rearing their animals around available water bodies because of the presence of lush pastures, thereby increasing exposure to the infective form of *Fasciola*.

The number of cattle that tested positive by the bile sedimentation method (23.90%) was twice higher than by the fecal sedimentation technique (11.02%). This appeared contrary to the finding of higher prevalence by the fecal sedimentation in sheep (8.75%), than by the bile sedimentation. Similarly, the bile egg count (BEC) was 2½ times higher than the fecal egg count (FEC) in cattle, while in sheep, it was 2 times higher than the FEC. The results of the prevalence and not EPG obtained by the two methods in sheep did not show any definite correlation. The findings on the EPG in cattle were similar to those previously reported by Sothoeun *et al.* (2006) among cattle from Cambodia using fecal sedimentation. Similarly, the higher prevalence by the bile sedimentation method is consistent with a previous finding in sheep (Shahzad *et al.*, 2012) and cattle (Adedokun *et al.*, 2008a), and can be justified by the fact that, the bile duct, the predilection site of *Fasciola* drains into the gall bladder, which in turn discharges eggs intermittently into the gastrointestinal tract. Thus, higher egg counts are expected in the bile than in the Feces. The finding of a higher prevalence in Feces than in bile had also been shown previously among cattle in Nigeria (Adedokun *et al.*, 2008b). Although, not common, this type of result may be found in animals with a low infection status where eggs per gram/milliliter of Feces/bile is low. Despite the superiority of the bile detection method in

cattle in the current study, it has limitation in its clinical application because of difficulties in collecting bile from live animals for the assays.

## Conclusion

Our study showed variations in the prevalence of *Fasciola* spp in cattle and sheep based on the agro-climatic divides of the three study locations. A clear relationship was observed between the fecal egg counts and the bile egg counts in both species, as the bile egg counts appeared twice or more times higher than the Fecal egg counts. Similarly, the wet season appeared to be a more common influence on prevalence and egg counts than other factors investigated in the study such as sex, breed and age.

## References

- Adang LK, Kela SL, Kashere MB, 2015. Fascioliasis in cattle slaughtered at Gombe abattoir, Nigeria. *International Journal of Biological and Chemical Science*, (2):783-792.
- Adedokun OA, Ayinmode AB, Fagbemi BO, 2008a. A comparative study of three methods for detecting *Fasciola* infections in Nigerian cattle. *Veterinarski Arhiv*, 78(5):411-416.
- Adedokun OA, Ayinmode AB, Fagbemi BO 2008b. Seasonal prevalence of *Fasciola gigantica* among the sexes in Nigerian cattle. *Veterinary Research*, 2(1):12-14.
- Affroze S, Begum N, Islam MS, Rony SA, Islam MA, Mondal MMH, 2013. Risk factors and gross pathology of bovine liver fluke infection at Netrokona district, Bangladesh. *Journal of Animal Science Advances*, 3(2): 83-90. Doi.5455/jasa.20130219031948.
- Ahmed EF, Markvichitr K, Tumwasorn S, Koonawootrittriron S, Choothesa A, Jittapalpong S, 2007. Prevalence of *Fasciola* spp Infections of sheep in the middle Awash River Basin, Ethiopia. *Southeast Asia Journal of Tropical Medicine and Public Health*, 38(suppl 1):51-57
- Aliyu AA, Ajogi IA, Ajanusi OJ, Reuben RC, 2014. Epidemiological studies of *Fasciola gigantica* in cattle in Zaria, Nigeria using coprology and serology. *Journal of Public Health and Epidemiology*, 6(2): 85-91.
- Ardo MB, Aliyara YH, 2014. Prevalence of fasciolosis in small ruminants slaughtered at Yola modern abattoir, Adamawa state, Nigeria. *Bayero Journal of Pure and Applied Sciences*, 7(2): 13 – 16.
- Badawy A, Abouzaid N, Merwad A, 2014. Occurrence of zoonotic fascioliasis in donkeys in Egypt with emphasis on PCR-RFLP of 28S rRNA gene. *Revue de Médecine Vétérinaire*, 165(5-6): 167-171.
- Biu AA, Paul BT, Konto M, Yauba AM, 2013. Cross-sectional and phenotypic studies on fasciolosis in slaughter cattle in Maiduguri, Nigeria. *Journal of Agriculture and Veterinary Sciences*, (2):155-162.
- Cruz-Mendoza I, Ibarra-Velarde F, Quintero-Martinez MT, Naranjo-García E, Lecumberrí-López J, Correa D, 2005. Seasonal transmission of *Fasciola hepatica* in cattle and *Lymnaea* (*Fossaria*) *humilis* snails in central Mexico. *Parasitology Research*, 95(4):283-286.
- Esonu DO, 2014. Prevalence of *Fasciola gigantica* eggs in sheep and goats and on salad vegetables in Zaria and environs, Nigeria. Unpublished Msc Thesis, Ahmadu Bello University, Zaria, Nigeria.
- Gboeloh, LB, 2012. Seasonal prevalence of *Fasciola gigantica* in slaughter cattle in major abattoirs in Port Harcourt. *Advances in Agriculture, Sciences and Engineering Research*, 2(9): 336-340.
- Greter H, Batil AA, Alfaroukh IO, Grimm F, Ngandolo BN, Keiser J, Utzinger J, Zinsstag J, Hattendorf J, 2016. Re-infection with *Fasciola gigantica* 6-month post-treatment with triclabendazole in cattle from mobile pastoralist husbandry systems at Lake Chad. *Veterinary Parasitology*, 230:43-48
- Gupta SC, 2014. Fasciolosis in man and animals: An overview retrospect to historical perspective, IAAVP Fellow Lead Paper XXIV, National Congress of Veterinary Parasitology and National Symposium on Towards Food Security through Sustainable Animal Production and Integrated Parasite Management, February 5 – 7, 2014, pp:164-174.
- Hussein, A-NA, Khalifa RMA, 2010. Fascioliasis prevalences among animals and human in Upper

- Egypt. Journal of King Saud University-Science, 22(1):15-19.
- Incáni RN, Vieira JM, Pacheco M, Planchart S, Amarista M, Lazdins J, 2003. Human infection by *Fasciola hepatica* in Venezuela: report of a geriatric case. *Investigacion Clinica*, 44:3.
- Itagaki T, Sakaguchi K, Terasaki K, Sasaki O, Yoshihara S, Dung TV, 2009. Occurrence of spermic diploid and aspermic triploid forms of *Fasciola* in Vietnam and their molecular characterization based on nuclear and mitochondrial DNA. *Parasitology International*, 58:81-85.
- Jean-Richard V, Crump L, Abicho AA, Nare NB, Greter H, Hattendorf J, Schelling E, Zinnstag J, 2014. Prevalence of *Fasciola gigantica* infection in slaughtered animals in south-eastern Lake Chad area in relation to husbandry practices and seasonal water levels. *BMC Veterinary Research*, 10:81 doi: 10.1186/1746-6148-10-81.
- Khanjari A, Bamonar A, Fallah S, Bagheri M, Alizadeh A, Fallah M, Khanjari Z, 2014. Prevalence of fasciolosis and dicrocoeliosis in slaughtered sheep and goats in Amol abattoir, Mazandaran, northern Iran. *Asian Pacific Journal of Tropical Disease*, 4(2): 120-124.
- Kithuka JM, Maingi N, Njeruh FM, Ombui JN, 2002. The prevalence and economic importance of bovine fasciolosis in Kenya--an analysis of abattoir data. *Onderstepoort Journal of Veterinary Research*, 69(4):255-62.
- Kusiluka LJM, Kambarage DM, 1996. Common diseases of sheep and goats in sub Saharan African. In *Diseases of Small Ruminants, a Handbook*. VETAID, Centre for Tropical Veterinary Medicine, Easter Bush, Roslin Midlothian EH25 9RG Scotland.
- Kleiman F, Pietrovsky S, Gil S, Wisnivesky-Colli C, 2005. Comparison of two coprological methods for the veterinary diagnosis of fasciolosis. *Arq. Bras. Med. Vet. Zootec*, 57(2):181-185.
- Magaji AA, Ibrahim K, Salihu MD, Saulawa MA, Mohammed AA, Musawa AI, 2014. Prevalence of fascioliasis in cattle slaughtered in Sokoto metropolitan abattoir, Sokoto, Nigeria. *Advances in Epidemiology*, volume 2014, Article ID 247258, 5 pages.
- Maqbool A, Hayat CS, Akhtar T, Hashmi HA, 2002. Epidemiology of fasciolosis in buffaloes under different managerial conditions. *Veterinarski Arhiv*, 72 (4): 221-228.
- Mai HM, Irons PC, Kabir J, Thompson PN, 2012. A large seroprevalence survey of brucellosis in cattle herds under diverse production systems in northern Nigeria. *BMC Veterinary Research*, 8:144.
- Martínez-Valladares M, Robles-Pérez D, Martínez-Pérez JM, Cordero-Pérez C, Famularo M-d R, Fernández-Pato N, González-Lanza C, Castañón-Ordóñez L, Rojo-Vázquez RA, 2013. Prevalence of gastrointestinal nematodes and *Fasciola hepatica* in sheep in the northwest of Spain: relation to climatic conditions and/or man-made environmental modifications. *Parasites and Vectors*, 6:282 doi:10.1186/1756-3305-6-282.
- Mas-Coma S, Valero MA, Bargues MD, 2009a. *Fasciola*, Lymnaeids and human fascioliasis, with a global overview on disease transmission, epidemiology, evolutionary genetics, molecular epidemiology and control. *Advanced Parasitology*, 69:41.
- Mas-Coma S, Valero MA, Bargues MD, 2009b. Climate change effects on trematodiasis, with special emphasis on zoonotic fascioliasis and schistosomiasis. *Veterinary Parasitology*, 163:264-280.
- Mufti S, Afshan K, Khan IA, Zafar Y, Rizvi SSR, Nazir F, Qayyum M, 2014. Genetic characterization of *Fasciola* samples from bovine hosts in Pakistan by sequences of ribosomal internal transcribed spacer regions. *Pakistan Veterinary Journal*, 34(3):361-366.
- Mungube EO, Sila DM, Kariuki CW, Bauni SM, Tenhagen BA, Wamae L, Nginyi J, Omondi GA, 2012. A cross-sectional survey on fasciolosis in selected settlements of Taveta Division, Coast Province, Kenya. *Livestock Research for Rural Development*. Volume 24, Article #58. Retrieved June 22, 2017, from <http://www.lrrd.org/lrrd24/4/mung24058.htm> ISO 9001 & ISO 13485 Certified.
- Nossair MA, Abdella DE, 2014. Serological detection of *Fasciola hepatica* antibodies among cattle and human in Behera province, west delta, Egypt. *Alexandria Journal of Veterinary Sciences*, 40:16-23.

- Olupinyo KC, Ajanusi JO, 2005. Prevalence of *Fasciola* species and *Dicrocoelium* species in sheep and goats slaughtered at Zaria abattoir. Nigerian Veterinary Journal, 26(2):73-75.
- Ortiz P, Cabrera M, Jave J, Claxton J, Williams D, 2000. Human fascioliasis: Prevalence and treatment in a rural area of Peru. The Infectious Disease Review - Microbes of man, animals and the environment, 2(1):42-46.
- Pam VA, Dakul DA, Karshima NS, Bata SI, Ogbu KI, Daniel LN, Udokaninyene AD, Kemza SY, Igeh CP, Hassan AA, 2013. Survey of *Cryptosporidium* species among ruminants in Jos, Plateau State, North-Central Nigeria. Journal of Veterinary Advances, 3(2): 49-54.
- Radostits OM, Gay CC, Hinchcliff KW, Constable PD, 2006. Veterinary Medicine: A textbook of diseases of cattle, sheep, goats, pigs and horses. Saunders Elsevier, Edinburgh. Pp:1576.
- Salib FA, Farghali HA, Abdou N-EMI, 2013. Hepatic pseudo-*fasciola* infection in German shepherd dogs. Journal of Advanced Veterinary Research, 3:83-85.
- Shahzad W, Mehmood K, Munir R, Aslam W, Ijaz M, Ahmad R, Khan MS, Sabir AJ, 2012. Prevalence and molecular diagnosis of *Fasciola hepatica* in sheep and goats in different districts of Punjab, Pakistan. Pakistan Veterinary Journal, 32(4): 535-538.
- Sothoeun S, Davun H, Copeman B, 2006. Abattoir study on *Fasciola gigantica* in Cambodian cattle. Tropical Animal Health and Production, 38:113-115
- Tasawar Z, Minir U, Hayat CS, Lashari MH, 2007. The prevalence of *Fasciola hepatica* in goats around Multan. Pakistan Veterinary Journal, 27(1):5-7
- Thrusfield M, 2005. Veterinary Epidemiology. (2nd ed), University of Edinburgh, Blackwell Scientific Publication, pp:180-188.
- WHO, 2016. Food borne trematodes: Fasciolosis. WHO Fact Sheet No 368
- Yatswako S, Alhaji NB, 2017. Survey of bovine fasciolosis burdens in trade cattle slaughtered at abattoirs in North-central Nigeria: The associated predisposing factors and economic implication. Parasite Epidemiology and Control, 2:30-39
- Yildirim A, Ica A, Duzlu O, Inci A, 2007. Prevalence and risk factors associated with *Fasciola hepatica* infection in cattle from Kayseri, Province, Turkey. Revue Méd Vét, 158(12): 613-617.

## CHARACTERISTICS AND MANAGEMENT PRACTICES OF GOAT PRODUCTION SYSTEMS IN ZAMBIA

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### Abstract

This study was undertaken to provide information on the characteristics and management practices of goat production system using data collected during the Zambia 2017/2018 livestock and aquaculture census. The census covered household populations in both rural and urban areas of the country using a digital platform. PUMS (Public User Microdata Sample) datasets were analyzed using both qualitative and quantitative methods. The main production system was essentially traditional and extensive with free range being the dominant feeding practices. The management practices were minimal although the main purpose of keeping goats was to generate income through sale of animals. The constraints to goat production bordered mostly on the inadequacies of the production systems and the limited management practices such as inadequate disease control, poorly managed grazing lands, poor feeds and feeding, thefts, inadequate livestock extension services, poor access to water, long distances to dipping facilities, lack of access to quality breeding stock, poor record keeping, limited access to credit and markets amongst others. The study revealed a wide array of genetic resources of local breeds, exotic breeds and crosses between and among local and exotic breeds. However, the local-exotic crosses represented the largest single genetic group which was a reflection of government and development organizations' programmes and the farmers' desire to improve productivity through crossbreeding although indiscriminately carried out. This may lead to the erosion of local genetic resources over time if not controlled. It is therefore imperative that a holistic system approach is designed to develop the goat sector in Zambia. A community goat breeding programme to optimally utilize available genetic resources and livestock extension services to reach farmers with husbandry skills that include crop livestock integration, improved feeding practices, promotion of pasture production with high yielding fodders, management of communal grazing lands, good housing, hygienic practices, disease control and market development would be key steps to improve production and productivity.

