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BULLETIN OF ANIMAL HEALTH AND PRODUCTION IN AFRICA
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EFFET DE L'UTILISATION DE QUELQUES LÉGUMINEUSES COMME SOURCE DE PROTÉINE SUR LA CROISSANCE PRÉ-SEVRAGE DES COBAYES (CAVIA PORCELLUS L.) NOURRIS AU *PENNISETUM PURPUREUM*

Miégoué E[1], Tendonkeng F[1], Lemoufouet J[1], Mweugang Ngouopo N[1], Noumbissi Marie N B[1], Fongang Mathieu D[1], Zougou T G[1], Matumuini N E F[2], Mboko A V[2], Boukila B[2] et Pamo T E[1]

[1]Laboratoire de Nutrition et Alimentation Animales, Département des Productions Animales, FASA, Université de Dschang, B.P. 222 Dschang, Cameroun. ftendonkeng@yahoo.fr / pamo_te@yahoo.fr

[2]Institut National Supérieur d'Agronomie et de Biotechnologies (INSAB), Université des Sciences et Techniques de Masuku, B.P. 941 Franceville, Gabon.

Résumé

Une étude sur l'utilisation de quelques légumineuses comme source de protéine sur la croissance pré-sevrage des cobayes (Cavia porcellus L.) nourris au *Pennisetum purpureum* a été menée entre Octobre 2014 et Mars 2015 à la Ferme d'Application et de Recherche de la Faculté d'Agronomie et des Sciences Agricoles (FASA) de l'Université de Dschang. Pour la réalisation de cet essai, 48 femelles âgées d'environ 5 mois, pesant en moyenne 500 g et préalablement mises en croisement avec 8 mâles pendant une période de 31 jours ont été utilisées. Les animaux ont été organisés selon un dispositif factoriel (Ration et sexe des animaux) de quatre lots comptant 12 femelles par lot. Le lot témoin T0 recevait du *P. purpureum* ad libitum associé à 40g/j/animal d'un aliment composé simple tandis que les animaux des lots T1, T2 et T3 recevaient 40g/j/animal d'un aliment composé contenant respectivement *Arachis glabrata* (T1), Calliandra calothyrsus (T2) ou *Desmodium intortum* (T3). Les résultats de cette étude montre qu'aucune différence significative n'a été observée ente les traitements T0, T2 et T3 alors que les femelles du lot T1 ont présenté la chute de poids significativement la plus élevée. A la naissance, le poids moyen des cochonnets était de 59,23; 77,31; 80,42 et 86,00g respectivement pour les traitements T0, T1, T2 et T3. La ration T3 a permis d'obtenir le poids moyen des cochonnets le plus élevé (86,00g). Au sevrage, ce poids est passé à 181,88g pour le même traitement. Les gains totaux (GT) et les gains moyens quotidiens (GMQ) des cochonnets nourris à base des rations contenant les légumineuses ont permis d'obtenir les gains significativement ($P < 0,05$) les plus élevés. Dans l'ensemble, les poids moyens, les GT et les GMQ ont été significativement ($P < 0,05$) plus élevés chez les mâles comparés aux femelles. Les animaux nés des naissances simples ont été plus lourds que ceux des animaux nés des naissances doubles mais, aucune différence significative ($P > 0,05$) n'a été observée entre les traitements pour ce qui est des gains gais de poids. Compte tenu de leur faible coût de production, les légumineuses apparaissent comme un complément de choix pour l'amélioration des performances de production des cobayes en milieu paysan.

Mots clés : Légumineuses fourragères, *P. purpureum*, cobayes, sources de protéines, performances de croissance.

Abstract

A study on the utilization of some legumes plants as protein sources in the pre-weaning growth of guinea pigs feed on *Pennisetum purpureum* between October 2014 and March 2015, was conducted at the Teaching and Experimental Farm of University of Dschang. To evaluate the growth performances, 48 females guinea pigs aged about 6 months and weighing averagely 500 g, were first put in breeding for a period of 31 days and then organized in a completely randomize design into four groups of 12 females each. The control group T0 received *P. purpureum* ad libitum associated to 40g/day/animal of mixed food only and animals of groups T1, T2 et T3 received 40g/j/animal of a mixed food containing respectively *Arachis glabrata* (T1), Calliandra calothyrsus (T2) or *Desmodium intortum* (T3). results of this study showed that there were no significant differences ($P > 0.05$) between treatment T0, T2 and T3 for the mean weekly live weighs of the breast-feeding females from parturition to weaning whereas breast-feeding females of group T1 present the weight fall significantly ($P < 0.05$) higher. At birth, the average live weighs of young guinea

pigs were 59.23; 77.31; 80.42 and 86.00g respectively for T0, T1, T2 and T3 groups. The diet T3 has permitted to obtain the highest mean live weigh both at birth (86,00g) and weaning (181.88g) of the young animals. Animals feed on diet containing legumes plants have permitted to obtain gains significantly higher. These parameters were significantly ($P < 0.05$) higher for males than for females. In general, animals from parity one was heavier than those of parity two but, no significant different was observed between treatments according to the body weight gains of young animals. Considering their low production cost, legumes plants appears to be good complement to improve the productive performances of the guinea pigs in small farmer environment.

Key words: Legumes plants, *Pennisetum purpureum*, guinea pigs, Protein sources, growth performances.

Introduction

Les cobayes constituent une ressource important dans le paysage rural en Afrique subsaharienne (Noumbissi *et al.,* 2013). Le cobaye est identifié comme source alimentaire dans plusieurs pays au sud du Sahara notamment au Cameroun (National research council, 1991 ; Fransolet *et al.,* 1994). Ils jouent un rôle vital dans l'approvisionnement en protéines animales et dans la génération des revenues en zones rurales au Cameroun (Ngou Ngoupayou *et al.,* 1994 ; Manjeli *et al.,* 1998). Malgré son importance dans le circuit économique informel des zones rurales, la production du cobaye au Cameroun se réalise principalement en système traditionnel (Niba *et al.,* 2009). Par conséquent, ces animaux sont relégués au second plan, apparaissent comme activité domestique secondaire pour les petits fermiers surtout les femmes (Ngou Ngoupayou *et al.,* 1994). Ceci a malheureusement réduit l'impact de cet élevage sur la qualité de vie de plusieurs éleveurs ruraux de faible revenues (Tchoumboué *et al.,* 2001).

Par ailleurs, l'un des facteurs majeurs qui affecte les productions animales notamment celles des cobayes au Cameroun est la disponibilité et la qualité des aliments à un coût abordable. Ils sont de pseudo-ruminants et, peuvent être maintenus au régime des végétaux sans complémentation au concentré. Mais, pour une bonne croissance, les fourrages peuvent être supplémentés.

C'est ainsi que *P. purpureum* a été utilisé seul ou associé au Tithonia diversifolia (Noumbissi *et al.,* 2013) ou au feuilles de manioc (Manihot esculenta) (Mweugang et al. 2014) chez les cobayes avec des gains de poids élevés. Par ailleurs, *Desmodium intortum* ou *Arachis glabrata* ont été utilisés comme supplément d'une alimentation de base chez les cobayes avec de bon résultats (Tchoumboué *et al.,* 2001 ; Kenfack *et al.,* 2006).

Ainsi, de nombreuses légumineuses et autres plantes riches en azote disponibles en zone tropicale peuvent être utilisées comme source de protéines dans la ration des cochons d'Inde pour améliorer leurs performances de production. C'est le cas de A. glabrata, C. calothyrsus ou D. intortum qui ont déjà été utilisé avec de meilleurs performances chez les petits ruminants (Boukila *et al.,* 2009 ; Pamo *et al.,* 2006). Inclure ces légumineuses dans les aliments composés comme source de protéine peut contribuer à réduire le coût de l'alimentation et en améliorant les performances de l'animal. La présente étude se propose donc de contribuer à l'amélioration des connaissances sur l'alimentation des cochons d'indes à travers la diversification des sources de protéines d'origine végétales. Dans cette étude il sera question d'évaluer l'effet de quelques légumineuses comme sources de protéines sur l'évolution du poids des femelles post-partum et celui des jeunes cobayes nourris au *Pennisetum purpureum* pour la période pré-sevrage

Matériel et méthodes

Site expérimental

L'étude s'est déroulée entre Octobre 2014 et Mars 2015 à la Ferme d'Application et de Recherche (FAR) de l'Université de Dschang, située à 5° 26' de Latitude Nord, à 10° 26' de Longitude Est et à une altitude d'environ 1420 m dans l'Ouest Cameroun. Le climat de la région est équatorial de type

camerounien d'altitude, avec une température moyenne annuelle de 20°C. Les mois de février et mars sont généralement les plus chauds, et les mois de juillet et août les plus froids. Les précipitations moyennes annuelles varient entre 1500 et 2000 mm, avec une humidité relative oscillant entre 40% (en pleine saison sèche) et 97% (durant les grandes pluies). La saison sèche alterne avec la saison des pluies.

Matériel Animal et logement

56 cobayes adultes de race Anglaise dont 48 femelles et 8 mâles âgés d'environ 6 mois et pesant en moyenne 500 g ont été utilisés dans cet essai. Tous les animaux utilisés étaient nés à la Ferme d' Application et de Recherche (FAR) de l'Université de Dschang. Les animaux ont été repartis dans des loges de 1 m de longueur, 0,8 m de largeur et 0,6 m de hauteur chacune et munis d'un dispositif d'éclairage et de chauffage électrique. Les animaux ont été élevés au sol, sur une litière en copeaux de bois sec non traité de 5 cm environ d'épaisseur, renouvelée tous les 2 jours pour éviter l'accumulation des fèces et des urines. Chaque loge était équipée de 2 mangeoires en bois pour l'aliment concentré et de 2 abreuvoirs en béton. Pour parer à une déficience éventuelle en vitamine C, cette dernière (01 comprimé de 240 mg dans 1,5 litre d'eau) était distribuée quotidiennement à tous les animaux via l'eau de boisson servie à volonté.

Matériel végétal

La graminée (*Pennisetum purpureum*) était fauchée dans le champ fourrager de la ferme la veille et conservée dans l'un des logis du bâtiment d'élevage et, pré-fané avant d'être servis le lendemain aux animaux. Les feuilles de légumineuses (*Arachis glabrata*, *Desmodium intortum* ou Calliandra colothyrsus), quant à elles, ont été récoltées avant floraison, séchées, broyées et incorporées dans la provende. Un échantillon de 100 g de chaque plante était prélevé, séché à l'étuve jusqu'à poids constant, broyé et conservé dans des sachets en plastique en vue de l'évaluation de la composition chimique (AOAC, 1990) (le tableau 1).

Conduite des essais

Fabrication des différentes rations

Les proportions des différents ingrédients achetés dans les provendéries de la ville de Dschang pour la fabrication de la provende de même que la composition chimique de celle-ci sont présentées dans le tableau 2

A partir des rations ainsi formulées, Un échantillon de 100g a été prélevé, séché, broyé et conservé dans les sachets en plastique pour l'évaluation de leur composition chimique (AOAC, 1990). Les différentes rations ainsi préparées ont servi à la fabrication des granulés.

Evaluation des performances de reproduction et de croissance en fonction des différentes rations

Pour cet essai, les femelles ont été placées dans un dispositif factoriel (Ration et sexe) de 4 lots homogènes (sexe, poids et âge) chacun et, mises en croisement avec un

Tableau 1: Composition chimique des différents fourrages (%MS)

Composition	**Différents fourrages**			
	P. purpureum	***A. glabrata***	***C. calothyrsus***	***D. intortum***
Matière sèche (MS en %)	94,83	90,92	93,29	92,38
Matière Organique (%MS)	85,98	88,02	90,22	89,65
Protéine Brute (%MS)	14,87	20,00	23,98	23,79
Lipides (%MS)	02,96	02,95	05,58	03,50
Cellulose brute (%MS)	34,78	26,30	31,63	29,63
Cendre (%MS)	14,02	11,98	09,78	10,35

Tableau 2: Composition des différentes rations expérimentales

Ingrédients	**R0**	**R1 (*A. glabrata*)**	**R2 (*C. calothyrsus*)**	**R3 (*D. intortum*)**
Remoulage	31	25	25,5	26
Mais	30	24	25	25
Tourteau de coton	5	4	4	4
Tourteau de palmiste	25	20	21	21
Tourteau de soja	2	1,5	1,5	1,5
Farine de poisson	3	2,5	2,5	2,5
Poudre de coquille	2	1	1,5	1,5
Prémix	1	1	1	1
Sel de cuisine	1	1	1	1
Légumineuses	0	20	17	16,5
TOTAL	100	100	100	100
Matière sèche (%)	91,97	92,10	92,47	92,90
Matière organique (%MS)	89,83	90,81	87,29	89,78
Protéine brute (%MS)	15,76	16,23	16,36	16,07
Lipides (%MS)	08,74	04,80	06,65	06,32
Cellulose brute (%MS)	17,48	19,94	12,95	15,44
Cendres (%MS)	10,17	09,19	12,71	10,22

ratio de 2 mâles pour 12 femelles pendant 31 jours et ensuite les mâles ont été isolés (Pamo *et al.,* 2005). Les animaux ont été identifiés par l'application des boucles numérotés aux oreilles.

Les rations suivantes ont été utilisées:
T0 = *P. purpureum* + 40g/animal/jour de R0 (sans légumineuses)
T1 = *P. purpureum*+ 40g/animal/jour de R1 (A. glabrata)
T2 = *P. purpureum* + 40g/animal/jour de R2 (C. Calothyrsus)
T3= *P. purpureum* + 40g/animal/jour de R3 (D. intortum)

Chacune des rations T0, T1, T2 et T3 était distribuée deux fois (1/4 le matin et ¾ le soir pour l'aliment composé) par jour entre 8-9 h et 16-18h, respectivement aux lots 1, 2, 3 et 4. S'agissant des quantités d'aliments servies, elles ont été maintenues chez les gestantes et les allaitantes jusqu'au sevrage des petits (21 jours après leur naissance). Pendant l'étude, l'eau de boisson ainsi que *P. purpureum* étaient servie ad libitum tous les jours à raison de deux fois par jours aux animaux.

Performances de croissance

Au cours de l'essai, le poids des parturientes a été pris au plus tard 12 heures de temps après la mise-bas et ensuite chaque semaine jusqu'au sevrage des petits, 3 semaines après leur naissance. Ceci a permis d'évaluer l'évolution pondérale post-partum de la mise-bas au sevrage. A sa naissance, chaque nouveau-né était identifié (coloration de son pelage et date de naissance) et pesé au plus tard 12 heures après, ensuite toutes les semaines jusqu'à sa 3ème semaine, date du sevrage. Les poids enregistrés ont permis d'évaluer l'évolution pondérale pré-sevrage et post-sevrage des cochonnets ainsi que les gains totaux (GT) et les gains moyens quotidiens (GMQ).

Analyse des données

Les données sur la croissance pondérale pré-sevrage et post-sevrage des cochonnets ont été soumises à l'analyse de la variance à 2 facteurs (ration alimentaire et sexe de l'animal ou le type de naissance) suivant le

model linéaire général (MLG). Les données sur la croissance pondérale pré-sevrage des allaitantes ont été soumise à l'analyse de variance à un facteur (ration alimentaire) suivant le MLG.

Lorsque les différences significatives existent entre les traitements, la séparation des moyennes a été faite par le test de Waller Dunkan au seuil de signification 5% (Steel et Torrie, 1980). Le logiciel d'analyse utilisé a été SPSS 19.0

Résultats

Croissance pondérale des cobayes

Evolution pondérale des femelles post-partum pour les cobayes nourris au *P. purpureum*

Au cours de la période du post-partum, le poids moyen hebdomadaire de toutes les femelles allaitantes a chuté, quelque soit la source de protéine de la ration jusqu'au sevrage (Figure 1).

Aucune différence significative ($P > 0,05$) n'a cependant été observée entre les traitements T0, T2 et T3 alors que les femelles allaitantes du lot T1 ont présenté la chute de poids significativement ($P < 0,05$) la plus élevée. Les pertes totales de poids de 27,51; 48,17; 41,00 et 42,25 g ont été enregistrées respectivement pour T0, T1, T2 et T3 soit 5,55% de perte de poids pour T0 ; 7,79% pour T1 ; 7,96% pour T2 et 7,98% pour T3. Le traitement T0 a présenté la chute de poids la plus faible. Par contre, cette chute de poids n'a pas beaucoup varié entre les différentes rations contenant les légumineuses.