**Keywords:** goat, census, production characteristics, management practices, Zambia

## CARACTÉRISTIQUES ET PRATIQUES DE GESTION DES SYSTÈMES DE PRODUCTION DE CHÈVRES EN ZAMBIE

### Résumé

Cette étude a été réalisée dans l'objectif de fournir des informations sur les caractéristiques et les pratiques de gestion du système de production caprine en utilisant les données collectées lors du recensement de l'élevage et de l'aquaculture de la Zambie de 2017/2018. Le recensement a couvert les populations des ménages dans les zones rurales et urbaines du pays à l'aide d'une plateforme numérique. Les ensembles de données PUMS (Public User Microdata Sample) ont été analysés à l'aide de méthodes qualitatives et quantitatives. Le système de production principal était essentiellement traditionnel et extensif, le libre parcours étant la principale pratique d'alimentation. Les pratiques de gestion étaient minimales, bien que le but principal de l'élevage de chèvres ait été de générer des revenus grâce à la vente d'animaux. Les contraintes à la production caprine étaient principalement liées aux insuffisances des systèmes de production et aux pratiques de gestion limitées, notamment le contrôle inadéquat des maladies, les pâturages mal gérés, la mauvaise qualité des aliments et de l'alimentation, les vols, les services

de vulgarisation inadéquats, le médiocre accès à l'eau, les longues distances à parcourir pour atteindre les installations d'immersion, le manque d'accès aux reproducteurs de qualité, la mauvaise tenue des registres, l'accès limité au crédit et aux marchés. L'étude a révélé un large éventail de ressources génétiques de races locales, de races exotiques et de croisements entre et parmi les races locales et exotiques. Cependant, les croisements locaux-exotiques représentaient le plus grand groupe génétique unique, qui était le reflet des programmes du gouvernement et des organisations de développement et du désir des éleveurs d'améliorer la productivité par le croisement, bien que ce croisement ait été mené sans discernement. Ce croisement non discerné peut conduire à l'érosion des ressources génétiques locales au fil du temps s'il n'est pas contrôlé. Il est donc impératif qu'une approche systémique globale soit conçue pour développer le secteur caprin en Zambie. Un programme communautaire d'élevage de chèvres visant à utiliser de manière optimale les ressources génétiques disponibles et les services de vulgarisation de l'élevage pour doter les éleveurs de compétences en élevage incluant l'intégration cultures-élevage, des pratiques d'alimentation améliorées, la promotion de la production de pâturages avec des fourrages à haut rendement, la gestion des pâturages communaux, un bon logement, les pratiques d'hygiène, le contrôle des maladies et le développement des marchés seraient des étapes-clés pour améliorer la production et la productivité.

**Mots-clés :** chèvre, recensement, caractéristiques de production, pratiques de gestion, Zambie

### Introduction

Zambia is a landlocked country in Southern Africa (Figure 1) with a largely agrarian population. The landscape covers 743,390 sq. Km and the country is reputed to hold at least 65% of the water bodies in the region. Zambia is divided into three major agro-ecological regions, namely Regions I, II and III based on climatological and soil characteristics as shown in Figure 2. Livestock production is one of the key agricultural activities of the smallholder farmers in Zambia. It was also identified by the Government as one of the key sectors to drive economic growth under the Zambia Seventh National Development Plan 2017 -2021. The livestock sub sector continued to support a robust food security through the provision of food products, employment, income and draught power. Goats have received more attention due to their resilience to unfavourable climatic conditions such as drought, adaptation to survive on poor vegetation not suitable for other livestock species, ability to utilize a broad range of feed resources and adapt to marginal conditions. Most development agencies have observed and realized that goats are the kingpin domestic livestock species in almost every home of the resource poor smallholder farmers. However, the observed importance is not commensurate with the efforts being put into the development of the species to achieve its optimal contribution to the GDP due to

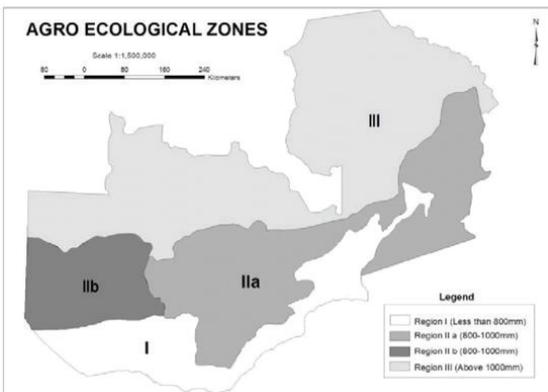
absence of credible data and information to drive appropriate policy development.

Generally, policy decisions in the livestock sub-sector have been based on outdated statistics. Zambia has never conducted a stand-alone comprehensive Livestock and Aquaculture Census besides the two Agriculture Censuses conducted in the 1970/1971 and 1991/1992 Agricultural Seasons. Even, the agricultural surveys conducted were skewed towards crop production. To address, this anomaly, the 2017/18 Livestock and Aquaculture Census was conducted by the Ministry of Fisheries and Livestock (MoFL) and the Central Statistics Office (CSO) to obtain baseline information and facilitate smooth policy formulation and implementation in the sub-sectors.

The Ministry of Fisheries and Livestock (2019) in its summary report of the 2017/18 Livestock and Aquaculture census, presented the demographic and agricultural characteristics of households (HH) and establishments engaged in agricultural activities as at January 2018. It also gave summaries of the goat population and its distribution by province, establishment and herd size. The summary of these statistics are presented in Tables 1 and 2 respectively. However, the summary report did not include salient goat production characteristics and management practices. Hence, this study aimed to further analyze the goat census data in order to provide



**Figure 1:** Map of Zambia showing the ten provinces and neighbouring countries



**Figure 2:** Zambia Agro-Ecological Regions (AER)

policy makers with baseline information on the characteristics and management practices of goat production systems with a view to improving decision making, policy formulation and providing impetus for the development of goat production enterprises

## Materials and methods

In January 2018, the Government of the Republic of Zambia through the Ministry of Fisheries and Livestock (MoFL) and Central Statistics Office (CSO) conducted the 2017/2018 Livestock and Aquaculture census for both households and establishments (Commercial, Government and NGO entities) in the country. The sample for the Census was based on the 2010 Population and Housing

Census. The Census covered all household populations in both the rural and urban areas sampled. The design of the survey called for a representative probability sample that was large enough to produce reliable estimates at national, provincial, rural, urban and district levels. More detailed information on the sample design specification and sampling is available in the summary report by the Ministry of Fisheries and Livestock (2019).

### Data collection

The Census and Survey Processing System (CSPro) software on tablets was utilized to obtain information on households, the demographics of households involved in livestock production, technical information on livestock production (including housing, health, reproduction and management) and crop and fodder production during the census. However for the purpose of the study, only information related to goat production was selected for analysis. The Public Use Microdata Sample (PUMS) datasets, a stratified random sample of the population were provided by the CSO.

### Data analysis:

Data analyses procedures comprised both qualitative and quantitative methods. Simple descriptive statistics were used to analyze the data collected. Data were presented in tables and bar charts.

## Results and Discussion

### Production systems

More than 96% of the HH engaged in the traditional and extensive production system which is highly subsistence oriented while others reported semi intensive and intensive systems. The intensive and semi intensive systems with external input supply and high financial requirements were associated with establishments which had commercial interests. The grazing system was tied to the production system hence almost the same number of HH reported communal grazing near the village as the main grazing system. The other mentioned systems included transhumance,

both communal grazing and transhumance, zero grazing, fenced paddocks and tethering. The implications of the high rate of communal grazing include over grazing, declining forage quality and the need for forage rejuvenation which makes communal grazing management very critical. Communal grazing lands were not managed in any way leading to degradation. There was a tendency for HH to shift towards

zero grazing as the capacity to provide adequate grasses and water increases.

#### *Goat breeds and population*

The census revealed that the main breeds kept by the HH include local breeds, exotics, crosses among local breeds, crosses among exotic breeds and crosses between local and exotics at different genetic levels.

**Table 1:** Summary of demographic and agricultural characteristics of Households engaged in Agriculture and Livestock keeping in Zambia

<b>Characteristics</b>	<b>Description</b>	<b>Percentage</b>
Households:	Total Number HH (3,727,362)	
	<sup>a</sup> Agricultural HH	60.8%
	Non Agricultural HH	39.2%
	<sup>b</sup> Livestock keeping HH	72%
Gender:	<sup>b</sup> Crop/Fodder HH	90.5%
	<sup>b</sup> Male headed Agricultural HH	76.3%
	<sup>b</sup> Female headed Agricultural HH	23.7%
	<sup>c</sup> Male headed Livestock keeping HH	74.9%
Age (Years):	<sup>c</sup> Female headed Livestock keeping HH	63.6%
	Male headed Livestock keeping HH	47.7
Marital status:	Female headed Livestock keeping HH	46.7
	Never married	43.8%
	Married	46.7%
Education:	Divorced, Separated	9.5%
	No formal	10.2 %
	Primary	51.1%
	Junior Secondary	19.4%
HH size:	Secondary and above	19.3%
	Male headed Livestock keeping	5.8
Main tillage method:	Female headed Livestock keeping	4.6
	Hand Hoe	37%;
	Ploughing	24%;
Hectares planted:	Ridging	23%
	Mean 0.69Ha (0.39 – 1.12Ha)	
Livestock kept:	Cattle, Goat Sheep, Pigs, donkeys, horses, rabbits, poultry, and rabbit	
Crops grown:	Maize, Rice, Sorghum, Millet, Sunflower, Soya beans, Groundnuts, Sweet Potatoes, Irish Potatoes, Cassava, Cow peas and Velvet beans.	

<sup>b</sup> is expressed as a proportion of <sup>a</sup>; <sup>c</sup> is expressed as a proportion of <sup>b</sup> in gender  
Compiled from Ministry of Fisheries and Livestock (2019)

**Table 2:** Goat population parameters in Zambia

Characteristics	Description	Population	Percentage
Total population:		3,583,696	
	From HH	3,558,614	99.3%
	Establishments	25,082	0.7%
Goat Herd size	From HH	7.4	
	Establishments	42	
Goat herd size	1-5		56.4%
distribution:	6-10		25.3%
	>10		18.3%

Compiled from Ministry of Fisheries and Livestock (2019)

The main local breeds were the Plateau, Gwembe and Sinazongwe breeds. Other HH reported keeping the Mambwe, Nsenga, Lenje, Lozi, Sene and Tonga breeds although in very small numbers and restricted to particular geographical locations. These breeds may be strains of the main breeds. The main exotic breeds include the Bantu, Boer and Nubian. Other exotic breeds in small numbers include, the Red Kalahari, Saanen, Toggenburg, Anglo-Nubian and Swaka-Lala. Various crosses were also reported between local breeds; local breeds with exotic breeds; and crosses among the exotic breeds.

The HH that kept the local breeds and exotics accounted for 23.8% and 18.3%, respectively while a significant 41.6% of the HH did not know the breeds of goats they kept. Only 0.3% of the HH kept crosses of local breeds while 2.9% of the HH kept exotic crosses. The HH with local-exotic crosses accounted for 13.1%. It was observed that the local-exotic crosses were mainly between the Bantu and Boer breeds. The high percentage of the exotic and local-exotic crossbreds could be attributed to direct government actions through the establishment of livestock breeding centres that stocked and sold exotic goat breeds to the smallholder farmers and the actions of non-government organizations such as Heifer International and World Vision which have been promoting crossbreeding. The imported exotic breeds were reportedly acquired from South Africa, Namibia and Botswana. Commercial goat enterprises have

also seen the need for exotic breeds given the need for higher production and productivity to offset the cost of inputs.

Zambia is a landlocked country with each of the provinces bordering a neighbouring country (Figure 1). It is therefore to be expected that Zambia has exchanges of animal genetic materials with the neighbouring countries.

The breed population analysis must be understood within the context of an earlier assertion that 41.6% of the HH did not know the breed of goats they keep. This group was excluded from the analysis presented in Table 4. The local breeds constitute the bulk of the goat population at 50% (Table 3) with the exotic breeds at 26.4% (the Bantu breed was responsible for 20%). The local-exotic cross proportion is equally high at 20.9%. It should be noted that the local-exotic cross represented the single largest genetic group and this should be a matter of concern in the use, development and conservation of local goat genetic resources.

The local breeds, Bantu and indigenous-exotic breeds were represented in all the provinces. There were very low numbers of goats arising from crossbreeding among the local breeds but it could be that they constitute part of the undetermined breeds due to lack of official breed standards. There is need for diligent goat genetic characterization studies involving phenotypic and molecular characteristics to develop appropriate breed standards. The goat dairy breeds (Nubian and Saanen) did not constitute a significant proportion as well as

the exotic – exotic crosses which were mostly found in Lusaka.

It was not possible to accurately determine the herd structure from the data set collected. While the herd sizes were known, the herd composition and structure would be a matter of conjectures and assumptions. The number of males and females were known

but these were composites without recourse to age or breeding status. In future, it may be important to include inquiries on the herd structure. Nevertheless, an attempt was made to determine the net flow in the entry and exit of goats in the herd and this was presented in Table 4.

**Table 3:** Goat breeds population

Breeds	Number	Percent
Plateau	291,392	13.8
Gwembe	419,818	19.9
Sinazongwe	162,338	7.7
Bantu	423,115	20.0
Boer	68,766	3.3
Saanen	14,287	0.7
Toggenburg	9,577	0.5
Nubian	42,547	2.0
Kalahari Red	471	0.0
Indigenous - Exotic Crosses	441,013	20.9
Exotic-Exotic crosses	58,404	2.8
Local but breed unknown	182,748	8.6

**Table 4:** Entry and Exit of goats in the herd between Oct 2016-Jan 2017 (4 months window)

Characteristics	Description	Average Number
Entry:	Born	2.13
	Purchased /bartered	0.55
	Received as gifts	0.06
	<b>Subtotal</b>	<b>2.74</b>
Exit:	Sold	1.37
	Disease (Mortality)	0.87
	Slaughtered	0.37
	Theft	0.22
	Bartered out/exchanged	0.19
	Given out	0.1
	Accident	0.1
	Others	0.16
	<b>Subtotal</b>	<b>3.38</b>
	<b>Net flow</b>	<b>-0.64</b>

The entry of goats into the herd were mainly through new born and purchase/ bartered animals while exits were through sales, diseases, slaughter, theft and barter/exchanges. The net flow was negative which could be interpreted as a declining goat population. However, consideration must be given to the fact that the number sold could have been captured multiple times as the goats exchanged hands (through middle men and informal markets) within the time period. Hence the exit and net flow must be viewed cautiously because of the challenges in livestock census data capture and analysis (Pica-Ciamara *et al.*, 2014; Odubote, 2019).

It was also important to note that the Department of Livestock development (2018) in its 2017 Annual report had projected annual growths of between 17 and 18% for the years 2014 – 2017 thereby estimating the national goat population to be 5,692,213 in 2017. However, the Census population of 3,583,696 in 2018 was well below this projection which further highlights the challenges with census projections. The introduction of an Animal Identification Registration and Traceability (AIRT) system may be a panacea to these challenges (Odubote, 2019).

#### *Management practices*

Management practices were heightened and highly correlated with intensive production systems. The management practices observed were thus minimal with the free range production system. Ninety one percent of the HH mentioned free range as the major feeding practice and this cut across all the provinces with another 5.9% providing supplementation while 2% were on zero grazing. In some other cases, goats were herded in the bush or on communal grazing lands or tethered near the dwelling place to avoid and prevent damage to farm crops. It was very clear that the nutritional requirement for the goats could hardly be met by free range hence some HH provided concentrates and mineral supplements.

The farmers reported growing a variety of crops namely maize (national staple food), rice, sorghum, millet, sunflower,

soya beans, groundnuts, sweet potatoes, Irish potatoes, cassava, cow peas and velvet beans. Farmers were also capacitated and sensitized to have sown pastures instead of depending on communal grazing lands. However, pasture production was still in its infancy among smallholder farmers. Fodders being promoted and grown included Rhodes grass, Rye grass, Kikuyu grass, Napier grass, Buffel grass, Panicum spp, Pigeon peas, orange-Sorghum, Star grass, Sunn hemp, Silverleaf, Sesbania sesban and Leucaena. It was, however, surprising that given the array of crops grown, the crops were not integrated into the goat production systems.

The goats generally fed on the stovers of planted maize, millet and sorghum directly from the fields after harvesting of the crops by which time the quality of the forage was already diminished with high lignification. This also implied seasonal variations in the availability of goat feed resources.. However, the stovers can be chopped into smaller pieces and fed to the animals with improved digestibility. The waste by products, maize bran can also be efficiently utilized to meet the nutritional requirements of the goats throughout the year especially during the long dry season.