Effet des sources d'azote de la ration, sur l'évolution pondérale des cochonnets pré-sevrés nourris au P. purpureum

Le poids des animaux a augmenté au cours du temps quelque soit le traitement considéré (Figure 3). En effet, de la naissance au sevrage, la différence de poids présente un gain total de 84,41g, 71,49 g ; de 76,50 g et de 95,88 g, respectivement pour les lots T0, T1, T2 et T3 soit des pourcentages de croissance pondérale respectifs de 58,76, 48,04, 48,75 et 52,72%. Les poids moyens des cochonnets du lot T3 étaient plus élevés que celui des cochonnets des autres. Les animaux du lot témoin, ont présenté des poids moyens les plus faibles comparés à ceux des animaux soumis aux rations contenant les légumineuses de la naissance au sevrage quelque soit le sexe.

Chez les mâles, les gains totaux de 84,83, de 76,08, 73,85 et de 95,09 g respectivement pour les lots T0, T1, T2 et T3. A partir de ces gains, il ressort que le traitement T0 à permis d'obtenir une croissance pondérale de 56,43%, T1 une croissance de 49, 81%, T2 une croissance de 48,22% et pour T3 une croissance de 52,80%. Chez les femelles,

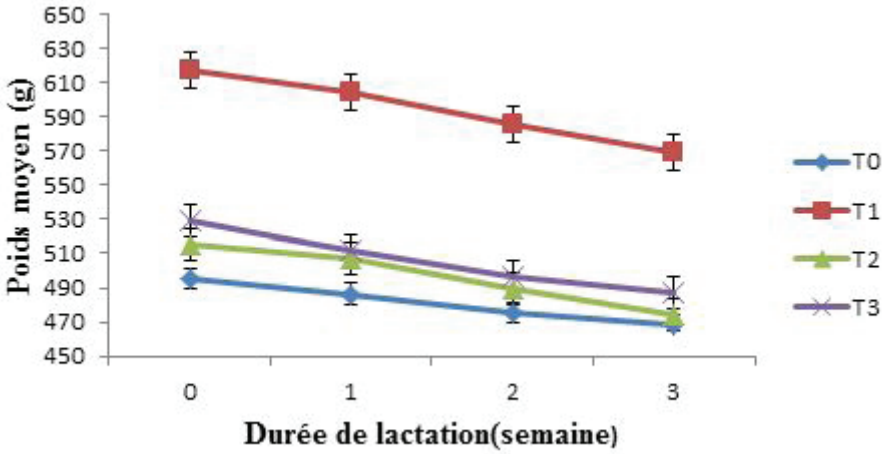

Figure 1 : Evolution du poids moyen des femelles allaitantes de la mise-bas au sevrage, en fonction du régime alimentaire des cobayes nourris au *Pennisetum purpureum*

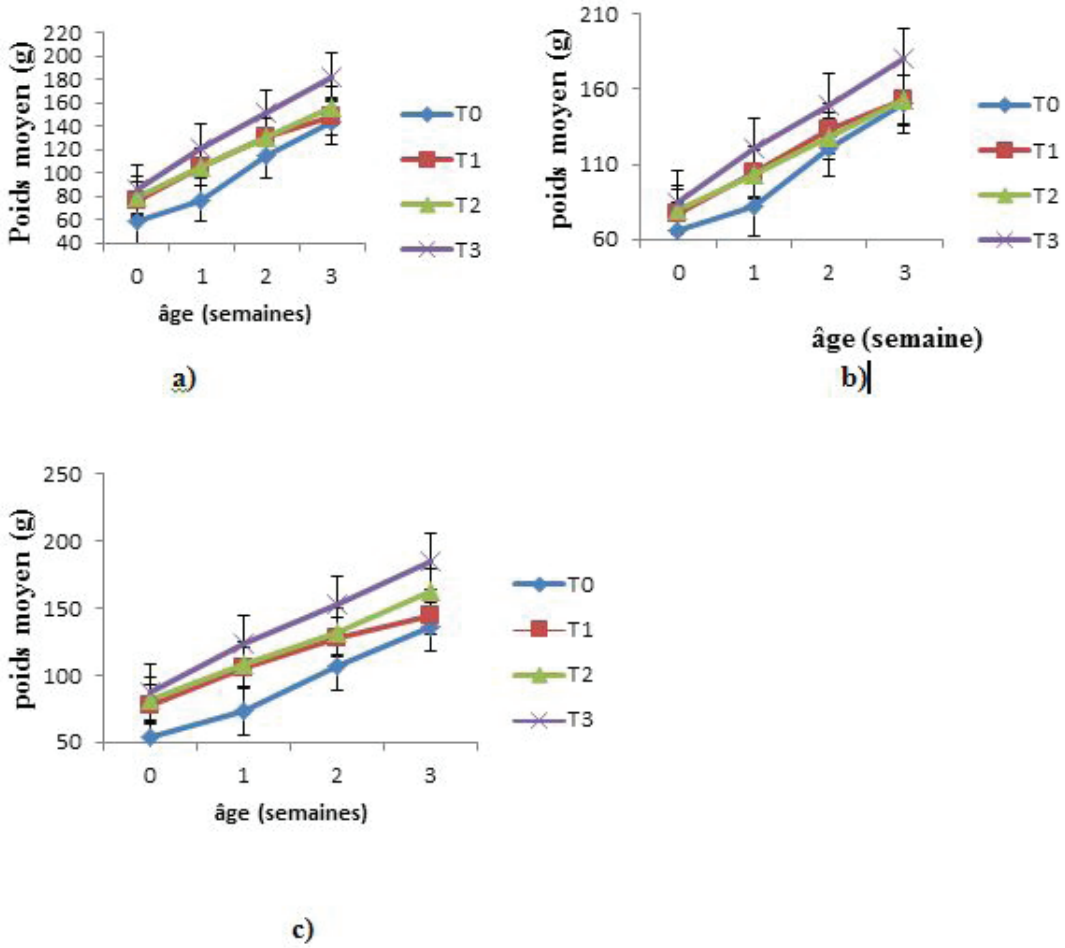

Figure 4: Courbes cumulatives des poids moyens a) des jeunes cochonnets b) des jeunes mâles et c) des jeunes femelles de la naissance au sevrage, en fonction des sources de protéines de la ration des cochons d'indes nourris au *Pennisetum purpureum*

les gains totaux de 81,74; 66,15; de 80,20 et de 97,34 g respectivement pour les lots T0, T1, T2 et T3 ont été obtenus au cours de cette période. Les traitements T0, T1, T2 et T3 ont conduit respectivement à 60,28; 45,85; 49,45 et 52,57% de croissance pondérale.

Gains de poids des cochonnets de la naissance au sevrage

Les poids des cochonnets à la naissance ou au sevrage et les gains totaux ont été significativement ($P < 0,05$) influencés par la variation des différentes sources de protéine (Tableau 3). En effet, chez le mâle le traitement T3 (65,50g) a permis d'obtenir le poids à la naissance significativement ($P < 0,05$) le plus élevé mais, statistiquement comparable ($P > 0,05$) à ceux des traitements T1 (76,67g) et T2 (79,19g). Par contre, le traitement T0 (65,50g) à permis d'obtenir le poids à la naissance significativement ($P < 0,05$) le plus faible mais, comparable ($P > 0,05$) à celui obtenu par le traitement T1. Avec les femelles, la tendance était la même pour le traitement T0 (53,86g) et T3. Cependant, les poids moyen à la naissance obtenus avec les traitements T1 (78,14g), T2 (82,00g) et T3 (87,83g) sont restés statistiquement comparables ($P > 0,05$) entre eux. Indépendamment du sexe, la tendance était la même que chez les femelles.

Quelquesoitlesexeouindépendamment

du sexe, le gain total significativement (P < 0,05) le plus élevé (95,09g) a été obtenu avec la ration T3 contenant D. intortum et le plus faible (73,75g) avec le traitement T1 contenant A. glabrata. Dans l'ensemble, quelque soit le sexe, ou indépendamment du sexe, les gains de poids significativement les plus élevés ont été obtenu avec le traitement T3.

Que ce soit chez les mâles ou chez les femelles, aucune différence significative (P > 0,05) n'a été observée entre les GMQ des animaux des différents lots, bien que les GMQ les plus faibles ont été obtenus avec les cochonnets du lot T1 chez les mâles et To aussi bien chez les femelles qu'indépendamment du sexe. Avec le traitement T0 le poids des mâles est resté supérieure à celui des femelles quelque soit l'âge des animaux. Par ailleurs, la tendance contraire a été observée avec les traitements T2 et T3. Mais, aucune différence significative (P > 0,05) n'a été observée entre les traitements autant à la naissance qu'au sevrage

Les gains de poids au sevrage ont été supérieures chez les mâles que chez les femelles pour les rations T0 et T1. Mais, la tendance inverse a été observé pour les traitements T2 et T3. Cependant, aucune différence significative (P > 0,05) n'a été observée entre les sexes quelque soit le traitement pour ce qui est des gains totaux

Gains de poids des cochonnets nourris au P. purpureum de la naissance au sevrage en fonction des traitements et du type de naissance

Les poids des cochonnets à la naissance ou au sevrage et les gains totaux ont été significativement (P < 0,05) influencés par la variation des la source de protéine pour chaque type de naissance (Tableau 4). En effet, avec les naissances simples, le traitement T0 a donné des poids à la naissance significativement (P < 0,05) les plus faibles (62,29g) et, le traitement T3 ceux les plus élevés (97,14g).

Avec les naissances simples le traitement T3 a permis d'obtenir le poids à la naissance (196,43g) significativement (P < 0,05) le plus élevé. Avec les naissances doubles, Le traitement T0 a donné le poids moyen à la naissance significativement (P < 0,05) le plus faible (136,00g) et T3 la valeur la plus élevée (173,33g).

Les gains totaux (99,29g) et les GMQ (4,73g) des animaux pour les naissances simples, significativement (P < 0,05) les plus élevés ont été obtenu avec le traitement T3 et, les plus faibles (70,63g et 3,36g respectivement pour le gain total et le GMQ) avec le traitement T1.

Pour les naissances doubles, la tendance était la même qu'avec les naissances

Tableau 3: Gains totaux et gains moyens quotidiens des cochonnets de la naissance au sevrage, en fonction des rations alimentaires chez les cobayes nourris au *P. purpureum*

Paramètres		**Traitements**				**ESM**	**P**
		T0	**T1**	**T2**	**T3**		
Poids à la naissance (g)	Male	65,50^{b}	76,67^{ab}	79,29^{a}	85,00^{a}	2,40	0,039
	Female	53,86^{b}	78,14^{a}	82,00^{a}	87,83^{a}	4,07	0,006
	Male et Female	59,23^{b}	77,31^{a}	80,42^{a}	86,00^{a}	2,22	0,000
Poids au sevrage (g)	Male	150,33^{b}	152,75^{b}	153,14^{b}	180,09^{a}	3,37	0,005
	Female	135,60^{b}	144,29^{b}	162,20^{ab}	185,17^{a}	5,99	0,008
	Male et Female	143,64^{b}	148,80^{b}	156,92^{b}	181,88^{a}	3,39	0,000
Gains totaux (g)	Male	84,83^{b}	73,75^{c}	76,00^{bc}	95,09^{a}	2,134	0,520
	Female	75,40^{b}	66,14^{b}	80,20^{b}	97,33^{a}	2,610	0,880
	Male et Female	80,55^{b}	70,20^{c}	77,91^{bc}	95,88^{a}	1,619	0,474
GMQ (g/j)	Male	4,04^{a}	3,51^{a}	3,62^{a}	4,53^{a}	0,102	0,520
	Female	2,56^{a}	3,15^{a}	3,82^{a}	4,63^{a}	0,124	0,880
	Male et Female	3,25^{a}	3,34^{a}	3,71^{a}	4,57^{a}	0,077	0,474

^{a} : Les moyennes portant les mêmes lettres sur la même ligne ne sont pas significativement différentes au seuil de 5%.; GMQ: Gain moyen quotidien ; ESM : Erreur Standard sur la Moyenne; Prob : Probabilité.

Tableau 4: Poids à la naissance, poids au sevrage, Gains totaux et gains moyens quotidiens des jeunes cobayes pré-sevrés en fonction des rations alimentaires des types de naissance (simple ou double) chez les cobayes nourris au *P. purpureum*

Paramètres		**Traitements**				**ESM**	**P**
		T0	**T1**	**T2**	**T3**		
Poids à la naissance (g)	Simple	62,29^{b}	89,88^{a}	92,57^{a}	97,14^{a}	3,11	0,000
	Double	55,67^{b}	64,75^{b}	59,33^{b}	76,90^{a}	2, 21	0,000
Poids au sevrage (g)	Simple	150,00^{c}	160,50^{bc}	172,29^{b}	196,43^{a}	4,50	0,000
	Double	136,00^{b}	135,43^{b}	135,40^{b}	173,33^{a}	4,39	0,000
Gains totaux (g)	Simple	84,00^{b}	70,63^{b}	79,71^{b}	99,29^{a}	2,91	0,001
	Double	76,40^{b}	69,71^{b}	74,75^{b}	94,67^{a}	2,79	0,000
GMQ (g/j)	Simple	3,43^{b}	3,36^{b}	3,80^{ab}	4,73^{a}	0,19	0,034
	Double	3,03^{b}	3,32^{b}	3,56^{ab}	4,51^{a}	020	0,011

$^{a, b}$: Les moyennes portant les mêmes lettres sur la même ligne ne sont pas significativement différentes au seuil de 5% ; GMQ: Gain moyen quotidien ; ESM : Erreur Standard sur la Moyenne; P : Probabilité.

simples à l'exception du traitement T0 qui a donné le GMQ significativement (P < 0,05) le plus faible par rapport aux autres traitements. Quelque soit l'âge et la ration, les animaux issus des naissances simples ont été plus lourds que ceux des naissances doubles

Discussion

De la mise-bas au sevrage, le poids moyen hebdomadaire de toutes les femelles allaitantes a baissé. Ces résultats sont en accord avec les observations de Pamo et al. (2005), de Noumbissi et al. (2013) et de Mweugang et al. (2014). En effet, au cours de la lactation, la mère dépense beaucoup d'énergie pour la production du lait (Michel et Bonnet, 2012) et non seulement ses besoins nutritionnels pendant la lactation sont souvent difficiles à couvrir, mais elle doit en plus fournir beaucoup d'efforts pour couvrir la demande des petits (Laurien-Kehnen et Trillmich, 2004). Par conséquent, elle doit, pour assurer la lactation, mobiliser ses réserves corporelles, ce qui expliquerait la perte de poids observée (Noumbissi *et al.,* 2013 ; Mweugang *et al.,* 2014).

A la naissance, les cochonnets soumis aux rations contenant les légumineuses étaient plus lourds que ceux du lot témoin. Ceci peut être attribué à la qualité des protéines reçue par leurs mères au cours de la gestation. Les cobayes étant des herbivores auraient mieux valorisé les protéines d'origine végétales. En effet, le cobaye est un herbivore monogastrique avec une forte capacité de consommation de fourrage (Dikko *et al.,* 2009). Selon Niraj et Vardhan (2012), la consommation des aliments entièrement d'origine végétale chez les cochons d'inde ralentis la digestion, permet une bonne absorption des aliments et un équilibre plus favorable des nutriments par calories lié à une bonne gestion de la croissance cellulaire. Un taux de protéines d'origine végétale de bonne qualité de 16% suffit à couvrir les besoins du cobaye à l'entretien (Boussarie, 2000). Par ailleurs, les protéines contribuent à l'accroissement du nombre et de la taille des cellules, entraînant ainsi la construction musculaire (Egena *et al.,* 2010). Pamo et al. (2005) et, Kouakou et al. (2012) ont fait les mêmes constats. Par ailleurs, les poids obtenus dans cette étude ont été comparables que ceux obtenus chez les cobayes par de nombreux auteurs (Manjeli *et al.,* 1998 ; Ngoupayou *et al.,* 1995 ; Niba *et al.,* 2009). Ceci montre que les rations utilisées dans cet essai se sont montrées intéressantes pour les femelles gestante.

Au sevrage, les poids des cochonnets dans tous les lots avaient doublé et même plus pour certains lots. Ceci serait associé à la rapide croissance pré-sevrage caractéristique des cobayes. En effet, le poids vif du cobaye est plus que doublé lors du sevrage normal à 3 semaines et il doublera une nouvelle fois au cours des 6 semaines suivantes (Cicogna,

2000). Des observations similaires ont été faites par de nombreux auteurs (Niba *et al.,* 2004 ; Pamo *et al.,* 2005). Le poids des jeunes du lot T3 (181,88g) était plus élevé que celui obtenu des cobayes sevrés au même âge, par Ngoupayou et al. (1995) (161 g) et Fonteh et al. (2005) (135 g) avec la supplémentation à la provende de type lapin. Ces poids étaient plus élevés que ceux obtenus par Noumbissi et al. (2013) (175,0g) chez les animaux supplémentés au T. diversifolia, par Tchoumboué et al. (2001) (173 g) avec la supplémentation à A. glabrata, par Niba et al. (2004) (173 g) et Niba et al. (2008) (152 g) avec la supplémentation au Desmodium spp. Cependant, il était inférieur à ceux obtenus par Tchoumboué et al. (2001) avec la supplémentation au D. intortum (195 g), par Pamo et al. (2005) avec la supplémentation au bloc multi nutritionnel (263 g), par Ngoupayou et al. (1995) en station en Italie (249 g) chez des cobayes dits "de race améliorée" et par Mweugang et al. (2014). Ces résultats montre que nos rations restent dans la marge des rations utilisables chez les cobayes.