#### *Access to water*

The main water sources were boreholes and streams/rivers accounting for more than 75%. Other sources included springs, lakes, water utility company, swamps/dambos/wetlands, dams/reservoirs, rainfall water harvesting and wells. Access to water points was higher in the areas covered under the AER III which included Luapula, Muchinga, Northern and North Western provinces. With 40% of the HH depending on streams and rivers, measures must be put in place to mitigate the declining rainfall amounts and short duration in AER I and II where the bulk of the goats were found. This is equally true for other water bodies as a result of climatic change. Water harvesting and storage during the rainy season for use in the long dry season could be options to explore..

The average distance to the nearest water source was 0.68Km, with Southern,

Central and Eastern provinces recording an average of close to 1.0 Km. Copperbelt and Luapula provinces however, had shorter distances of an average of 0.25 Km. It should be noted that in some areas the distances could be as far as 5Km. Close to 60% of the HH reported not providing water for the goats. In 43.5% of the HH that provided water, the male spouse were responsible for watering the animals while the female spouse do so in 14% of the HH. There was no difference in the gender of the children providing water for the animals. However, this did not preclude hired workers who were males from performing the same role. Watering of the animals was done more than once in a day for the majority of the HH in which water was offered.

### *Housing*

The housing system for the goats was mainly confinement in sheds and kraals and mostly for the night time by 80% of the HH with a few others having fences and paddocks. However, 15% HH had no form of housing or confinement. Roofing materials were mostly (77%HH) made of thatch using grass, reeds and stalks. Other HH made use of asbestos, wood and iron sheets. Still other HH (9%) had no roofing. It is to be expected that the roofing would require constant replacement after every rainy season. Rainfall seepages through the roofing materials could have implications for water run off of and leaching of manure apart from exposure of animals to inclement weather.

The main flooring materials for those with some form of housing were mostly raised wooden poles and mud. A third of the HH did not provide any flooring material. The flooring has implications for manure collection and disease control amongst others. Establishments with commercial interests provided slatted floors or concrete floors.

The main wall and fence materials were mostly wooden poles for 68% HH, burnt and unburnt bricks (20%) while the remaining 12% HHs made use of various materials including wooden poles and mud, metal poles, grass, wire on metal or wooden poles and cement blocks.

Nevertheless, 93% of the HH did not have their livestock holdings enclosed in a fence.

### *Disease prevalence*

Twenty seven percent of the HH, responded that goats suffered from diseases within the three month window of Oct 2016 - Jan 2017 and these were prevalent in Southern, Central, North Western and Lusaka provinces. Mange, cowdriosis (heart water), brucellosis, helminthiosis, foot and mouth disease (FMD), anthrax, black quarter (BQ), tick borne diseases, haemorrhagic septicaemia (HS), footrot, tetanus, babesiosis (Red Water), anaplasmosis, trypanosomiasis and rabies were among the diseases reported. It was also worth noting that almost 25% HH claimed not to know the diseases that attacked their herds. Even more serious was the fact that of the diseases reported, only 20.7% of the cases were confirmed by a veterinary professional with half receiving curative treatments while the other half did not.

### *Disease control*

A third of the HH did not use any method in the control of diseases and this should be a source of concern for animal health and public health practitioners. This could be attributed to the lack of access to animal health facilities and personnel which could also account for the high goat mortality recorded. It was equally possible that treated diseased animals could get re-infected as they mixed at grazing and watering points. Close to a third of the HH made use of conventional medicines, while a similar number used traditional medicines (indigenous knowledge) to control diseases. The documentation and efficacies of the indigenous knowledge may require further investigation. Vaccinations were low at 6.5% although prevalent in the traditional goat rearing areas of Southern, Central and Eastern provinces. The remaining 1.7% either slaughtered/destroyed or used other methods to control the diseases. The disease burden was very prevalent and the government in partnership with the farmers should therefore put up preventive measures such as regular and

routine animal health awareness campaigns, vaccination programmes, dipping and spraying to minimize disease outbreaks and parasitic infestations.

#### *Tick control methods*

The tick control methods were mainly through spraying, dipping, injectables and traditional knowledge. Other methods included the use of pour on acaricides and tick grease. Almost half of the HH did nothing.

#### *Vaccination*

HH that vaccinated their animals confirmed that they vaccinated against the following diseases, black quarter, haemorrhagic septicaemia, East Coast fever (ECF), foot and mouth Disease (FMD), brucellosis, rabies and anthrax. The majority of the HH affected were from the Southern, Central and Eastern provinces, perhaps because of the high goat populations. The low vaccination rates recorded in the Copperbelt, Luapula, Muchinga, Northern and Western provinces could be a reflection of the availability of the facilities, services and personnel.

#### *Treatment*

The Majority of the respondents mentioned HH members as the persons responsible for treating the goats when they fell sick. Government Veterinarians and Extension officers were mentioned by 14% of the HH while those that mentioned private veterinary and extension staff together with community livestock officers were less than 5%. This is possibly reflective of the inadequate veterinary facilities, services and personnel within the vicinity and/or the costs attached which may be prohibitive for the smallholder farmers. The Department of Livestock Development (2018) admitted that the livestock extension officer to farmers' ratio should be 1:200 but due to the inadequate number, the country is grappling with ratio higher than 1:2500.

#### *Breeding practices and genetic improvement*

The main breeding strategy was natural mating which is mostly uncontrolled and is

practiced by 98% of the HH. The sires were mostly bucks running around in the community (52%); bucks selected from within a herd and used within the herd and at times within the community (32%); bucks purchased from or exchanged (14%). Artificial Insemination (AI) was practiced by 1% HH and another 1% purchased does specifically for breeding. It must be mentioned that castration was mostly not practiced. As would be expected, Southern and Eastern were the two leading provinces making use of these technologies.

In a structured breeding programme, the selection of breeds with desired traits is of primary importance and then the selection of the males with good characteristics for the traits of interest. The very high rate of use of communal sires indicated that the structures necessary to anchor community based breeding programmes (CBBP) are already in practice and should be supported by the government with technical expertise. CBBP therefore can be a panacea as it lends itself to small flocks and genetic gains would be possible through a group approach to breeding (Gizaw *et al.*, 2009; Mueller *et al.*, 2015, Ojango *et al.*, 2016). The CBBP could also be used for the development, use and conservation of the local breeds to prevent fast genetic erosion while at the same time taking advantage of structured crossbreeding to take advantage of local adaptive features, disease resistance and exotic higher body size and weight.

The traits perceived as being of primary importance included the size and body condition of the animals which correlated with the main purpose of keeping animals for sale. Larger animals were sold for better prices than smaller animals. However, it must be borne in mind that genetic improvement must be hinged on improved husbandry practices. Bett *et al.*, (2009) indicated that improving small ruminants' productivity in unfavourable environmental conditions can generally be enhanced by focusing on improving husbandry.

#### *Use of dung*

The majority of the HH (75%) claimed they did not have any use for the dung. Only

25% of the respondents claimed to have made any use of the dung/animal droppings produced. The usage was concentrated in the Central, Eastern and Southern provinces and mainly as manure by 99.9% of the households with the remaining HH mentioning fuel, construction material, feed to other animals and sale. Less than 1% (0.6%) indicated that they sold the dung that was produced. There were variations in the quantities sold and the income earned from the sale of dung/animal droppings although these were minimal.

#### *Record keeping:*

Despite the fact that almost 40% of the HH heads had at least post primary education, it was surprising that 96% HH did not keep livestock records. It goes to show that despite the income derived from goat production, it was not taken as a business to be monitored very closely through the keeping of records. There is need to encourage small holder farmers on the importance of simple record keeping and this includes the ability to assess performance, trends, profitability and the use of the records to support management decisions.

#### *Labour*

Almost 95% of the HH reported not hiring labour to help with the keeping of the goat herds. The number of hired labour was highest and significant in Eastern province. The labour utilized generally were paid and unpaid household members, hired casual and hired permanent workers. Labour hired and paid for included that for vaccination and herding and these were mostly in Southern, Eastern, North-Western and Central provinces.

#### *Gender*

The implications of the gender, age structure and education levels within households on incomes, asset ownership and livelihoods within the communities requires further investigation as this would potentially have great impact on livestock development within the communities.

#### *Livestock extension services*

Only 21.4% of the HH confirmed that they had access to livestock extension services. Within the provinces, access to livestock extension services was very high in the Southern, Western and Eastern provinces, almost attaining 50% of HH. In all the other provinces access were less than 10% of HH. The national average distance to livestock extension services was 15.4Km. Distances as high as 30Km to 50Km were mentioned which discouraged access to the services

#### *Constraints to goat production*

The respondents' revealed a myriad of constraints to goat production encountered by the farmers and the major ones were illustrated in Figure 3. Other constraints included, limited access to equipment for livestock feed processing, long distance to dipping facilities, inadequate access to breeding technology, inadequate fencing, accidents – vehicular, injury or death from human attacks, destruction of farm crops, difficulty in herding, lack of herders, tethering during the rainy season, inadequate housing, inadequate land for grazing, insufficient slaughterhouses, miscarriages, snake bites and red ant attacks.

All the constraints identified require intervention strategies at the level of both production characteristics and management practices. Efforts must be made to sustain the production in the Southern, Eastern and Central provinces of Zambia which hold the bulk of the national herd by provision of water and improvement of the communal grazing lands for forages. Given the effects of climate change in the traditional goat production areas, there should be conscious efforts aimed at increasing the goat populations in the Northern, Muchinga Luapula and Northwestern provinces as these areas are well endowed with good rainfall and arable land and vegetation to support goat production. This could be achieved by the government vigorously embarking on stocking and restocking of goats in these areas which fall in AEZ I (Figure 2). However, this must be backed with intense training to inculcate goat raising culture and practices among the farmers

There is the need to promote and support the development of goat markets (Namonje-Kapembwa *et al.*, 2016) through a well-defined and coordinated value chain supply of live goats or goat meat products locally and regionally.

### Conclusions

The study underscored the importance of conducting regular livestock census to provide critical data for evidence based key livestock policy decisions. Goat production systems in Zambia are essentially low input low output traditional and extensive systems with the goat population concentrated in three provinces namely Southern, Eastern and Central. The management practices were minimal with feeding mostly from free range and communal grazing lands. There were little or no interventions in the matings, housing, watering, and health care practices. There is need to capacity improve animal husbandry skills and the application of best practices in goat production to enhance productivity with disease control and pasture development being accorded priority. The high population of local and exotic crossbreds threatens the development of the local breeds with the increasing risk of genetic erosion. However, there are prospects for community based breeding programmes for local breeds anchored by farmers with technical support from government and non-governmental organizations. A detailed characterization of the breeds in Zambia will lead to breed standards, record keeping, breeding goals and objectives and breeding strategies.

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### References

- Bett RC, Bett, HK, Kahi AK, Peters KJ, 2009. Evaluation of effectiveness of breeding and production services for dairy goat farmers in Kenya. *Ecol. Econ.*, 68: 2451–2460.
- Department of Livestock Development 2018. Annual Report for 2017. Ministry of Fisheries and Livestock. Government of the Republic of Zambia
- Gizaw S, Hans K, van Arendonk JAM, 2009. Optimal village breeding schemes under smallholder sheep farming systems. *Livest. Sci.*, 124: 1–3.
- Ministry of Fisheries and Livestock 2019. The 2017/2018 Livestock and Aquaculture Census – Summary report. Ministry of Fisheries and Livestock and Central Statistics Office. Lusaka, 2019
- Mueller JP, Rischkowsky B, Haile A, Philipsson J, Mwai O, Besbes B, Wurzinger M, 2015. Community-based livestock breeding programmes: essentials and examples. *J. Anim. Breed. Genet.* 132: 155–168. doi: 10.1111/jbg.12136.
- Namonje-Kapembwa T, Chiwawa H, Sitko N, 2016. Value Chain Analysis of Goats in Zambia: Challenges and Opportunities of Linking Smallholders to Markets. Working Paper 117. Indaba Agricultural Policy Research Institute (IAPRI) Lusaka, Zambia. Downloadable at: <http://www.iapri.org.zm> and <http://www.aec.msu.edu/agecon/fs2/zambia/index.htm>
- Odubote IK, 2019. Establishment of National Livestock Databank for Genetic Improvement Programmes in Zambia. *Bulletin of Animal Health and Production Volume 67 (2)* 161-168
- Ojango JMK, Audho J, Oyieng E, Recha J, Okeyo AM, Kinyangi J, Muigai AWT, 2016. System characteristics and management practices for small ruminant production in “Climate Smart Villages” of Kenya. *Animal Genetic Resources*, 2016, 58, 101–110. © Food and Agriculture Organization of the United Nations, 2016 doi:10.1017/S2078633615000417
- Pica-Ciamarra U, Baker D, Morgan N, Zezza A, Azzarri C, Ly C, Nsiima L, Nouala S, Okello P, Sserugga J, 2014. Investing in the Livestock Sector: Why Good Numbers Matter, A Sourcebook for Decision Makers on How to Improve Livestock Data. World Bank, Washington, DC. World Bank.

[Online]. Available from <https://openknowledge.worldbank.org/handle/0986/17830>. License: CC BY 3.0 IGO, 144pp [Accessed Dec 1, 2016]

## INTENSITY AND RISK FACTORS ASSOCIATED WITH GASTRO INTESTINAL PARASITE INFECTIONS OF CATTLE IN MATHIRA SUB COUNTY, KENYA

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### Abstract

Infection by gastro intestinal parasites is a serious issue in cattle management. There is however inadequate information regarding gastro intestinal tract parasite infections of cattle in Mathira sub County in Nyeri County in Kenya. The main aim of the study was to determine the risk factors and intensity of gastro intestinal parasite infections of cattle in Mathira sub County. Overall, 384 fecal samples were collected directly from the rectum in cattle. The Willis technique was used to identify any stages for nematodes and cestodes; the sedimentation method was used for trematodes identification, direct smears were used to identify any stages for protozoans and the modified McMaster technique was used to determine the number of eggs per gram (epg). The risk factors associated with intestinal parasite infection were drawn from the analysis of the questionnaires. The highest infection rate of 33% was recorded among the younger cattle aged between 1 to 2 years (group 1). The least infected cattle by gender were male with (62.83%) as compared to female with (66.4%) The Friesian breed with 140 of 213 was the most infected compared to the other breeds. Most of the cattle (63.5%) had between 0-200 epg which was the lowest intensity of infection. Risk factors such as deworming, watering place of the cattle and farming methods were statistically significant whereas the education level of the farmers, housing of the cattle, housing floor types and cleaning practices of the cattle houses were insignificant. Other factors such as age and breed also influenced infection. Young female cattle aged 1 to 2 years and the Friesian breed were the most affected groups compared to other groups. The lower intensity of gastro intestinal parasite infections was related to improved farming practice .