A la naissance et au sevrage, aucune différence significative n'a été observée entre les poids des mâles et celui des femelles. Cette observation est en accord avec celles obtenus par Pamo et al. (2005) qui ont rapporté à la naissance et au sevrage des gains de poids respectifs de 4,95 et 5,38 g chez les femelles contre 4,45 et 4,61 g chez les mâles.

De manière générale, les animaux les plus lourds autant à la naissance qu'au sevrage étaient issus des naissances simples. Ces résultats sont en accord avec ceux de nombreux auteurs qui pensent que le poids à la naissance et au sevrage sont lié à la taille de la portée (Fotso *et al.,* 1995 ; Manjeli *et al.,* 1998 ; Tchoumboué *et al.,* 2001 ; Niba *et al.,* 2004). Ceci montre que plus la portée est nombreuse, moins les nouveau-nés pèsent.

Les gains de poids n'ont présenté aucune différence significative quelque soit la ration. Néanmoins, le GMQ le plus élevé a été obtenu des cochonnets du lot T3 (4,23 g/j) nourrit à la ration contenant D. intortum. Ce gain est supérieur à ceux observés par Kouakou et al. (2012) (1,9 g/j) chez les cobayes en élevage non complémenté, par Tchoumboué et al. (2001) (3,5 g/j) chez les cobayes supplémentés au D. intortum, par Noumbissi et al. (2013) chez les animaux supplémentés au T. diversifolia et Mweugang et al. (2014) avec les animaux supplémentés à la poudre des feuilles de manioc. Il est par ailleurs faible comparé aux GMQ obtenus par Tchoumboué et al. (2001) chez les cobayes supplémentés avec A. grabrata (4,5 g/j), par Pamo et al. (2005) chez les cobayes supplémentés au M. oleifera (5 g/j) et au bloc multi nutritionnel (7 g/j), par Kouakou et al. (2012) chez les cobayes supplémentés avec du granulé pour lapin (6,2 à 7,1 g/j). Ceci pourrait s'expliquer par la qualité nutritionnelle des différents suppléments utilisés par chacun des auteurs.

Conclusion

L'évaluation de quelques légumineuses comme source de protéine sur la croissance pré-sevrage des cobayes (Cavia porcellus L.) nourris au *Pennisetum purpureum* a montré que les légumineuses utilisées ont:

- induit l'amélioration des poids des femelles post-partum. En effet, de la mise-bas au sevrage, toutes les femelles allaitantes ont perdu du poids. Cependant, la perte a été moins importante chez les animaux des lots complémentés comparés à ceux du lot témoin ;
- amélioré significativement ($P < 0,05$) les poids des cochonnets de la naissance au sevrage. A la naissance et au sevrage, les mâles des lots nourris aux rations contenant les légumineuses ont significativement ($P < 0,05$) été plus lourds que les femelles. Au sevrage, les GT et les GMQ n'ont pas été significativement ($P > 0,05$) influencés par la complémentation. Par ailleurs, les mâles ont eu des meilleurs gains comparés aux femelles. Les animaux issus des naissances simples ont été plus lourds autant à la naissance qu'au sevrage que ceux issus des naissances doubles.

Arachis glabrata, Calliandra colothyrsus et *Desmodium intortum* peuvent être utilisé avec de bons résultats comme source de protéines

dans l'alimentation des cobayes surtout si elles sont associé au *P. purpureum*.

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PREVALENCE OF CAMEL *TRYPANOSOMOSIS* AND ITS ASSOCIATED RISK FACTORS IN MOYALE DISTRICT, BORENA ZONE, SOUTHERN ETHIOPIA

Isa Abdukadir, Nuraddis Ibrahim and Yosef Deneke
Jimma University, School of Veterinary Medicine

Abstract

A cross-sectional study coupled with questionnaire survey was conducted to determine the prevalence of camel *trypanosomosis* and assess associated risk factors in Moyale district, Borena Zone, Oromia region, southern Ethiopia from November 2014 to April 2015. Blood samples were collected from randomly selected 384 camels. Giemsa-stained blood smears were used for the detection of Trypanosomes infection. Out of 384 examined camels, 39 (10.2%) were positive for Trypanosoma evansi. There was statistically significant difference between age groups and trypanosome infection (P<0.05). Higher prevalence of the infection was recorded in Age group of >4 years (15.5%) followed by 3-4 years (5.6%) and < 3 years old camels (2.6%), respectively. A higher infection was found in males (15.6%) as compared to females (9.1%). However, there was no statistically significant difference in prevalence between sex categories (P >0.05). The prevalence was varied among study localities within the district revealing the highest prevalence in Bokola (14.3%) and the lowest (7.1%) in Lagasure. A questionnaire survey was administered to 45 respondents comprised of 80% of the interviewed camel herders were pastoralists while the rest were agro-pastoralists to assess knowledge, attitude and practices of the community about camel *trypanosomosis*. All respondents (100%) were familiar with the disease and knew the typical clinical signs of the disease. According to the respondents the cause and means of the transmission of the disease was by biting flies at congregation of camel herds around water and in pasture. About 88.9% of householders stated that the disease occurs at onset of major rainy season. All of them mentioned that the disease causes abortion. The present study revealed that camel *trypanosomosis* is prevalent in Moyale district at relatively low levels. Thus, there is need of further study with the use of more sensitive diagnostic tests in order to establish effective control measures.

Key words: Blood, Camel *trypanosomosis*, Moyale, Prevalence, Smear, Survey

LA PREVALENCE DE LA TRYPANOSOMIASE CHEZ LE CHAMEAU ET SES FACTEURS DE RISQUE DANS LE DISTRICT DE MOYALE, LA ZONE DE BORENA ET LE SUD DE L'ETHIOPIE

Résumé

Une étude transversale couplée d'une enquête par questionnaire a été menée de novembre 2014 à avril 2015, afin de déterminer la prévalence de la trypanosomiase chez le chameau et évaluer les facteurs de risque associés dans le district de Moyal□, la zone de Borena, la région d'Oromia et le Sud de l'Ethiopie. Les échantillons de sang ont été prélevés au hasard sur 384 chameaux. Des frottis sanguins colorés au Giemsa ont été utilisés pour la détection de l'infection par les trypanosomes. Sur 384 chameaux examinés, 39 (10,2%) étaient infectés du Trypanosome Evansi. Il y avait une différence statistiquement significative entre les groupes d'âge et l'infection trypanosome (P <0,05). La prévalence la plus élevée de l'infection a été enregistrée chez le groupe de chameaux donc l'âge respectivement est supérieur à 4 ans (15,5%), suivie de 3 à 4 ans (5,6%) et inférieur à 3 ans (2,6%). On a constaté une infection élevée chez les males (15,6%) comparé aux femelles (9,1%). Cependant, il n'y avait pas de différence statistiquement significative de la prévalence entre les catégories de sexe (P> 0,05). La prévalence variait entre les localités d'étude au sein du district révélant la plus forte prévalence à Bokola (14,3%) et la plus faible (7,1%) à Lagasure. Pour évaluer les connaissances, les attitudes et les pratiques de la communauté à propos de la trypanosomiase chez le chameau, une enquête par questionnaire a été administré à 45 répondants donc 80% des éleveurs de chameaux interrogés étaient des pasteurs tandis que le reste était des agropasteurs. Toutes les personnes

Corresponding Author: Nuraddis Ibrahim, Tel: +251-047111 6778, Mob: +251917808966.

interrogées (100%) étaient au courant de la maladie et connaissaient les signes cliniques typiques de la maladie. D'après les personnes interrogées, la cause et les voies de transmission de la maladie se faisaient par morsure d'insectes sur le troupeau de chameaux rassemblés autour de l'eau et en pâture. Environ 88,9% des ménages ont déclaré que la maladie se produit au début de la grande saison des pluies. Tous ont mentionné que la maladie provoque l'avortement. La présente étude a révélé que la trypanosomiase chez le chameau est très répandue dans le district de Moyale à des niveaux relativement bas. De ce fait, une étude plus approfondie avec l'utilisation de tests de diagnostic plus sensibles est nécessaire afin d'établir des mesures de contrôle efficaces.