**Key words:** Intensity, gastro intestinal parasite infection, farming method and risk factors.

## INTENSITÉ ET FACTEURS DE RISQUE ASSOCIÉS AUX PARASITOSE GASTROINTESTINALES DES BOVINS DANS LE SOUS-COMTÉ DE MATHIRA AU KENYA

### Résumé

L'infection par des parasites gastro-intestinaux est un problème grave dans la gestion des bovins. Cependant, les informations disponibles concernant les infections parasitaires du tractus gastro-intestinal des bovins dans le sous-comté de Mathira dans le comté de Nyeri au Kenya sont insuffisantes. L'objectif principal de l'étude était de déterminer les facteurs de risque et l'intensité des parasitoses gastro-intestinales des bovins dans le sous-comté de Mathira. Dans l'ensemble, 384 échantillons fécaux ont été prélevés directement dans le rectum des bovins. La technique Willis a été utilisée pour identifier les stades des nématodes et des cestodes ; la méthode de sédimentation a été utilisée pour l'identification des trématodes ; des frottis directs ont été utilisés pour identifier tous les stades des protozoaires, tandis que la technique modifiée de McMaster a été utilisée pour déterminer le nombre d'œufs par gramme (epg). Les facteurs de risque associés à une infection parasitaire intestinale ont été tirés de l'analyse des questionnaires. Le taux d'infection le plus élevé de 33% a été enregistré chez les jeunes bovins âgés de 1 à 2 ans (groupe 1). Les bovins les moins infectés par sexe étaient les mâles (62,83%) par rapport aux femelles (66,4%). La race frisonne avec 140 sur 213 était la plus infectée par rapport aux autres races. La plupart des bovins (63,5%) avaient entre 0-200 epg, qui était la plus faible intensité d'infection. Les facteurs de risque

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tels que le déparasitage, l'abreuvoir des bovins et les méthodes d'élevage étaient statistiquement significatifs alors que le niveau d'éducation des éleveurs, le logement des bovins, les types de sols et les pratiques de nettoyage des étables étaient insignifiants. D'autres facteurs tels que l'âge et la race ont également influencé l'infection. Les jeunes femelles âgées de 1 à 2 ans et la race frisonne étaient les groupes les plus affectés par rapport aux autres groupes. L'intensité plus faible des infections parasitaires gastro-intestinales était liée à l'amélioration des pratiques d'élevage.

**Mots-clés :** Intensité, parasitose gastro-intestinale, méthode d'élevage et facteurs de risque.

## Introduction

Apart from poor hygiene there are other risk factors that influence the prevalence and severity of gastrointestinal (GIN) infections. These include age, sex, weather conditions and husbandry or management practices (Khan *et al.*, 2009). There are other multiple factors that influence the occurrences of GIN infections such as breed, nutritional status, environment, ecology and pathogenicity of the parasites (Pfukenyi and Mukaratirwa, 2013). The people of Mathira depend on agriculture and animal husbandry for their livelihoods. Small scale cattle farming is of great economic importance to the people of Mathira Sub County ([www.nyeri.go.ke/livestock](http://www.nyeri.go.ke/livestock)). This study investigated the intensity of gastrointestinal parasites and the associated risk factors in cattle in Mathira Sub County in order to design and recommend appropriate mitigative measures. A lower prevalence of GIT infections was observed in a study carried out in Nakuru district in Nakuru County and Mukurweini District in Nyeri County. This was attributed to the improved management practices in both districts, especially in Mukurweini district, where the dairy farmers use zero grazing units and treat for GIT infections regularly. In the two districts, the farmers have stepped up management activities, such as proper housing, feeding and helminth control (Kabaka *et al* 2013). The milk yield after anthelmintic treatment of pastured dairy cattle in the Netherlands was estimated to increase by 1 kg/cow/day (Charlier *et al.*, 2009).

The understanding of the prevalence, predisposing risk factors, control and preventive measures of gastrointestinal tract (GIT) parasites will improve cattle herd health and result in reduced severity of GIT parasites,

increased production and profitability of cattle farming and ensure a supply of safe and nutritious dairy products for consumers throughout Mathira Sub County and Nyeri County at large.

Gastrointestinal infections in cattle are of tremendous economic importance as they cause clinical disease and mortalities. More importantly, they may cause subclinical chronic production losses as a result of weight loss, reduced weight gain, and reduced milk production (Over *et al.*, 1992). The average daily milk production for non-infected cows was 7.8 litres compared to 5.4 for the GIN-infected milking cows. At a cost of 0.25 USD per litre, this translates to a daily loss of 0.35 US dollars (USD) per cow per day (Kabaka., *et al*, 2013).

The majority of farmers are unable to control the occurrence of gastro-intestinal tract infections due to low incomes and limited information on the prevalence and risk factors of GIT parasites in Africa and more specifically in Mathira (Peter *et al.*, 2015). Most of the research carried out deals with a single specific parasite either a nematode or cestode or a protozoan without putting into consideration that other parasites may cause an impact on the cattle productivity (Peter *et al.*, 2015).

Studies have shown that helminthic parasites are by far the most serious causes of production losses in farmed ruminants and that nematodes are indisputably the cause of serious production losses to ruminants in sub-Saharan Africa (Odoi *et al.*, 2007 and Kanyari *et al.*, 2009). The prevalence of subclinical infections leads to great economic losses due to high morbidity and mortality in young animals and production losses in adults. Major economic losses that are caused by GI parasites include reduced work capacity, lowered fertility, reduction in feed

conversion efficiency, lower weight gain, lower milk production, increased treatment costs and mortality in heavily parasitized animals (Fikru *et al.*,2006). Approximately US\$ 2.5 billion is spent on drugs in the cattle industry for parasite control (Williams and Loyacano,2001). According to research carried out in Kiambu District in Kenya, infection levels vary from locality to locality, so extensive epidemiological studies on the intestinal parasites of cattle in the various agro climatic zones in the country should be undertaken and sound control programmes formulated. Most of the animals examined had low to moderate strongyle type and liver fluke Fecal egg counts (Waruiru, 2000). Agro-ecological conditions, animal husbandry practices such as the housing system, deworming intervals and pasture management are among the major factors that influence the type, incidence and severity of various parasitic diseases (Ratanapob *et al.*, 2012).

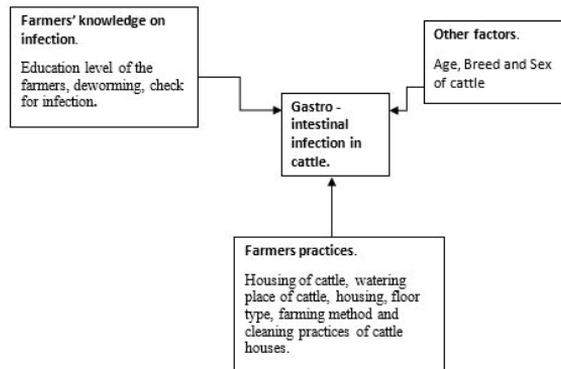
Athanasiadou *et al.* (2001) found that pasture management combined with nutritional supplementation during the dry season could be a sustainable solution for

controlling helminth infections without using antihelmintics in grazing production systems.

Grazing management and deworming management, particularly among young animals, were the main factors associated with GIN infections. Other factors included age, time, geographic location, last deworming, frequency of manure removal, source of forage and type of de-wormer used last (Kabaka, 2012).

*Conceptual Framework*

A conceptual framework was prepared for various factors that had an association with gastro intestinal parasite infections in cattle as illustrated in figure 1. Although many studies have been done in Kenya, there are still a number of localities in the County which include the present study area, Mathira sub County, for which information about the risk factors associated with intestinal parasitic infections is not available. Therefore, the purpose of this study was to obtain information about the intensity of infection and associated risk factors from farmers, farms and cattle populations in Mathira Sub County



**Figure 1:** Conceptual framework of risk factors associated with GIN parasite infections in Mathira, Kenya 2019.

**Materials and Methods**

*Geographical and climatic conditions of the study area*

A cross-sectional study was conducted in six wards in Mathira sub County from February to March 2019. Nyeri County has some of the lowest average daily temperatures in Kenya which range between 12°C in the cold months (June and July) and 27°C in the

hot months (January-March and September-October). The rainfall average lies between 500 mm and 1500 mm during the short and long rainy periods respectively, making it conducive for its diverse agricultural activity. In addition, the study area receives adequate equatorial rainfall, making it suitable for coffee, tea and dairy farming. Dairy farming is mainly done on smallholder farms on which zero-grazing is also practiced.

### *Data and specimen collection*

A research permit was obtained from the National Commission for Science, Technology and Innovation before embarking on the research project. Informed verbal consent was obtained from the study participants before interviews. Questionnaires were administered during faecal collections and each participant filled a questionnaire with the help of an expert. The samplings were undertaken in six wards (Ruguru, Magutu, Iriaini, Konyu, Kirimukuyu and Karatina town) in Mathira Sub County.

The sampling frame for the study were dairy cattle on smallholder farms segregated by; Breed (Friesians, Ayrshires, Guernseys, Jerseys), age (Group 1 (1-2yrs), Group 2 (3-4yrs) and Group 3 (>5 yrs.), sex (male and female) and farms (43 farms within Mathira sub County)

Cattle information such as breed, gender, age and ward was filled in a form and each animal was given a specific serial number. Fresh specimens of feces were collected in covered plastic containers that were labeled with serial numbers that matched with details of the cattle in the form for each animal sampled. Stool samples obtained from each of the 384 subjects were immediately transferred to the laboratory of the Eastern and Southern Africa Centre of International Parasite Control, Kenya Medical Research Institute (KEMRI) for laboratory investigation. Both inclusion and exclusion criteria were applied. For a farm to be sampled the following factors were considered: must have more than one breed of cattle which is a pure breed, have a minimum of 9 cattle of different age groups and genders. Farmers rearing only one breed of the same age and gender were excluded.

### *Diagnostic techniques*

Four different methods were used to detect the parasites as follows: 1) The Willis technique to identify any stages for nematodes and cestodes; 2) The sedimentation method for trematodes identification and 3) Direct smears to identify any stages for protozoans.

The modified McMaster technique was also used to determine the number of eggs per

gram (epg) to provide data on the intensity of infection.

### *Sample size calculation*

Sample size was determined using the equation  $n = 1.962pq/L^2$  (Thrusfield, 1997), where  $n$  = sample size,  $p$  = expected prevalence,  $q = 1 - p$  and  $L$  = limits of error on the prevalence (absolute precision at 95% confidence interval) 0.05.

As this was the first ever prevalence study for GIT parasites in Mathira sub County, the overall prevalence rate of GIT parasites in the Sub County was not previously known. The sample size was therefore calculated using  $P=0.5$  as recommended by Lwanga and Lemeshow, (1991) and  $p$  was taken to be 50%. A total of 384 cattle were sampled.

### *Data analysis.*

Animal and laboratory data were entered into MS Excel and analyzed using SPSS software version 23.

The prevalence of each parasite was analysed using descriptive statistics and frequencies. The association between the infection of gastro-intestinal parasites and age, breed and gender of the cattle was tested using the Chi square test.

The effects of the risk factors on the infection of gastrointestinal (GIT) parasites: Ordinal logistic regression analysis was preferred for this model, since the response variable that is infection of gastro intestinal parasites is ordinal. The model is as follows;

$$\log \frac{p}{1-p} = \alpha + \beta_1 X_1 + \beta_2 X_2$$

Where

$p$ - Probability of success

$1-p$ -probability of failure

$X_1$  - Farmers knowledge.

$X_2$  - Farmers practices.

The intensity of infection was analysed using descriptive statistics to determine whether the infection was low, moderate or high.

The following factors were independent variables ; age, breed and gender of cattle, farmers knowledge on infection, education level of the farmer, deworming, housing of cattle, watering place of cattle, housing floor type, farming method and cleaning practices of cattle house. The dependent variables included infection and intensity of infection

Each analysed data output was represented in the form of pie charts for a better understanding.

## Results

The results for the descriptive and inferential statistics of the infection of gastro-intestinal parasites (response variable) on various regressors which were age, breed and gender of the cattle, farmers' knowledge on infection, education level of the farmer, deworming, housing of cattle, watering place of cattle, housing floor types, farming methods and cleaning practices of cattle house were analysed.

### 1. Intensity of Infection

Most of the cattle (63.5%) had between 0-200 epg which was the lowest intensity of infection. The highest intensity of infection (>500 epg) accounted for only 8.6% of the cattle, moderate intensity of infection (300-400) accounted for 27.9% as illustrated in table 1.

### 2. Effects of risk factors on infection of cattle with GI parasites

*Ordinal regression analysis.*

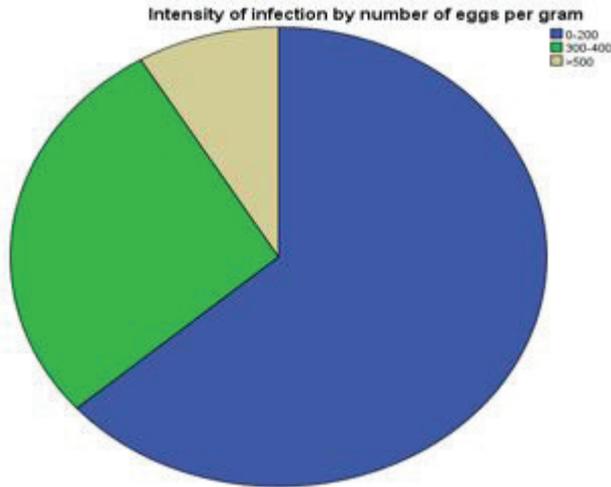
*Testing the significance of the independent variables with dependent variable (infection rate)*

An ordinal regression analysis was carried out in which each covariate, (i.e. farmers' knowledge on infection, education level of the farmers, deworming, housing of cattle, watering place of cattle, housing floor type, farming method and cleaning practices of cattle houses) were fitted. The results are shown in Table 2.

From the parameter estimates in Table 2, deworming, watering place of cattle and farming method were statistically significant whereas education level of the farmer, housing of cattle, housing floor type and cleaning practices of cattle houses were insignificant. For a one unit increase in deworming (i.e., going from irregular to regular), a 2.382 decrease was expected in the ordered log odds of being in a higher level of the infection rate, given all of the other variables in the model are held constant. A unit increase in the watering place of cattle in comparison with stagnant water, decreases of 14.531, 14.695 and 13.435 in the ordered log odds of being in a higher level of the infection rate were expected for at home/designated place, at home/undesignated place and at the river, respectively, given all of the other variables in the model held constant.

**Table 1:** Intensity of infection by number of eggs per gram

Intensity of infection	EPG	Frequency	Percent	Valid Percent	Cumulative Percent
Low	0-200	244	63.5	63.5	63.5
Moderate	300-400	107	27.9	27.9	91.4
High	>500	33	8.6	8.6	100.0
<b>Total</b>		<b>384</b>	<b>100.0</b>	<b>100.0</b>	



**Chart 1:** Intensity of infection by number of eggs per gram

**Table 2:** Effects of risk factors on the infection of cattle with GI parasites

		Estimate	Std. Error	Wald	Df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	Infection Rate = 1	-19.639	3200.023	.000	1	.995	-6291.568	6252.290
	InfectionRate = 2	-16.416	3200.023	.000	1	.996	-6288.345	6255.513
Location	FK.check infection=1	-1.412	1.177	1.439	1	.230	-3.719	.895
	FK.check infection=2	0a	.	.	0	.	.	.
	FK. Education level=1	-14.171	3200.024	.000	1	.996	-6286.102	6257.760
	FK. Education level=2	-16.195	3200.023	.000	1	.996	-6288.124	6255.735
	FK. Education level=3	-16.033	3200.023	.000	1	.996	-6287.963	6255.897
	FK. Education level=4	0a	.	.	0	.	.	.
	FK. Deworming =1	-2.382	.950	6.293	1	.012	-4.244	-.521
	[FK.deworming=2]	0a	.	.	0	.	.	.
	[FP.housing=1]	2.711	3.605	.565	1	.452	-4.355	9.777
	[FP.housing=2]	0a	.	.	0	.	.	.
	[FP.Wateringplace=1]	14.531	4.532	10.279	1	.001	5.648	23.415
	[FP.wateringplace=2]	14.695	3.209	20.967	1	.000	8.405	20.985
	[FP.wateringplace=3]	13.453	4601.114	.000	1	.998	-9004.566	9031.472
	[FP.Wateringplace=5]	0a	.	.	0	.	.	.
	[FP.farmingmethod=1]	-13.544	2.053	43.528	1	.000	-17.567	-9.520
	[FP.farmingmethod=2]	-15.014	3.253	21.301	1	.000	-21.390	-8.638
	[FP.Farmingmethod=3]	-18.509	.000	.	1	.	-18.509	-18.509
	[FP.farmingmethod=4]	0a	.	.	0	.	.	.
	[FP.Housingtype=1]	1.471	2.563	.329	1	.566	-3.553	6.495
	[FP.housingtype=2]	0a	.	.	0	.	.	.
[FP.Cleaninghouse=1]	1.170	2.664	.193	1	.661	-4.051	6.390	
[FP.cleaninghouse=4]	-2.229	3.044	.536	1	.464	-8.195	3.737	
[FP.Cleaninghouse=5]	0a	.	.	0	.	.	.	

For the farming methods, a one unit increase in farming method (in comparison with free range), decreases of 13.544, 15.014 and 18.509 in the ordered log odds of being in a higher level of the infection rate, given all of the other variables in the model are held constant were expected for paddocking, tethering and zero grazing, respectively.

**4. Association between infection with git parasites and cattle breed, age and gender**

*Chi-squared Test*

To test whether there was any association between the dependent variable (infection rate) and the explanatory variables (breed of cattle, gender and age) a chi square test was conducted. The results are shown in table 3.

The Pearson Chi-Square P-values for type of breed (0.032<0.05) and age of cattle (0.018<0.05) showed there was association between GIT parasite infection with breed and also with the age of the cattle. For gender there was no association since the Pearson Chi-Square P-value was 0.501>0.05.

**5. Distribution of infection across breed, gender and age of the cattle.**

Among the 384 cows that were sampled, 71 of 113 males were infected while 180 of 271 females were also infected. Cattle of the Friesian breed (140) were the most infected compared to the other breeds. Infection occurred most among the younger cattle (127) than in the older ones.

**Table 3:** Association between infection with GIT parasites breed, age and gender.

		Chi-Square Tests		
		Value	Df	Asymp. Sig. (2-sided)
Breed	Pearson Chi-Square	1.287	3	0.032
	Likelihood Ratio	1	3	0.033
Age	Pearson Chi-Square	3.435	2	0.018
	Likelihood Ratio	3,351	2	0.0187
Gender	Pearson Chi-Square	0.454	1	0.501
	Continuity Correction	0.309	1	0.578
	Likelihood Ratio	0.451	1	0.502

**Table 4:** Distribution of infection across age, breed and gender

		Infection		Total
		Positive	Negative	
Gender	Male	71	42	113
	Female	180	91	271
	Total	251	133	384
Breed	Freshian	140	73	213
	Ayrshire	58	26	84
	Gernsey	29	19	48
	Jersey	24	15	39
	Total	251	133	384

		Infection		Total
		Positive	Negative	
Age	1-2	127	59	186
	3-4	38	30	68
	>5	86	44	130
	Total	251	133	384

## Discussion and Conclusion

The results of this study indicated that age, breed, deworming, watering place of cattle and farming method were significantly associated with the prevalence of GIT parasite infections. The results agreed with those of a previous study carried out in Nakuru and Mukurweni on the risk factors associated with gastrointestinal nematodes, which identified that animal age, and deworming management were significantly associated with the prevalence of gastro intestinal parasite infections in dairy cattle (Kabaka *et al.*, 2012). A study carried out in the central Kenya highlands (Odoi *et al.*, 2007) on small holder mixed farming systems indicated that the grazing system, deworming status and education of the farmer were the major predictors of gastro intestinal parasite infections.

Young cattle between 1-2 years (group I) were more affected than the other age groups. The results concurred with previous studies carried out in Kiambu District which showed that cattle between weaning and one year of age were more susceptible to gastrointestinal parasite infections compared to other groups (Waruiru *et al.*, 2001). Older animals are more resistant since their adaptive and innate immune system is more developed to counteract gastrointestinal parasite infections (Male *et al.*, 2006)

Infection with GIN parasites in female animals was higher compared to the males. However a higher number of female cattle were encountered in the whole population sampled, as farmers prefer female cattle. Hence gender was not significant in the analysis.

The cattle breed was an important factor in the prevalence of gastro intestinal

parasite infections. The results of this study indicated that the breed of the animals showed a significant association ( $P=0.032<0.05$ ) with the prevalence of the parasites; in which the Friesian breed was more highly infected at a rate of 140 of 213 than the Ayrshire, Guernsey and Jersey breeds. The significant degree of association between the four breeds and the prevalence of gastro intestinal parasite infections agrees with the studies reported by Etsehiwot (2004) and Berhanu (2008) which that showed there was a significant difference between the breeds of the animals with the gastro intestinal parasite infections.

Deworming was an important factor for GIN parasite infections. Since one unit increase in deworming (i.e. going from irregular to regular), led to an expected 2.382 decrease in the infection rate, all variables in the model held constant. This finding was in agreement with previous reports that demonstrated that the time from the last deworming was an important factor, with infection prevalence being higher among dairy cattle that were dewormed in the last 5 to 6 months compared with animals dewormed within the previous 5 months (Kabaka *et al.*, 2012). Farmers practicing a deworming frequency of less than 3 month had an overall low prevalence of nematode infections (Kabaka *et al.*, 2012).

The watering place of the cattle had a significant influence on the rate of infection, since a unit increase in watering place of cattle (in comparison with stagnant water), led to expected 14.531 (at home/designated place), 14.695 (at home/undesignated place) and 13.453 (at the river) decreases in the infection rates, given all of the other variables in the model held constant. Watering cattle at home aids in decreasing the rate of GIN infection

compared to watering at the river or on stagnant water. Kumar *et al.*, 2013 reiterated that water should be clean and free from Fecal matter and watering areas should be situated in well drained places with gravel or even cemented floors. Animals must be prevented from accessing parasite infected water bodies. Facilities for proper drainage in the animal sheds reduce the chances of survival of the parasites.

Similarly, farming methods had a major influence on the rate of GIN infections. For an increase in one unit in farming method (in comparison with free range), decreases of 13.544 (paddock), 15.014 (tethering) and 18.509 (zero grazing) were expected in the rate of infection, given all of the other variables in the model held constant. Hence, farming methods such as zero grazing, paddocking and tethering decrease the rate of infection compared to free range farming. This is in agreement with the findings of Waller (2004) that under free-range grazing systems there is continuous infection and re-infection from heavily contaminated pastures and (Odoi *et al.*, 2007 that helminth control is easier in zero-grazing production systems, due to the decreased risk of exposure to infective larvae. Short-term rotational grazing strategies, as developed for parasite control in small ruminants in the wet tropics requires the subdivision of available pastures into small plots. Animals are then moved around these pastures in quick succession (3 - 4 days grazing only on each plot), returning to their original plot after approximately 30 - 40 days. (Waller 2004; Barger *et al.* 1994; Sani and Chandrawathani 1996).

The education level of the farmer, housing of cattle, housing floor types and cleaning practices of cattle houses were insignificant in this study, which was at variance with reports from other studies. According to Madke *et al.*, (2010), maintaining the required humidity and air circulation in an animal shed through proper ventilation and lighting results in animals that can resist or tolerate against infection with internal parasites as compared to animals kept under poor housing conditions. The bedding material should be allowed to

decompose along with manure for better control of parasites as it acts as an important source of various parasitic infections like winter coccidiosis. (Howell *et al.*, 1999). It is therefore necessary to ensure that houses for the cattle are well ventilated, lit, clean and have dry floors to reduce parasite infections.

Most of the cattle (63.5%) had between 0-200 eggs per gram which is the lowest intensity of infection compared to the highest intensity of infection (>500 epg) which accounted for 8.6% of the cattle. The lower intensity of infection was as a result of improved farming practices such as deworming, watering cattle at designated places and farming methods such as zero grazing and paddocking.

### Recommendations

Farmers should be informed on the risk factors such as irregular deworming, free range farming and watering the animals on stagnant water that were identified as the major causes of GI parasitic infections of cattle in Mathira sub County. The County government should support mass deworming programs to assist farmers who cannot carry out regular deworming. Veterinary personnel should enlighten farmers on the need for regular assessments for infection, use of the right drugs to treat infected cattle, advice farmers on the best method of farming to reduce infection and reinfection and the importance of proper hygiene which includes clean water for drinking, clean housing for cattle and feeding cattle with non-contaminated pasture or fodder. Other factors such as age and breed have an influence on GI parasitic infection. Farmers should be updated that young and old cattle are more vulnerable to infection due to their poor immune response to infection. Young cattle should be regularly checked for infection, reared in environments that are free from GI parasites and be promptly treated when infected. Older cattle that are not economically important should be discarded to minimize sources of infection.

The results of this study indicated that the Friesian breed was more vulnerable to

infection compared to the other three breeds reared in Mathira sub County. Farmers should be encouraged to rear breeds that are more resistant to GI parasite infections. Veterinary services should be brought close to the farmer which will facilitate quick access to information and veterinary services.

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### References

- Athanasiadou, S., Arsenos, G., & Kyriazakis, I. (2001). Animal health and welfare issues arising in organic ruminant production systems. *Publication-European Association for Animal Production*, 106, 39-56.
- Akanda, M. R., Hasan, M. M. I., Belal, S. A., Roy, A. C., Ahmad, S. U., Das, R., & Masud, A. A. (2014). A survey on prevalence of gastrointestinal parasitic infection in cattle of Sylhet division in Bangladesh. *American Journal of Phytomedicine and Clinical Therapeutics*, 2(7), 850-860.
- Berhanu G (2008) A cross sectional study of major gastrointestinal parasites of cattle in Bako District of West Shoa. DVM Thesis, JUCAVM, Jimma, Ethiopia.
- Barger, I.A., Siale, K., Banks, D.J.D. and LeJambre, L.F. (1994). Rotational grazing for control of gastrointestinal nematodes of goats in a wet tropical environment. *Veterinary Parasitology* 53: 109-116
- Charlier, J., Höglund, J., von Samson-Himmelstjerna, G., Dorny, P., & Vercruyssen, J. (2009). Gastrointestinal nematode infections in adult dairy cattle: impact on production, diagnosis and control. *Veterinary Parasitology*, 164(1), 70-79.
- Charlier, J., Sanders, M., & Vercruyssen, J. (2009). The direct costs of infections with gastrointestinal nematodes and liver fluke in the Flemish dairy population. *Vlaams Diergeneeskundig Tijdschrift*, 78(4), 196-200.
- Etsehiwot, W. (2004). Study on bovine gastrointestinal helminthes in dairy cows in and around Holetta. DVM thesis, Debrezeit, Ethiopia.
- Fikru, R., Teshale, S., & Reta, D. Yosef. K. 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia". *Intern J Appl Res Vet Med*, 4(1), 12.
- Kumar, N., Rao, T. K. S., Varghese, A., & Rathor, V. S. (2013). Internal parasite management in grazing livestock. *Journal of parasitic diseases*, 37(2), 151-157.
- Howell, J. M., Luginbuhl, J. M., Grice, M. J., Anderson, K. L., Arasu, P., & Flowers, J. R. (1999). Control of gastrointestinal parasite larvae of ruminant using nitrogen fertilizer, limestone and sodium hypochlorite solutions. *Small Ruminant Research*, 32(3), 197-204.
- Over, H. J., Jansen, J., & Van Olm, P. W. (1992). Distribution and impact of helminth diseases of livestock in developing countries (No. 96). *Food & Agriculture Org.*
- Kanyari, P.W. N., Mhoma, R. J., & Kagira, J. M. (2009). Prevalence and intensity of endoparasites in small ruminants kept by farmers in Kisumu Municipality, Kenya.
- Kiptarus, J. K., & Director, L. P. (2005, March). Focus on Livestock sector: Supply policy framework strategies, status and links with value addition. In Workshop on value Assess food and export investment. Held at Grand Regency hotel, Nairobi, Kenya. 3rd March.
- Mwihaki, K. (2015). The relationship between agricultural financing and productivity of dairy farming in central Kenya (Doctoral dissertation,

University of Nairobi).

Khan, M. K., Sajid, M. S., Khan, M. N., Iqbal, Z., & Iqbal, M. U. (2009). Bovine fasciolosis: prevalence, effects of treatment on productivity and cost benefit analysis in five districts of Punjab, Pakistan. *Research in veterinary Science*, 87(1), 70-75.

Kaplan, L. D., Lu, Y., Snitzer, J., Nemke, B., Hao, Z., Biro, S., ...& Baum, S. Z. (2009). The effect of early hyaluronic acid delivery on the development of an acute articular cartilage lesion in a sheep model. *The American journal of sports medicine*, 37(12), 2323-2327.

Kabaka, W. M., Gitau, G. K., Kitala, P. M., Maingi, N., & Vanleeuwen, J. A. (2012). Risk factors associated with gastrointestinal nematode infections of cattle in Nakuru and Mukurweini districts of Kenya. *Bulletin of Animal Health and Production in Africa*, 60(4), 410-416.

Kabaka, W. M., Gitau, G. K., Kitala, P. M., Maingi, N., & Van Leeuwen, J. A. (2013). The prevalence of gastrointestinal nematode infection and their impact on cattle in Nakuru and Mukurweini districts of Kenya. *Ethiopian Veterinary Journal*, 17(1), 95-104.

Madke, P. K., Lathwal, S. S., Yajuvendra, S., Anil, K., & Vinay, K. (2010). Study of behavioural and physiological changes of crossbred cows under different shelter management practices. *Indian Journal of Animal Sciences*, 80(8), 771-774.

Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2006). *Immunology* 7th. Canada: Elsevier, 401-19.

Maichomo, M. W., Kagira, J. M., & Walker, T. (2004). The point prevalence of gastro-intestinal parasites in calves, sheep and goats in Magadi division, south-western Kenya. *Onderstepoort Journal of Veterinary Research*, 71(4), 257-261.

Odoi, A., J.M. Gathuma, C.K. Gachuri, and A. Omoro. 2007. Risk factors of gastrointestinal nematodes parasite infections in small ruminants kept in smallholder mixed farms in Kenya. *Vet. Res. Com.* 3(6): 1746-1186

Pfukuanyi, D. M., & Mukaratirwa, S. (2013). A review of the epidemiology and control of gastrointestinal nematode infections in cattle in Zimbabwe. *Onderstepoort Journal of Veterinary Research*,

80(1), 01-12.

Pandey, V. S., Chitate, F., & Nyanzunda, T. M. (1993). Epidemiological observations on gastro-intestinal nematodes in communal land cattle from the highveld of Zimbabwe. *Veterinary Parasitology*, 51(1-2), 99-106.

Peter, G. S., Gitau, G. K., Mulei, C. M., Vanleeuwen, J., Richards, S., Wichtel, J., ...Mainga, O. (2015). Prevalence of *Cryptosporidia*, *Eimeria*, *Giardia*, and *Strongyloides* in pre-weaned calves on smallholder dairy farms in Mukurwe-ini district, Kenya. *Veterinary World*, 8(9), 1118-1125. <http://doi.org/10.14202/vetworld.2015.1118-1125>

Njonge, F. K. (2017). Epidemiology of Helminths in Cattle of Kirinyaga County, Kenya.

Ratanapob, N., Arunvipas, P., Kasemsuwan, S., Phimpraphai, W., & Panneum, S. (2012). Prevalence and risk factors for intestinal parasite infection in goats raised in Nakhon Pathom Province, Thailand. *Tropical animal health and production*, 44(4), 741-745.

Sani, R.A., Chandrawathani P. (1996): Gastrointestinal parasitism in small ruminants in Malaysia . In: Sustainable Parasite Control in Small Ruminants. Le Jambre, L.F and. Knox, M.R. (Eds). Australian Centre for International Agricultural Research (ACIAR) Proceedings No.74, pp.98-100.

Seó, H. L. S., Machado Filho, L. C. P., Honorato, L. A., da Silva, B. F., do Amarante, A. F.T., & Bricarello, P. A. (2015). The effect of gastrointestinal nematode infection level on grazing distance from dung. *PLoS one*, 10(6), e0126340.

Sykes, A. R. (1994). Parasitism and production in farm animals. *Animal Science*, 59(2), 155-172. [www.nyeri.go.ke/livestock](http://www.nyeri.go.ke/livestock).