Mots clés : le sang, la trypanosomiase chez le chameau, le district de Moyale, la prévalence, le prélèvement et l'enquête.

Introduction

The dromedary camel (*Camelus dromedarius*) is well adapted to hot and arid environments prominent to its unique anatomical, physiological and behavioral characteristics. Dromedaries offer the only means of utilizing large areas of arid lands in many countries around the globe (Bornstein and Younan, 2013). The camels are of great importance socially and culturally as well as economically and thus cornerstone in the social organization of many of the camel-keeping societies (Wako *et al.,* 2012). As the world expects increased global warming, the camel would perhaps be the most favored animal to develop (Ahmed *et al.,* 2010).

World Camel population is estimated to be around 25.89 million spread across 47 countries. About 85% of the camel population inhabits mainly Eastern and Northern Africa and rest in Indian subcontinent and Middle East countries. Somalia has the highest population of 7 million followed by Sudan 4.25 million and Ethiopia 2.4 million camels (FAO STAT, 2011). In the Ethiopia camels are kept in arid and semi-arid lowlands of Borana, Somali and Afar region (Teshome *et al.,* 2003).

According to Hukka (1998) the Borana pastoralist probably started camel production in early 1560 in the gedda period of Abbay Orro. It has been also speculated the Muslim Gebra communities were said to the instrumental in introducing camels to the Borana plateau (Coppok, 1994). Camel husbandry is the main source of living for millions of pastoralists in the semi-arid zones of Ethiopia, including the Borana lowland. Undoubtedly, camels represent a vital contribution to food security and human welfare in vulnerable households of the dry areas. They are important for milk and meat productions, transportation, draft power, and household income generations. They possess several attributes as; minimum contribution to environmental degradation, utilization of scarce natural resources (feed and water), minimum competition with other ruminants and good adaptation to harsh environment (Megarssa, 2010).

However, infectious and parasitic diseases appear to be the major constraints for the realization of the full potential of these animals. *Trypanosomosis*, camel pox, pneumonia, contagious skin necrosis, mange mite infections and internal parasite are among the major health problems previously reported in camel Borana areas (Getahun, 1998).

There are many parasites that affect the productivity of camel of which the Trypanosoma evansi, the protozoan parasitic cause of camel *trypanosomosis* (Surra), constitutes one of the major veterinary problems worldwide (Omer *et al.,* 2004). T.evansi is transmitted mechanically, non-cyclically, by haematophagus flies such as horseflies (Tabanus) and stable flies (Stomoxys) which are endemic in Africa, Asia and South America; although in America the vampire bat also acts as a vector as well as reservoir hosts (Urquhart *et al.,* 1996).

The disease is an important single cause of economic losses, causing morbidity of up to 30.0% and mortality of around 3.0% camels in Ethiopia (Njiru *et al.,* 2001; Tekle and Abebe, 2001). The cost of treatment is also another economic loss to the camel breeders in particular and to the nation's economy in general (Tekle and Abebe, 2001). In Ethiopia, the occurrence of Surra reported

as it has been associated with camel rearing areas (Tekle and Abebe, 2001; Getachew, 2005; Bogale *et al.,* 2012). However, there is no documented information about the prevalence of camel *trypanosomosis* in the study area. And therefore, the objectives of the present study were to determine the prevalence of camel *trypanosomosis* and to identify the associated risk factors with disease occurrence in the study area.

Materials and Methods

Description of the Study Area

The district of Moyale is geographically located 3° 34' 9N and 39° 4' 60E at a distance of 777km south of Addis Ababa. The area is bordered on the south by Kenya, on the west by Dire, on the northwest by Arero, on the north by the Dawa River which separates it from Liben, and on the east by the Somali region. The agro-ecology is lowland or kola with topography consisting predominantly of plains. The vegetation coverage consists of thorny bush scrub, acacia species and bush encroachment. The altitude ranges from 1150 to 1350 m.a.s.l. Moyale district comprised of 9 pastoral and 8 agro-pastoral associations (kebeles). Approximately, there are about more than 700,896 human populations (CSA, 2008) living in it with an estimated area of 15,575.47 square kilometers. Livestock population of the district were Cattle (55134), Goats (64995), Sheep (14725), Poultry (27252), Camels (16998), Donkey (4912), Mule (27) and Horse (10) (MPCDO, 2014). Numerically camels are the most abundant domestic animals in these areas next to cattle and small ruminant and thus they have crucial contribution in social and economic aspect of agro-pastorals and pastoral livelihood of this area (MCPDO, 2014). The climate of Moyale is generally tropical climate, with little rainfall throughout the year with the annual rain fall is estimated at 500 – 600mm. The temperature is very hot with an average of 37°C and reaching as high as 41°C. The driest month is August with 13 mm and with an average of 189 mm most precipitation falls in April. July has the lowest average temperature of the year with only 19.9 °C.

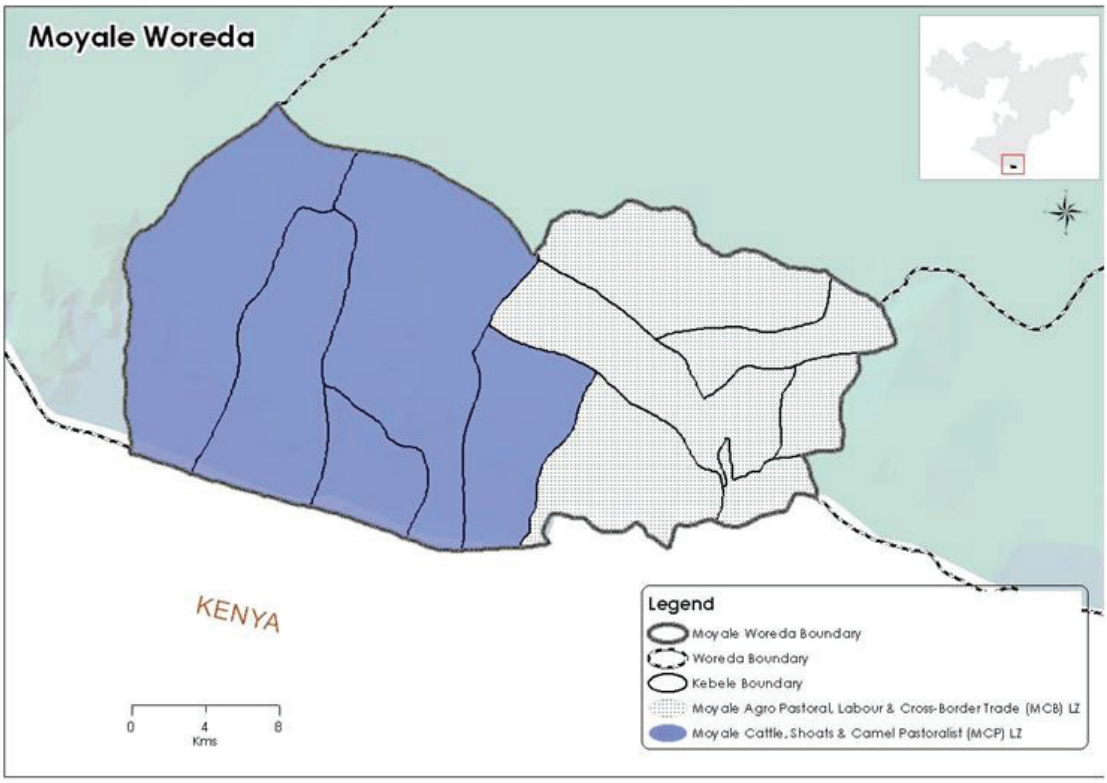

Figure 1: Maps showing study area

The area is characterized by arid and semi-arid lowlands with some mid-altitude areas. The semi-arid lowlands are predominantly occupied by pastoral and agro-pastoral population whose livelihood is mainly dependent on range livestock production. The area receives bimodal rainfall distribution. The main rainy season (Ganna) extends from March to May whereas the short rainy season (Hagaya) lasts from October to November followed by the long dry season (Bonaa). However, the actual length of the rainy season is getting shorter and shorter through time and the area is prone to more frequent drought.