Waruiru, R. M., Kyvsgaard, N. C., Thamsborg, S. M., Nansen, P., Bøgh, H. O., Munyua, W. K., & Gathuma, J. M. (2000). The prevalence and intensity of helminth and *Coccidial* infections in dairy cattle in central Kenya. *Veterinary Research Communications*, 24(1), 39-53.

Waruiru, R. M., Munyua, W. K., Kanyari, P. N., Mbuthia, P. G., Njiro, S. M., Ngotho, J. W., & Weda, E. H. (1995). Prevalence of gastrointestinal parasites

and lungworms in wild and domestic ruminants in a game ranching farm in Kenya.

Waruiru, R. M., Mutune, M. N., & Otieno, R. O. (2005). Gastrointestinal parasite infections of sheep and goats in a semi-arid area of Machakos District, Kenya. *Bulletin of Animal Health and Production in Africa*, 53(1), 25-34.

Waruiru, R. M., Kyvsgaard, N. C., Thamsborg, S. M., Nansen, P., Bøgh, H. O., Munyua, W. K., & Gathuma, J. M. (2000). The prevalence and intensity of helminth and *Coccidial* infections in dairy cattle in central Kenya. *Veterinary Research Communications*, 24(1), 39-53.

World Health Organization. (1994). Bench aids for the diagnosis of intestinal parasites.

Williams, J.C. and Loyacano, A.F. (2001). Internal parasites of cattle in Louisiana and other southern states. Louisiana State University. Agcenter Research Information Sheet, 104:1-19.

Waller, P. J. (2004). Management and control of nematode parasites of small ruminants in the face of total anthelmintic failure. *Trop Biomed*, 21(2), 7-13.

## STATUS OF THE ANIMAL HEALTHCARE DELIVERY SYSTEMS IN WEST POKOT AND TURKANA DISTRICTS OF KENYA

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### Abstract

This study, undertaken in 2010, was designed to evaluate animal health care delivery services in selected areas of Turkana and West Pokot districts in Kenya. The main goal was to provide the necessary information to inform the strengthening of animal health service delivery systems within these and similar areas and subsequently, upgrade and revitalize the existing disease control systems to acceptable standards for the control of economically important livestock diseases. The purpose of this publication, is therefore, to provide baseline data for the purposes of tracking progress made towards the provision of Animal Health Service Delivery (AHSD) in the present Turkana and West Pokot Counties since the devolution of government functions, including AHSD following the adoption of a new national Constitution that was promulgated in August 2010.

Field surveys for the collection of information were conducted using questionnaires. The results of the study indicated that the delivery of animal health care services by the Public Veterinary departments in the two districts was under-resourced, often requiring staffing and transport reinforcement when specific tasks were to be executed. This was attributed to failure to prioritize livestock in planning and resource allocation in the two districts. Besides, the challenging environments that included long distances between market centers, poor infrastructure, prolonged droughts, insecurity, frequent violent conflicts, high service delivery costs and the frequent movements of the communities and livestock were unfavorable for the delivery of conventional veterinary services by either the private or public sectors. The results of Participatory Rural Appraisals (PRA), group discussions and direct observations, animal health service delivery by community animal health workers (CAHWs) as undertaken at the time in the two districts, was not sustainable as it was heavily dependent on funding from the sponsoring Non-Governmental Organisations (NGOs) which lacked proper exit strategies. Furthermore, the CAHWs were not supported by a reliable veterinary drug supply system, had poor returns on investment and were not backstopped by public or private sector professionals. There was also a very high desertion rate of the trained CAHWs. In addition, although provided with a harmonized training manual by the Kenya Veterinary Board (2004), the CAHWs' delivery system was not supported by any legal and policy frameworks. There were also no policy or legal frameworks to guide the relationships between the CAHWs, veterinary paraprofessionals (AHAs) and veterinarians and this posed challenges for the supervision of the CAHWs' activities. This cadre of animal health service providers thus lacked proper backstopping by the public or private sector professionals.

The study concluded that the delivery of animal health services in the Turkana and West Pokot districts in Kenya was inadequate and recommended that an alternative animal health care delivery model in the Arid and Semi-Arid Lands (ASALs) other than CAHWs be explored. The adoption of pastoral field

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schools and their domestication is proposed as a suitable alternative for these areas. This would require the recruitment of sufficient veterinarians and animal health technicians specifically for the ASALs, the prioritization of livestock in the development planning processes and the increased allocation of resources both financial and human at the County governments for the delivery of animal health services. This should be further supported by the provision of adequate tools and equipment to the respective County departments of veterinary services, the empowerment and expansion of the County extension services to pastoral areas, strengthening of disease surveillance and response to emerging and re-emerging diseases and empowering pastoral capacity for peace building.

**Key words:** Animal Health, delivery systems, Community Animal Health workers (CAHWs), Participatory Rural Appraisal (PRA), Pastoral Field Schools, Livestock policy and legal frameworks, West Pokot and Turkana districts, Kenya

## ÉTAT DES SYSTÈMES DE PRESTATION DE SOINS DE SANTÉ ANIMALE DANS LES DISTRICTS DE WEST POKOT ET TURKANA DU KENYA

### Résumé

Cette étude, entreprise en 2010, a été conçue pour évaluer les services de prestation de soins de santé animale dans certaines zones des districts de Turkana et de West Pokot au Kenya. L'objectif principal était de fournir les informations nécessaires pour éclairer le renforcement des systèmes de prestation de services de santé animale dans ces domaines et dans des domaines similaires et, par la suite, de moderniser et de revitaliser les systèmes existants de lutte contre les maladies selon les normes acceptables pour la lutte contre les maladies animales d'importance économique. Le but de cette publication est donc de fournir des données de référence afin de suivre les progrès accomplis par rapport à la prestation de services de santé animale (AHSD) dans les comtés actuels de Turkana et de West Pokot, depuis la décentralisation des fonctions gouvernementales, y compris l'AHSD, à la suite de l'adoption d'une nouvelle Constitution nationale promulguée en août 2010.

Des enquêtes sur le terrain pour la collecte d'informations ont été menées à l'aide de questionnaires. Les résultats de l'étude ont indiqué que la prestation de services de santé animale par les services vétérinaires publics dans les deux districts manquait de ressources, nécessitant souvent un renforcement du personnel et des transports lorsque des tâches spécifiques devaient être exécutées. Cette lacune a été attribuée à la non priorisation de l'élevage dans la planification et l'allocation des ressources dans les deux districts. En outre, les environnements difficiles comprenant de longues distances entre les centres de marché, la médiocrité des infrastructures, les sécheresses prolongées, l'insécurité, les conflits violents fréquents, les coûts de prestation de services élevés et les mouvements fréquents des communautés et des animaux étaient défavorables à la prestation de services vétérinaires conventionnels par le secteur privé ou public. Les résultats des évaluations rurales participatives (ERP), des discussions de groupe et des observations directes, de la prestation de services de santé animale entreprises par les agents communautaires de santé animale (ACSA) à l'époque dans les deux districts, n'étaient pas viables car ils dépendaient fortement du financement des organisations non gouvernementales (ONG) promotrices qui ne disposaient pas de stratégies de sortie appropriées. De plus, les ACSA n'étaient pas soutenus par un système fiable d'approvisionnement en médicaments vétérinaires, avaient un faible rendement d'investissements et n'étaient pas appuyés par des professionnels du secteur public ou privé. Le taux de désertion des ACSA formés était également très élevé. De plus, bien que le Kenya Veterinary Board ait fourni un manuel de formation harmonisé (2004), le système de prestation des ACSA n'était soutenu par aucun cadre juridique et politique. Il n'existait pas non plus de cadre politique ou juridique conçu pour guider les relations entre les ACSA, les para-professionnels vétérinaires (AHA) et les vétérinaires, et ceci a posé des défis à la supervision des activités des ACSA. Ce cadre de prestataires de services de santé animale ne bénéficiait donc pas de soutien adéquat de la part des professionnels du secteur public ou privé.

L'étude a conclu que la prestation de services de santé animale dans les districts de Turkana et West Pokot du Kenya était inadéquate et a recommandé l'exploration d'un modèle alternatif de prestation de soins de santé animales dans les terres arides et semi-arides (ASAL : Arid and semi-arid lands) autre que

celui des ACSA. L'adoption des écoles pastorales de terrain et leur domestication est proposée comme alternative appropriée pour ces zones. Cette adoption nécessiterait le recrutement d'un nombre suffisant de vétérinaires et de techniciens en santé animale spécifiquement pour les ASAL, la priorisation de l'élevage dans les processus de planification du développement et l'allocation accrue de ressources financières et humaines aux administrations des comtés pour la prestation de services de santé animale. Cela devrait être davantage soutenu par la fourniture d'outils et de matériels adéquats aux divers départements des services vétérinaires du comté, le renforcement et l'expansion des services de vulgarisation du comté aux zones pastorales, le renforcement de la surveillance des maladies et de la réaction aux maladies émergentes et ré-émergentes ainsi que le renforcement des capacités pastorales pour la consolidation de la paix.

**Mots-clés :** santé animale, systèmes de prestation, agents communautaire de santé animale (ACSA), évaluation rurale participative (ERP), écoles pastorales de terrain, cadres politiques et juridiques de l'élevage, districts de West Pokot et de Turkana, Kenya.

## Introduction

The provision of quality animal health inputs and services is key to increased and sustained livestock production and productivity the world over. After the World economic recession of the late 1970s, and the subsequent structural Adjustment Programs (SAPs), many developing countries instituted structural reforms some of which targeted the livestock sector and sought to shift the delivery of veterinary services from the public domain to the private sector. The reforms, however, did not work as expected and as a result, the provision of animal health services to the poor and marginal populations, especially those in the pastoral areas, throughout the developing world remains an ongoing challenge. Many developing countries have overburdened systems of animal health care delivery that consistently fail to provide animal health care in rural locales. Nowhere is this more pronounced than in the pastoral areas (Ahuja, Jan and Arindans, 2003).

This study evaluated the performance of animal health delivery systems in selected areas of Turkana and West Pokot districts of Kenya and identified constraints and opportunities for improvement. The results could better inform policy makers and project implementers when allocating resources for interventions in these areas.

## Materials and methods

### *Study area*

The study was conducted in 2010 in West Pokot and Turkana Districts, which were

part of the 14 districts in the Rift Valley Province of Kenya. Following the promulgation of a new national Constitution in August 2010 and the subsequent adoption of a devolved system of government from March 2013, the Rift Valley Province was dissolved and apportioned into devolved Counties. As a result, West Pokot and Turkana Districts became Counties. Due to devolution, most Government functions including animal health service delivery were devolved and delivery of animal health services became the responsibility of the County governments.

West Pokot and Turkana Counties which border Uganda to the west, South Sudan to the north and Ethiopia to the north east, are occupied by pastoral, agro-pastoral and sedentary Pokot and Turkana communities. The areas have a harsh climate that is compounded by years of poor development. Unreliable rainfall patterns render the two areas very low in arable agricultural potential and they are thus only suitable for the extensive rearing of indigenous livestock and livestock production is the main economic activity in the two Counties accounting for 93.2% of most household incomes and 95% of most households' employment.

### *Sources and collection of data*

Primary (raw) data were collected through questionnaire interviews, focus group discussions (FGDs) and other participatory methods. The questionnaires were developed, pre-tested on selected households in the study areas and adjusted as appropriate. Different

questionnaires were developed for the various cadres of animal health service providers, and another questionnaire developed for the herders. In each of the two districts, a total of 80 households were selected. Data were collected on household sizes and characteristics, numbers of livestock owned, sources of income, access to markets and roads, access to water, access to veterinary and extension services, and affordability of the services. The identification and training of enumerators from the target communities was carried out before the actual fieldwork was undertaken. The rapporteurs were trained to ensure that they did not deviate from the required protocol, thereby reducing bias in the sample data collected.

#### *Selection of study units and sampling*

A stratified random sampling procedure was used to collect the socio-economic data. The goal of stratified sampling was to achieve the desired representation from various subgroups in the population (Mugenda and Mugenda, 1999). A list of all the administrative divisions in each of the districts was obtained from the district administrative authorities. Then two divisions in each district that had the highest cattle populations were purposively selected. The selection of these primary sampling units (PSUs) was followed by the selection of households in the PSUs and finally the determination of the households and the people to be included in the study. A list of households in each selected division was obtained from which a sample frame was drawn. Random sampling was done in which the selection of the sample was made using a deliberate, unbiased process, so that each sampling unit in a group had an equal probability of being selected (Levy and Lameshow, 1996). Computer generated random numbers were used for the selection. Considering the logistics, the security situation and accessibility of the study areas in each of the divisions, a sample size of 40 households, which is large enough and is acceptable in social studies (Freund *et al.*, 2006), was considered, making a total of 80 households per district. For the purposes of the study, the household was defined in terms of

people considered resident in the divisions, or family compound and included not only people living there, but also household members living elsewhere.

#### *Selection of animal health service providers (veterinarians, paraveterinarians and Community Animal Health Workers (CAHWs))*

In each district, a list of all the animal health service providers was obtained from the District Veterinary Officer (DVO). The census method was used in which all veterinarians and animal health assistants were selected, whereas a total of 60 CAHWs in the two districts were selected using simple random sampling.

#### *Data collection and entry.*

Each household was visited individually with each enumerator visiting an average of three (3) households per day. For the animal health service providers, data was collected using the method described by Mulwa and Nguluu (2003). A list of organizations promoting animal health in each location as well as households keeping livestock was compiled. The animal health care interventions in each location were identified and described. Gender, age and socio-economic standing were among the factors considered. Structured questionnaires were used to assess the various cadres of animal health service providers whereas a structured (open-ended interviews and guided dialogue technique) questionnaire was used to collect household information on the situation of basic social services, family structure, production and consumption. A total of 160 herders, 8 veterinarians, 60 CAHWs and 18 animal health technicians were interviewed in both districts.

In addition to the various qualitative techniques, including in-depth interviews, observations, and narratives, the Focus Group Discussions (FGDs) method was used to collect data (Odimengwu, 2000). Participatory epidemiology methods (Mariner and Passkin, 2000; Catley, 2005) were used to obtain information during the FGDs. Secondary data and information were used to complement the primary information. The secondary data used

were obtained from the Ministry of Agriculture, Livestock and Fisheries development of the Government of Kenya. In addition, various Acts of Parliament governing the establishment of veterinary practices (The Veterinary Surgeons Act-Cap 366), disease control (Animal Diseases Act-Cap 364) and the supply and distribution of veterinary drugs and chemicals (the Pharmacy and Poisons Act – Cap 244) in the laws of Kenya were also studied.

#### *Data analysis*

Data was coded, entered in Microsoft (MS) access and excel for storage and analysis. The Statistical Package for Social Sciences (SPSS) was used for data manipulation and socio-economic analysis (Maddala, 2001; Stock and Watson, 2003). Data were analyzed using descriptive statistics.

### **Results**

#### *Livestock diseases and response to disease outbreaks*

During a pairwise ranking technique in Turkana District, diseases in the region were reported and ranked in order of prevalence as follows: trypanosomiasis, mange, eye infections, black quarter, heartwater, contagious bovine pleuropneumonia (CBPP), East Coast fever (ECF), Rift Valley fever (RVF), foot and mouth disease (FMD), peste des petits ruminants (PPR) and tick infestations. By the time of the study, it was found that there were Integrated National Action Plans for diseases such as Avian Influenza (HPAI). However, other important diseases such as RVF and PPR that were of high importance in the ASALs had not been catered for in the plans. Subsequently, the reaction or response time to such disease outbreaks by the relevant authorities was usually prolonged. Epidemio-surveillance systems were also found to be weak and this was mainly attributed to inadequate human and financial resources.