Study Population

The study population consisted of camels of all age groups and both sex residing in Moyale district that are reared under extensive husbandry system. All study animals were randomly selected from the population at livestock camps ("Fora"), at grazing and watering points. The age of the animals was recorded based on information from the owners during sampling. Camels below 3 years of age were considered as calves, those between 3-4 years as young animals, while those above 4 years of age were considered as adults according to the owners of camels.

Study Design

A cross-sectional study design was carried out to determine the prevalence of camel *trypanosomosis* and assess associated risk factors in the study area. CAHWS were used as channel to reach camel owners and camel population in the villages. Herds were visited and sampled early in the morning before released to the field, and the samples were processed there immediately to make smear. Simple random sampling was used to select each sampled camel. Pre-tested semi-structured questionnaires were used to assess the knowledge, attitudes and practices of camel owners with regards to camel *trypanosomosis* by considering average population and giving equal chance of both agro-pastoral and pastoral communities in districts. A total of 10 villages were selected from 5 pastoral and agro-pastoral associations (communities), mainly Dambi, Bokola, Maddo, Laga-sure and Malab were included in the study. The villages were selected randomly, but with some restrictions on the selection imposed based on accessibility to villages by vehicle or proximity to road and camel population.

Sample Size Determination

The number of animals to sample was calculated considering a minimum expected prevalence of 50%, an accepted error of 5% and a confidence level of 95%, since there was no previous survey conducted in the study area. Therefore, the sample size for this study was determined using the following formula by Thrusfield (2005):

$N=1.962P_{exp}(1-P_{exp})\ /d2$ which is equal to 384 where,

N=Sample size,

P_{exp}= expected prevalence.

Hence, a total of 384 one humped camels of different ages and both sexes were randomly selected from herds in this study.

Blood sample collection.

After animals were restrained by owners whole blood samples (5ml) were collected from jugular vein of 384 camels into heparinized vacutainer tube 5 ml Ethylene Diamine Tetra-acetic Acid (EDTA) coated vacutainer tubes, after proper disinfection of the site with 70% alcohol and then samples were labeled on species, identification number, sex, age and village and immediately kept in cooler box and transported immediately to the Yabello Regional Veterinary parasitology laboratory for examination. Parasitological examination of blood samples was conducted using Giemsa stained thin blood smears and examined (Uilenberg, 1998).

Questionnaire survey

Questionnaire data were collected from camel herders at the wells and dwelling areas of pastoral and agro-pastoral associations and temporary livestock camps ("Fora"). Semi-structured questionnaire was used for 45

camel owners and asked to obtain information on the herd size, year of possession (how long herder experienced with the camel), seasonal occurrence of the disease in the herds and associated risk factors, types of livestock grazed together with camels as well as camel management and husbandry practices, herd movement, feeding and water source, camel diseases of importance, *trypanosomosis* situation and *trypanosomosis* control measures.

Data collection and analysis

The data collected during sampling and laboratory results were entered in Microsoft Excel spread sheet. Descriptive statistic was used to estimate the prevalence for camel *trypanosomosis* in the study area. Risk factors such as age, sex and study areas were considered and their difference with infection was analysed by chi-square. In all the analyses, confidence level will be held at 95% and P<0.05 was set for significance. The statistical software SPSS version 20 was used for data analysis.

Results

Results of Laboratory Analysis

Of the total 384 blood samples collected and examined 39 (10.2%) samples were positive for T. evansi. Of the total camels examined 10 (15.6%) males and 29 (9.1%) females were positive for camel *trypanosomosis* and with statistically non-significant variation (P>0.05) (Table 1).

There was significant difference in prevalence of parasites with age (P< 0.05) of the camels observed. Highest trypanosome infection was recorded in age group of >4 years (15.5%), followed by 5.6% and 2.6% in 3 to 4 years and <3 years old camels, respectively (Table 2).

Table 1: Prevalence of T. evensi based on sex

Sex	No. of examined	No. of positive	Prevalence	X^2	P-value
Male	64	10	15.6%	2.517	0.113
Female	320	29	9.1%		
Total	384	39	10.2%		

Table 2: Age-wise prevalence of T.evansi infections in camels

Age	No. of examined	No. of positive	Prevalence	X^2	P-value
<3 years	76	2	2.6%	13.480	0.001
3-4 years	108	6	5.6%		
>4 years	200	31	15.5%		
Total	384	39	10.2%		

Table 3: Prevalence of T. evansi among PAs (kebeles) in the study area

Kebeles (PAs)	No. of animals examined	No. of positive	Prevalence%	X^2	P value
Bokola	105	15	14.3%		
Dambi	83	9	10.8%		
Maddo	73	6	8.2%	3.397	0.494
Laga-sure	70	5	7.1%		
Malab	53	4	7.5%		
Total	384	39	10.2%		

There was statistically non-significant variation (P>0.05) in *trypanosomosis* prevalence among the five PAs of Moyale district (Table 3). In this study, Trypanosoma evansi infection was found in all the five examined PAs of the district. The prevalence was found to be different among camels from different PAs, the highest being 14.3% in Bokola, 10.8% in Dambi, 8.2% in Maddo, 7.5% in Malab and 7.1% in Lagasure (Table 3).

Questionnaire Survey Results

In this study, number of households surveyed was 45 from which 80% of them were from the pastoral communities and the rests were agro-pastoralists area. The householders age ranges from 25-70 years and the majority (75.6 %) of them were illiterate. The survey result indicated that all householders have more than 5 years of camel herding experience and about 46.7% of them have herded camel for more than 25 years, 24.4% of them herded camel for the past 15 to 20 years and 4.4% of them have herded camel for less than 5 years (Table 4). And also, average possession of the camels is 40 with range of 5-80 numbers of camels.

Householders awareness on camel Trypanosomosis

A 100% of the herders mentioned that they knew camel *trypanosomosis* which they call "Dhukkaana" in their vernacular name. They described the disease accurately and ranked as a disease of first priority in camel. They thought that biting flies are important vectors for camel *trypanosomosis* to occur. They mentioned that camel contract the disease when moved to other place for long distance and get mixed with camels from neighboring herds (Golbo). The herder added that congregation of camel herds around water and in pasture into close proximity facilitated efficient transmission of the disease by the biting flies.

Further, on the assessment of the route of migration, it claimed that it depend on season as the camel prefers the dry ecology instead of wet ecology. So, their movement depend on season that routed to Golbo and Forole Southern ward of district during dry seasons ("Bona and Adolessa") and Northern ward during wet seasons ("Hagayya and Ganna"). With regard to abortion all of the herders mentioned that camel *trypanosomosis* causes abortion in pregnant animal. About 74.2 % of the herders mentioned that abortion occurs in mid-gestation (130-260days) and 15.6% stated that it occurs in late gestation (261-360 days). Small number (10.2%) of herders believe occurrence of abortion in

Table 4: Demographic characteristics of camel owners

Parameter	Frequency	Percentage
Categories of pastoral association (PA's)		
pastoral	36	80%
agropastoral	9	20%
Age of the herders		
25-50	11	24.4%
>50	34	75.6%
Householders education level		
Illiterate	34	75.6%
Primary	11	24.4%
Experience of herding the camels		
<5	2	4.4%
5-10	4	8.9%
10-15	7	15.6%
15-20	11	24.4%
>20	21	46.7%

Table 5: Local and scientific name of major clinical signs mentioned by camel herders.

Local name of clinical signs	Scientific names of clinical signs and symptoms
Nyaata dhowwa	Inappetance
Rifeensi irra dhuma	Loss of hair
Ni dadhabsa	Weakness
Ni huuqqata	Emaciation
Aannan diqqeessa	Reduction in milk yield
Ni salleessa	Abortion
Imimmanti ijaa yaa'a	Lacrimation
Morma dheeressa	Stretching of neck
Fincaan fooli qaba	Urine odour
Ni golgolaa'a	Depression
Ogore ajjeesa	Death in calves

early gestation (<130 days). Moreover, all the interviewed camel herders mentioned that the disease causes dramatically reduction in milk production.

The questionnaire was designed to extract specific information on camel *trypanosomosis*, its occurrence in their herds and also the typical clinical signs of the disease. The camel herders mentioned the clinical signs of the disease (Table 5).

The majority (88.9%) herders stated that the disease occurs at onset of major rainy season ("Ganna") extending from March to May, the herder added that they relate between seasonal outbreaks of camel *trypanosomosis* and increase in number of insect flies responsible for disease transmission during the rainy season. However, 11.1% argued as the disease happen mostly at the onset of warmer dry season ("Bona") from December to February of the year. These respondents mention the reason for the occurrence of the disease during the dry season, because camels are usually in stress suffer from low plane of nutrition and trek for long distances in search of water and pasture.