#### *Status of animal health care service delivery in West Pokot and Turkana districts*

By the time of the study, providers of livestock services at the herder level were

found to be diverse and were characterized by the presence of self-treatments, provision of animal health services by CAHWs and NGOs, Veterinary professionals, and private formal and informal sellers of drugs and vaccines. Supervision networks by veterinarians were weak and poorly resourced. Although the roles of the various players in animal health service delivery in the two districts (DVO, NGOs, Associations, CAHWs, drug suppliers and livestock keepers) were defined to a large extent, in practice these players did not adhere to their roles and as a result, quality controlled animal health service delivery that requires that veterinarians, either private or public are the principle agents in directing the service delivery system and providing a lead role in technical guidance, coordination, supervision and monitoring of animal health service delivery in the two districts, was missing.

The disease reporting systems in the two districts were found to be clearly defined but mechanisms to ensure adherence were found to be weak. CAHWs provided a useful link between the livestock keepers and the district veterinary authority in terms of disease reporting and surveillance but as a whole, there was no motivation for them to submit reports, nor were there any compelling mechanisms in place to make them accountable. On the other hand, livestock owners were not keen to report diseases to the animal health service providers as they feared that the authorities would slap movement restrictions that were usually detrimental to the live animals and meat trade. Besides the modes of animal health service delivery systems identified, herders in the two districts were found to possess sound and effective indigenous knowledge about the management of their herds.

Considering the vastness, poor infrastructure, communication barriers and other challenges in the operating environment, the district staffing levels were found to be inadequate in terms of the numbers and experience of the personnel. However, the providers of livestock services at the herder level were found to be diverse and were characterized by the presence of self-

treatments, the provision of animal health services by CAHWs and NGOs, veterinary professionals, and private formal and informal sellers of veterinary drugs and vaccines. Table 1 shows the public and private sector animal health services human resources available in West Pokot and Turkana Districts by the time of the study.

#### *Service delivery by the District Veterinary Services (Public sector)*

At the time of the study, the Director of the Veterinary Services, under the Ministry of Agriculture, Livestock and Fisheries, department of Veterinary Services, had the mandate of being the primary provider of veterinary services. The core service of the department at both national and district levels was to provide public goods including selected clinical services, quality assurance of veterinary inputs (drugs and vaccines), and vaccinations of economically and socially important animal diseases, disease surveillance and veterinary extension and advisory services. By the time of the study, and in the two districts, the public

sector services were occasionally supported by selected NGOs, CAHWs, and the livestock keepers themselves, who provided some of the animal health services and inputs. In principle, the district veterinary departments was supposed to play a regulatory role to other Animal Health service deliverers; however, by the time of the study, the services by the district veterinary offices were weak and thin on ground with the majority of government staff based at the county headquarters. The district Veterinary Offices were under-resourced, often requiring staffing and transport reinforcements when specific delivery tasks were to be implemented. Government disease control was done on NGOs facilitation but only in accessible areas. At the same time, NGOs were supporting the establishment of community animal health service delivery systems with limited prospects for sustainability, which only served to weaken animal health service delivery to herders. An analysis of the responses obtained in this study indicated that in the last one year preceding the interviews, no interviewees from either district had had their animals vaccinated

**Table 1:** Public and private sector animal health services human resources available in West Pokot and Turkana Districts by the time of the study

District	Veterinarians	Animal Health Auxilliaries	Livestock officers	CAHWs
Turkana	4	4	0	140
West Pokot	5	15	2	144
<b>Total</b>	<b>9</b>	<b>19</b>	<b>2</b>	<b>284</b>

**Table 2:** Returns from various CAHWs' activities in West Pokot and Turkana districts

Activity	No. of CAHWs	Percentage of CAHWs
CAHWs mainly selling drugs	46	76
Treatments	4	6.6
Equal returns from both sale of drugs and treatments	10	16.7
<b>Total</b>	<b>60</b>	<b>100</b>

**Table 3:** Main practices by CAHWs in West Pokot and Turkana Districts

Main practice	Number out of 60	Percentage of CAHWs
CAHWs mainly selling drugs	44	73.3
CAHWs mainly treating animals	2	3.3
CAHWs doing both treatments and selling of drugs in equal proportions	14	23.3
<b>Total</b>	<b>60</b>	<b>100</b>

against any of the common economically and socially important animal diseases and none had received extension services from the government veterinarians and animal health technicians. Many constraints affecting the delivery of veterinary services by the district veterinary office as reported by the district veterinary officers included: limited resources, both human and financial; an aging veterinary department (average staff age was 49 years); limited facilities and equipment; inadequate resource allocation for operations; low staff morale; weak coordination and monitoring; inadequate records keeping and data management and weak linkages between the various Animal Health Service providers on the ground. Following the devolution of governance in Kenya in 2013, most of the veterinary services became part of the devolved functions of the County governments.

#### *Service delivery by the Community Animal Health Workers*

By the time of the study, the community animal health workers system, supported by NGOs was the main mode of service delivery, with poor prospects of sustainability once the funding from the NGO came to an end. The approaches of CAHWs' programs in the two districts included: NGO-CAHWs-Farmer approach where an NGO trained CAHWs and issued them with initial drug kits, with or without cost-sharing; NGO-Private veterinarian-AHA-CAHW-Farmer (there was only one program with this arrangement in West Pokot district and the only one of its kind in the country. It was implemented with support from the African Union InterAfrican Bureau for Animal Resources); NGO-AHA-CAHW-Farmer where the NGO had either a veterinarian or an Animal Health Technician who supervised the CAHWs.

During selection of CAHWs for training, the facilitating agents introduced the concept to the District Veterinary Office, followed by discussions with the community leaders who eventually took the lead role in selecting the trainees. The facilitating organizations provided the necessary guidance

and criteria for the selection of trainees. Trainees had to be trustworthy, respectful, hardworking, had the ability to read and write, and must have been community members owning livestock. Women were rarely considered nor did they participate in the selection process.

Training was normally conducted by resource persons from the public or private sectors or the organization funding the Community Animal Health Program (CAHP). By the time of the study, the Kenya Veterinary Board (KVB) had developed training guidelines for CAHWs, referred to as 'the minimum standards and guidelines for the design and establishment of Community Based Animal Health Workers systems' (KVB, 2004). The process of harmonizing the standards and rationalizing the training was however not implemented and as a result, no mechanisms were put in place to ensure adherence to the guidelines. In principle, the CAHWs were provided with starter kits containing essential drugs and basic equipment at the end of the training and were expected to replenish the kits as and when necessary.

The functions and responsibilities of the CAHWs in the surveyed districts included the following: provision of basic animal health care including treatments, sale of drugs to livestock keepers, reporting disease incidences to the district Veterinary services, community mobilization during vaccination campaigns, participation in vaccination activities, participation in disease surveillance and investigation and giving advice to livestock keepers. CAHWs kept records of their activities, albeit incomplete. The records captured only the number of cases handled; amount, type and price of drugs used and the species of animals treated. CAHWs handled diseases and ailments in cattle, sheep, camels and goats. No cases were handled in poultry, dogs and cats. Payment for services by herders was either in kind or in cash. Table 2 shows returns from various CAHWs' activities in West Pokot and Turkana Districts by the time of the study, whereas table 3 shows the main practices by the CAHWs in the two districts.

In the two districts, there was a high CAHWs' dropout rate after training. By the time of the study, and in West Pokot district alone, a total of 144 CAHWs had been trained by different organizations, out of which only 30 were active, reflecting a drop out of 79.2%. In Turkana district 104 CAHWs were trained, out of which 30 were active, reflecting a drop out of 71.2%. The high drop-out rate was indicative of the instability and unsustainable nature of the CAHW animal health service delivery model. The reasons given by the District Veterinary Officers for the high CAHWs drop out included: lack of interest and self-drive, other more lucrative business opportunities, inability to replenish the drug kits, inadequate follow up, a wrong selection of the trainees and farmers' inability to pay for the services.

During focus group discussions, it was reported that CAHWs were supposed to migrate together with the pastoralists, carrying adequate drugs along with them. However, this was not possible due to the low purchasing power of the pastoralists for veterinary drugs and the lack of means of transport. Moreover, some herders paid for drugs in kind and this aggravated the CAHWs' situation because there were no ready markets for the animals. In addition, the CAHWs faced competition from the free supply of drugs by some NGOs. In Turkana district, for example, the International Committee of the Red Cross (ICRC) gave drug vouchers to livestock owners to acquire drugs for free from agro-vet shops. Other forms of emergency delivery systems included NGOs buying drugs from pharmacies and either distributing them to herders for free or selling them at subsidized prices during droughts. This created dependency on the part of the herders who were not willing to buy the drugs at full cost after the relief thus adversely affecting the (CAHWs') businesses.

Other constraints facing the CAHWs at the time of the study included the following: heavy dependency on facilitating agents (NGOs) leading to low purchasing power of pastoralists, lack of or weak supportive drugs supply systems, inadequate policies, low livestock productivity and the different perceptions of pastoralists

who do not view livestock as an economic unit, lack of clear exit plans by the facilitating agents raising doubts on the sustainability of the services. Key gaps included limited knowledge on drugs and drugs administration and sampling especially the collection of blood samples, inadequate harmonized or systematic approaches to refresher courses, limited opportunities for sharing information and experiences, poor supervision and monitoring of their activities. Weak linkages with the district veterinary offices, competition from livestock owners who kept their own drugs or used traditional medication, competition from drug peddlers who supplied cheaper but low quality drugs, lack of incentives to report diseases, low volumes of operating inputs/drugs, high transaction costs and the occurrence of droughts leading to free veterinary drugs distribution and animal treatment interventions by various organizations.

#### *General Constraints to access to veterinary services*

This study identified the lack of infrastructure, lack of funds and inadequate animal health service providers as the greatest problems affecting access to veterinary drugs and other services in Turkana and West Pokot districts in Kenya. As a result, veterinary drugs were purchased from local agro-vets or CAHWs in open markets. Other constraints included insecurity and human diseases.

## **Discussion**

Economic studies have shown that the cost of disease prevention is cheaper than the cost of disease control in the long run (Tambi *et al*, 1999). In this relation, the district administration (currently the county governments after devolution of government functions) and other stakeholders should replicate the mechanisms in place for the prevention and control of emerging and re-emerging epizootic diseases such as RVF and PPR. This suggestion needs to be adopted and incorporated into the policy frameworks supported at the highest level e.g. the Ministry of Agriculture, Livestock and Fisheries

headquarters. Moreover, since there is limited documentation showing how much is lost due to most animal diseases, socio-economic studies need to be done to produce convincing data to policy makers and partners, showing clearly the long term impacts of the diseases on livelihoods.

Adequate vaccination coverage of livestock against diseases is one of the key animal disease control measures that ensures that livestock have the required protective herd immunity to prevent outbreaks and spread of diseases and whereas the District Veterinary offices played a major role in disease control and surveillance (Animal Diseases Act, Cap 364), it was found in this study that, in the two districts, these offices did not have sufficient capacity, both physical and financial to adequately undertake these functions.

Community animal health workers were not prominently present in the two districts. Focus groups held with CAHWs revealed a number of causes for the poor performance CAHWs as follows: group members believed that training programs were often too fragmented and that community-level support was poor; most of the CAHWs interviewed had undergone training courses over a period of time (21 days) followed by a refresher course; many CAHWs complained that the long time period between trainings made it difficult to retain the skills acquired during training; some suffered from demands from friends and family members to give free livestock drugs; there were also problems in targeting appropriate candidates for training; lack of recognition by the government and lack of collaboration and co-ordination among CAHWs projects and programmes. The high dropout rates of trained CAHWs were indicative of the instability and unsustainable nature of the CAHWs as animal health service delivery agents.

These findings are in agreement with those of Oakeley (1999), who reported that the sustainability of CAHWs' programs is often questionable. Based on the findings of this study, this could have been partly due to the fact that the district veterinary services in, in Turkana

and West Pokot districts, were not usually actively involved in their implementation and so they had little control and thus did not own the process and products (CAHWs). Besides, by the time of the study, there was no policy or legal framework in the structure of the national animal health care system defining and setting out the relationship between the CAHWs, paraprofessionals (AHAs), and veterinarians. However, later, the Veterinary Surgeon's and Paraprofessionals Act (No 29 of 2011), made provisions for the training, registration and licensing of veterinary surgeons and veterinary para-professionals, and allowed veterinary para-professional to operate under the act. However, under this act, CAHWs are not recognized as legal animal health service providers.

However, despite the high dropout rate, in this study, the distribution of paraprofessionals and CAHWs was found to exceed that of veterinarians in the two counties. This is consistent with the findings of Leonard *et al.*, (1999), and Oruko *et al.*, (2000), who also reported that the distribution of paraprofessionals exceeded that of veterinarians in any small holder farms. Paraprofessionals (in this case AHAs) live closer to the pastoral communities and would therefore be more accessible to herders than veterinarians. However, they are also few in numbers and are only allowed to deliver a limited range of services under the supervision of Veterinary surgeons. Moreover, legislation presently creates entry barriers to their participation in private practice. One way to utilize their potential for the provision of services more effectively is to increase their numbers through training and also enhance their interface with veterinarians as a way of increasing penetration into pastoral communities and improving service quality.

One way of increasing veterinarians' density as well as reducing farmers' travel distances would be achieved through contracting services by the government to private veterinarians (Turkson, 2009), allowing state employed veterinarians to engage in private practice (Leonard, 1999), or through employing more veterinarians.

The current veterinary surgeons and Veterinary Paraprofessionals Act does not prohibit the farmer from treating his own animals and herders in the Turkana and West Pokot districts were found to possess sound and effective indigenous knowledge about the management of their herds. Reconsideration of this indigenous knowledge and information systems could provide a basis for further livestock research and could serve future livestock extension programs tailored to their special circumstances. Besides, using indigenous knowledge could also lead to increased participation of pastoralists in pastoral development projects and could be a starting point for supporting grassroots institutions such as herders' associations and groups that can back up technical and social interventions (Fre, 1992).

Other major constraints to effective disease control in recent years have been due to the decline of veterinary diagnostic services through under-resourcing and the slow development of alternative ways of providing reliable veterinary diagnostic services. This situation can have serious effects on the spread of diseases and effectiveness of the national response to an emerging disease threat.

In developing countries like Kenya, pastoral communities have little or no opportunity to access international markets for animals and animal products and are struggling to enter and maintain markets at the regional level. This is largely because they do not meet the expected standards for veterinary services or disease status. There is thus a need for a long term strategy to build marketing opportunities for poor countries, without putting other countries at risk (Carlos, 2007).

### **Conclusion**

It can be concluded from this study that the delivery of animal health services in the Turkana and West Pokot districts in Kenya was inadequate, often requiring staffing and transport reinforcement when specific delivery tasks were to be executed. The challenging environment that includes long

distances between centers, poor infrastructure, prolonged drought, limited communication, insecurity, high service delivery costs and the frequent movement of the communities and their livestock were unfavorable for the delivery of conventional veterinary services by either the private or public sectors. Animal health service delivery by Community Animal Health Workers (CAHWs) as undertaken at the time of the study, was found to be neither sustainable nor tenable as the CAHWs were heavily dependent on facilitating agents and lacked supportive drug supply systems. In addition, there were no clear exit plans from the Community Animal Health Programs (CAHPs) by the facilitating agents. The animal health service delivery systems by CAHWs also lacked proper backstopping by the public or private sector professionals.

### **Recommendations**

The study established that there was real need to strengthen the existing capacity in animal health service delivery in the two districts and as a result, the following were recommended:

- Prioritizing livestock in planning: Prioritizing livestock in planning at the county governments and capacity building through increased allocation of resources, both financial and human and the provision of adequate tools and equipment to the county veterinary services
- Seeking alternative service provision system other than CAHWs. Further investigation of an alternative animal health care delivery system in the Arid and Semi-Arid Lands (ASALS) such as the adoption of pastoral field schools, and their domestication as a possible way forward in animal health service delivery. Such an action should be supported by the Director of Veterinary services and the County governments through recruitment of adequate numbers of veterinarians and animal health technicians specifically for the ASALS
- Empowerment and expansion of the

County extension services to pastoral areas. In recognition of the increasing role of other stakeholders in extension service provision, it was recommended that the county veterinary offices promote pluralism in extension service delivery and institute mechanisms to coordinate these services to ensure delivery of quality extension services in ASALs. It was recommended that the County veterinary office should establish a harmonized institutional framework for coordination of all extension programs within the livestock sub-sector in line with the aspirations of the National Agricultural Sector Extension Policy (NASEP) and Pastoral Field schools should be empowered and used to educate both the pastoralists and the consumers.

- Integrating public health and communication departments into disease surveillance and response for emerging and re-emerging diseases. There were no linkages between the public health, livestock and communication sectors departments in responses to emerging and re-emerging diseases, particularly during emergencies. This study recommended the formation of collaborative structures to prepare for and respond to emergencies.
- Empowering capacity for peace. It was recommended in this study that the traditional peace mechanisms already on the ground be strengthened and facilitated to work on their own towards peace initiatives.
- Use of study results to track progress in the delivery of animal health service delivery in the two counties since devolution of the services: It was recommended that the results of this study be used in future as baseline data to track progress made in the delivery of animal health services in the two Counties since the devolution of animal health services provision in Kenya.

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### References

- Ahuja, V., Jan, M., and Arindans, S. (2003). Veterinary services delivery and the poor: Case of rural Orissa, India. *Scientific and technical review*, Vol 22 (3).
- Carlos, S. (2007). "Livestock, livelihoods and local markets". A paper presented during an ILRI workshop held in Stockholm, Sweden on 26th September
- Catley, A. (2005). *Participatory epidemiology; A guide for trainers*, African Union /Inter African bureau for animal resources, Nairobi, Kenya, pages 1-116
- Fre, Z (1992). Pastoralists and agropastoralists losing ground: a horn of Africa perspective. Paper presented to the workshop on security in African drylands. Scandinavian Institute of African Studies (SIAS), Uppsala, Sweden. November 5-7.
- Freund, J. E., and Benjamin, Perles, M. (Modern elementary statistics (2006). 12th edition, Prentice Hall Publishers. London
- Laws of Kenya. Veterinary Surgeons Act, CHAPTER-366 (2012). [www.kenyalaw.org](http://www.kenyalaw.org)
- Laws of Kenya. Animal Disease Control Act, CHAPTER-364 (2012). [www.kenyalaw.org](http://www.kenyalaw.org)

Laws of Kenya. Pharmacy and Poisons Act, CHAPTER-244 (2012). [www.kenyalaw.org](http://www.kenyalaw.org)

Laws of Kenya. The Veterinary Surgeon And Veterinary Para-professionals Act NO 29 (2011) [www.kenyalaw.org](http://www.kenyalaw.org)

Leonard, D.K. (1999). Africa's changing markets for health and services: The new institutional issues, Palgrave, Basingstoke.

Leonard, D.K. (2000). The new institutional economics and the restructuring of animal health services in Africa: the new institutional issues, Palgrave Macmillan, Basingstoke, pp 1-39

Levy, P.S., Lameshow, S (1996): Linear Algebra and its applications. 237-238, pages 225-238. Elsevier Science Inc.

Maddala, G.S (2001). Introduction to econometrics. 2nd edition MacMillan, New York.

Mariner, J.C., and Paskin, R (2000). Participatory epidemiology: Methods for the collection action-oriented epidemiology intelligence. FAO Animal Health Manual No. 10.

Mugenda, O.M., Mugenda, A.B (1999). Research methods: Quantitative and Qualitative approaches. African Center for Technology Studies (ACTS), Nairobi, Kenya. [Webis.bioline.org.br/pdf/lp08001](http://webis.bioline.org.br/pdf/lp08001).

Mulwa, F.W., and Nguluu, S.N. (2003). Participatory Monitoring and Evaluation: A strategy for organization strengthening. Eldoret, Kenya: Participatory community development series no. 10 : Zapf chancery, Nairobi: PREMESE-Olivex.

Odimengwu, C.O (2000). Methodological issues in the use of focus group discussions as a data collection tool. Journal of social Sciences, 4(2-3): 207-212.

Oakeley, R.D. (1999). Community livestock workers: A review of experiences with community based animal health care delivery. World anim. Rev., Vol 92, pages 47-54.

Oruko, L.O (1999): Delivery of animal health services in Kenya. PhD. Thesis. Department of Agricultural and Food Economics, University of Reading.

Stock, J.H and Watson, M.W. (2003). Introduction to econometrics. Addison-Wesley, higher education group publishers.

Tambi, E.N.M., Mukhebi, A.W., Maina, O.W., and Solomon, H.M (1999). Probit analysis of livestock products demand for private veterinary services in the high potential agricultural areas of Kenya. Agricultural systems, Vol 59, issue 2, February, pages 163-176.

Turkson, P.K (2009): Clients satisfaction with delivery of animal health-care services in peri-urban Ghana. Preventive Veterinary medicine. Elsevier, 90, issues 3-4.

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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  
March 2020

## Aims and scope

The Bulletin of Animal Health and Production in Africa (BAHPA) of the African Union Inter-African 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.

The Bulletin of Animal Health and Production publishes articles on original research on all aspects of animal health and production, biotechnology and socio-economic disciplines that may lead to the improvement of animal resources. Readers can expect a range of papers covering well-structured field studies, manipulative experiments, analytical and modeling studies of the animal resources industry in Africa and to better utilization of animal resources.

The BAHPA encourages submission of papers on all major themes of animal health and production, wildlife management and conservation, including:

- Veterinary microbiology, epidemiology
- Marketing, economics
- Infectious and non infectious disease
- Parasitology
- Genetic improvement and biotechnology
- Animal production, nutrition and welfare
- Science and policy in animal health and production
- Beekeeping and honey bees
- Ecology and climate change impacts on animal resources in Africa
- Wildlife management
- Fisheries and aquaculture development
- Food safety and food hygiene
- One health
- Emerging and re-emerging issues in animal resources
- Biosecurity
- Animal resources trade and value chain
- Socio economics and economics of animal resources development

## Language

The language of submission should be either in U.K. English or Standard French. The abstract is translated to the other three languages of the African Union (Arabic, English, French and Portuguese), by the editors, after acceptance. Full articles submitted in French will also be published in English.

## Manuscripts Submission

Authors are invited to submit electronically their manuscripts via attachment only at [bahpa@au-ibar.org](mailto:bahpa@au-ibar.org) in a secured PDF and word format. Manuscript can be sent by post in case of unavailability of internet services (authors should be aware that in this case it will take longer time to be published).

Authors submitting articles to the BAHPA must follow the guidelines in this document. Submissions that deviate from these guidelines will be returned to the corresponding authors for changes and compliance.

To be considered for publication in the BAHPA, any given manuscript must satisfy the following criteria:

- Originality. BAHPA does not accept manuscripts that have already been published elsewhere. However, studies that replicate results that are already in the literature may be considered for publication, as the independent confirmation of results can often be valuable, as can the presentation of a new dataset.
- Audience. Manuscripts submitted must be of broad interest to animal health and production professionals in general, they must capture and hold readers' attention.
- Usefulness. Manuscripts submitted must help researchers, trainers, educators and policy makers in all regions of Africa improve their effectiveness.
- Rigorous methodology. Manuscripts submitted must be based on valid and reliable information, documentation or sound concepts, empirically, logically and theoretically supported.
- Well written to ensure clear and effective presentation of the work and key findings. The BAHPA editorial staff does not copyedit the text of accepted manuscripts, it is therefore important for the work, as presented, to be intelligible. Perfect, stylish language is not essential but it must be clear and unambiguous. If the language of a paper is not clear, Academic Editors should recommend that authors seek independent editorial help before submission of a revision. Poor presentation and language is a justifiable reason for rejection.
- Experiments, statistics, and other analyses performed are described in sufficient detail. The research must have been performed to a technical standard to allow robust conclusions to be drawn from the data. Methods and reagents must also be described in sufficient detail so that another researcher is able to reproduce the experiments described.
- Conclusions are presented in an appropriate fashion and are supported by the data. The results must be interpreted appropriately, such that all conclusions are justified. However, authors may discuss possible explanations for their results as long as these are clearly identified as speculations or hypotheses, rather than as firm conclusions. Inappropriate interpretation of results is a justifiable reason for rejection.
- The research meets all applicable standards for the ethics of experimentation and research integrity. Research to be published must have been conducted to the highest ethical standards. A brief description of the most common of these is described in our Editorial and Publishing Policies.
- Because the guidelines are updated as appropriate, authors should check them again before they submit their articles. Manuscripts submitted for publication will be considered for acceptance on the understanding that they present original work which has not been published or submitted for publication elsewhere and that they are subject to peer review.

## Types of contribution

Full papers providing accounts of original work: Research containing significant new findings. The material presented should be original and not have been published elsewhere, except in a preliminary form. Papers will be reviewed by three referees familiar with the subject matter of the paper.

*Short Communications:* are intended to provide quick publication of highly relevant and interesting information. Manuscripts will be peer reviewed by two reviewers and the Editor.

*Review Articles:* should cover subjects falling within the scope of the bulletin, which are of active current interest. Papers need not contain original work or ideas. They will be reviewed for completeness, accuracy, style and suitability of content by referees familiar with the subject and the Editor-in-Chief.

*Editorial:* articles are short articles describing news about the bulletin or the opinion of the editor-in-chief, the publisher or a guest editor of a thematic series.

**Letters to the Editor:** the bulletin welcomes letters to the editor. The purpose of Letters to the Editor is to provide a forum for positive and constructive views on articles and matters published in the bulletin. Letters to the Editor must not exceed 300 words. Letters to the editors include technical reports from countries or projects.

**Key notes and special calls:** The editor will, from time to time, invite selected key figures in the field of animal health and production for key notes on specific topics. Book Reviews: are accepted and should provide an overview of the work's contents and a critique of the work's value. Book reviews should be limited to 1000 words.

**Conference Proceedings:** Special Issues of the bulletin may be dedicated to publication of proceedings of key meetings/conferences

Obituary articles to honor prominent African scientists that have made significant contribution to animal resources research and development

**News and announcements:** BAHPA is pleased to publish information on animal health and production activities/meetings. Please send the following information to the Editor: Date of the event, title, organization offering the event, location and contact information.

### Submission Guidelines

Full papers of original research

All manuscripts submitted to BAHPA should include the following features:

1. On cover page of the manuscript, the following should be clearly written/inserted: the corresponding author, name of the institution, title of the manuscript, names of the authors, the addresses of the authors and the e-mail address of the corresponding author. The corresponding author should ensure that all the other authors consent to their names being included. The consent should be sent directly by co-authors to the editor via email.
2. Each original article should be divided into Abstract and Keywords, Introduction, Materials and Methods, Results, Discussion, conclusion, Acknowledgments and References. A textbox containing a public brief on the study for the benefit of policy makers should also be provided. This textbox will not be included in the published article but will be compiled and published in a separate edition at the end of the year.
3. Title, which should be concise, preferably not more than 15 words long, followed by the author(s) name(s) and institution(s) to which work should be attributed and address for correspondence, if different.
4. The Abstract should not be longer than 300 words giving a synopsis of the work and should contain the objectives, briefs description of materials and methods, highlights of significant results, conclusions and recommendations. Up to six keywords should be provided..
5. The Introduction should contain the problem statement, the hypothesis and the objective of the work and cite recent important work undertaken by others.
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.
7. Results should be presented clearly and concisely, in a non-

repetitive way. Subheadings may be accepted.

8. Discussion of significance should be focused on in the interpretation of results. Subheadings are not accepted in this section.
9. Acknowledgements. Where necessary acknowledgements of grants and technical assistance should be included under this heading. Please also include any potential conflict of interests if appropriate. Suppliers of materials should be named and their location (town, state/county, country) included.
10. State the conclusions, and any implications that may be drawn from the study.

**Short Communications:** Manuscripts should contain original data and be limited to 1500 words. The number of tables and figures are limited to two. A limited number of references should be included. Headings are not allowed in short communications.

### Sequence of Preparation

1. The data files must be PC/Windows-compatible. The text should be prepared using standard software (Microsoft Word) format; do not use automated or manual hyphenation. Please do not include footnotes.
2. Use Times New Roman 12 point font for all text except for tables and figures where Times New Roman 10 font should be used.
3. Use 1 inch margins on top, bottom, left and right margins,
4. Every line on the text should be numbered.
5. Use double line spacing for body of text. For Abstract, Figures, Tables and References use single line spacing.
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7. Run "the spell check" and "grammar check" on the entire file before submission using either the UK English or French standard.
8. Avoid using abbreviations for the names of concepts. Use ordinary words for variable names – not code names or other abbreviations. Use the same name for a variable throughout your text, tables, figures and appendices. Names of organizations and research instruments may be abbreviated, but give the full name (with abbreviation in brackets) the first time you mention one of these.
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The authors should be cited in a chronological order by year and then by a or b; in the reference list they should be listed alphabetically.

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### Examples of References

- **Journal Articles:** Ouyang D, Bartholic J, Selegean J, 2005. Assessing sediment loading from agricultural croplands in the Great Lakes basin. *Journal of American Science*, 1(2): 14-21.
- **Books:** Durbin R, Eddy SR, Krogh A, Mitchison G, 1999. *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids*. London, Cambridge University Press.

- *Chapter in a Book*: Leach J, 1993. Impacts of the Zebra Mussel (*Dreissena polymorpha*) on water quality and fish spawning reefs of Western Lake Erie. In *Zebra Mussels: Biology, Impacts and Control*, Eds., Nalepa T, Schloesser D, Ann Arbor, MI: Lewis Publishers, pp: 381-397.
- *Reports*: Makarewicz JC, Lewis T, Bertram P, 1995. Epilimnetic phytoplankton and zooplankton biomass and species composition in Lake Michigan, 1983-1992. US EPA Great Lakes National Program, Chicago, IL. EPA 905-R-95-009.
- *Conference Proceedings*: Stock A, 2004. Signal Transduction in Bacteria. In the Proceedings of the 2004 Markey Scholars Conference, pp: 80-89.
- *Thesis*: Strunk JL, 1991. The extraction of mercury from sediment and the geochemical partitioning of mercury in sediments from Lake Superior, Unpublished PhD thesis, Michigan State University, East Lansing, MI.
- *Web links*: Cerón-Muñoz M F, Tonhati H, Costa C N, Rojas-Sarmiento D and Solarte Portilla C 2004 Variance heterogeneity for milk yield in Brazilian and Colombian Holstein herds. *Livestock Research for Rural Development*. Volume 16, Article #20 Visited June 1, 2005, from <http://www.lrrd.org/lrrd16/4/cero16020.htm>

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Please send the figures as separate files and do not import them into the text file. Put all tables, figures, diagrams and artwork on separate pages. Each figure, table, and bibliographic entry must have a reference in the text. References to tables and figures in the text should be by number and not to "table below" or "figure below". The Editor will place them in the appropriate place in the text of article during the final edit. Tables and figures should be numbered consecutively. Please submit the data for figures in black and white.

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All specifications must be stated according to the S.I. system. Concentrations of chemical solutions are to be given in mol/l. All other concentrations should be given in % (volume or weight). Any abbreviations of chemical, biological, medical or other terms should only be employed when it is certain that they are internationally known. The full name must be stated in brackets when the abbreviation is first used. Names of micro-organisms and zoological names should be italicized in the manuscript.

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BAHPA adheres to the below ethical guidelines for publication and research. Experimentation will only be published if such research has been conducted in full accordance with ethical principles. Manuscripts containing experimentations must be accompanied by a statement that the experiments were undertaken with the understanding and written consent of each subject and according to the above mentioned principles. Editors reserve the right to reject papers if there are doubts as to whether appropriate procedures have been used.

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