Based on evaluation those practicing the isolation of the infected camels from those uninfected camels, only 24.4% herders mentioned that they separate camel suffering from camel *trypanosomosis* from healthy camels.

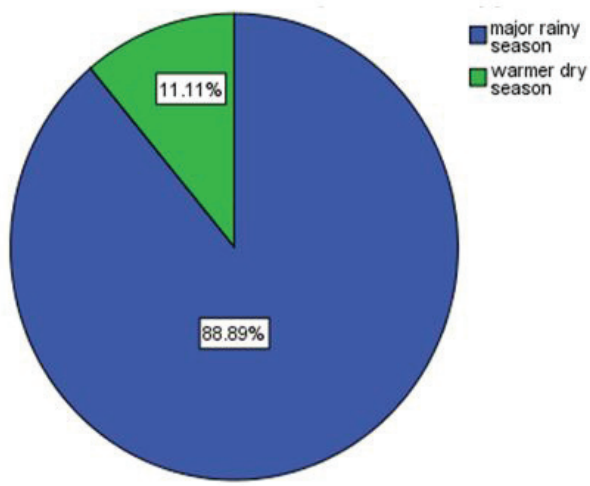

Figure 2: Season of the year for disease occurrence in the study area.

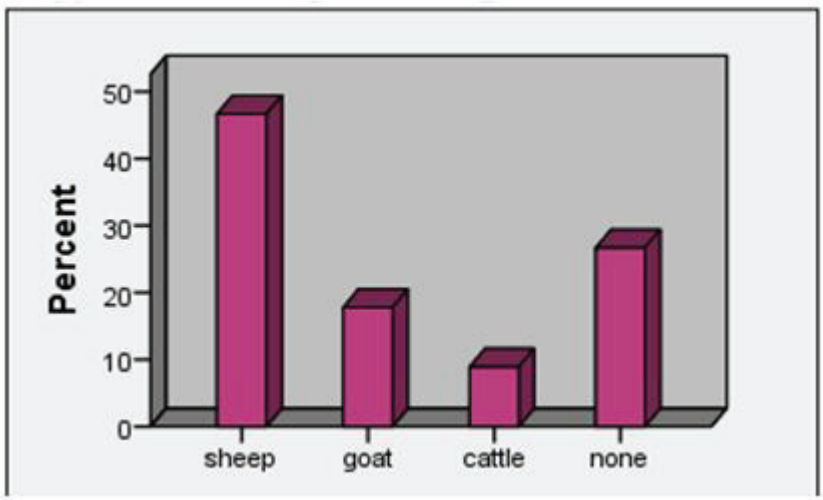

Figure 3: Type of animal grazed together with camel.

The rest 75.6% responded that they don't practice isolation of diseased animal from the healthy one due to the requirement of extra penning during night.

Also, 73.3% of camel herders responded that they mix camel with other livestock species particularly with goats and sheep during herding.

A 60% of the herders respond that they keep camel calf together with adult camel in night penning and the rest 40% of the respondent isolate calf camel from adult camel at night penning. 71.1% of the herders responded that they herd camel calf together with adult camel during herding and only 28.9% of the herders isolate camel calf from adult during herding.

All herders mentioned that no veterinary intervention was taken by government and other non-governmental organizations as option to control the occurrence of the disease in their herds and their camel received poor attention from district veterinary services unlike other livestock species in the same area. Additionally, the majority (75%) of herders mentioned that veterinary health post was very far away from their villages and on average it took 3 hours to reach a nearby livestock health clinics and posts. They added that this situation forced them to look for other options and 77.8% of them said that they buy drug from market and administer drug by themselves and 22.2% of the herders use the traditional remedy. The herders mentioned that the traditional remedy which involved the application of a concoction of herbs, mixed with soup and the branding of oedematous areas on sick animals using hot metal. They believe that this subsides the swelling.

Discussion

The overall prevalence of 10.2% recorded in the current study interestingly, in agreement with the investigations made by Getahun (1998) and Tekle and Abebe (2001) who recorded 10.2% and 10.9% of prevalence of camel *trypanosomosis* in Liban district, Borena Zone and Southern range land of Borena, respectively. This might be due to the same agro-ecological condition of the study area. The current finding was also in consistent with that reported by Hagos et al. (2009) who obtained 12.1% prevalence of camel *Trypanosomosis* by using parasitological examination in dry and wet areas of Bale Zone. This might be associated with the season of the study period and sensitivity of the diagnostic techniques used. From abroad country of Pakistan and Saudi Arabia the current results are parallel with the investigations made by Bhutto et al. (2010), Shah et al. (2004) and Hussain et al. (1991) who reported 11.25%, 10.9% and 13.2% prevalence of camel *trypanosomosis*, respectively.

The present result was higher compared with the investigations made by Kassa et al. (2011), Tadesse et al. (2012) and Eshetu et al. (2013), who reported 4.4%, 3.5% and 6.5% prevalence in Fentale district South East Shoa Zone, Jijiga Administrative Zone of the Ethiopian Somali Region and Jijiga Administrative Zone of the Ethiopian Somali Region, respectively. This may be due to type of test used, appropriate technique used during sampling and appropriate procedure used. This result is also higher compared with report in the Punjab region of Pakistan in camels (Murtaz *et al.,* 2006) who reported the prevalence of 3.3% and 4% from parasitological and serological examinations, respectively.

However, the present finding was lower than the previous study of Abera et al. (2014) and Bogale et al. (2012) who reported 17.9 % and 18.22% prevalence at Sawena district and Delo-Mena District of Bale Zone, Oromia Region, Southwest Ethiopia, respectively. The prevalence in the current study is also lower than the findings by previous workers who reported a prevalence of 21% in eastern Ethiopia, in selected semi-nomadic household (Zeleke and Bekele, 2001), 28% in Kenya (Njiru *et al.,* 2001), 29% in Niger (Pacholek *et al.,* 2001) and 33% in Sudan (Elamin *et al.,* 1999). The possible explanation for the lower prevalence rate detected in this study might be related to distribution, challenge and density of parasite vector. The current study was also conducted during the dry season where the distribution of biting flies is very low in this dry season as their reproduction is high in rainy season.

In this study, a significantly ($P< 0.05$) higher prevalence of camel *trypanosomosis* was noted in adult camels (15.5%), followed by young ones (5.5%) and calf less than 3 years old (2.6%). This result agrees with a previous report from Jijiga, Somali Region, Ethiopian, who reported that in adult camels above 4 years old had a significantly higher prevalence of infection as compared to the young ones below 4 years old (Eshetu *et al.,* 2013). The current result is in line with that of Abera et al. (2014) in bale zone in which higher infection rate was recorded in camel above 4 years. Similar suggestion was also given in the study in Saudi Arabia who reported that the younger were less susceptible to infection than adults (Mohammed and Bernard, 2013). The higher prevalence in old camels might be due to they move long distance in search of water and pasture as a result they are more exposed to biting flies and many stress impose them more susceptible to the infection. This idea is supported by Bogale et al. (2012), who reported the higher prevalence in old camels might be due to heavy stress through their use for transportation of goods from one place to another and poor management.

Our result is in close agreement with the report of Atarhouch et al. (2003) who showed that the infection rate of camel *trypanosomosis* increased with age up to maximum in the 7-10 years old age. However, this result is reverse to the observations of Lemecha et al. (2008), who reported a higher prevalence in young compared to adults by using standard parasitological detection techniques. The present study was contradicted with that of Pathak and Khanna (1995), who reported that all camels were equally susceptible to trypanosome infection regardless of breed and age. A greater proportion of the herders (60%) keep camel calf together with adult camel both in penning and during herding. This practice considered as risk for camel *trypanosomosis* spread within and between herds from adult to susceptible young animals. Separately keeping animals with different age structure is useful not only to prevent camel *trypanosomosis* transmission but also for other contagious diseases. In addition, lack of isolation of infected from non-infected camels in herding and penning puts the majority of the herds at risk of developing the disease sooner or later.

In the present study, there was no statistically significant difference observed between sex and the disease ($P>0.05$). This might be due to all camels were equally susceptible to trypanosome infection regardless of breed and sex (Pathak and Khanna, 1995). However, the highest prevalence of the disease was recorded in male (15.6%) than female (9.1%). This might be due to the fact that male camel were used for work all the time and travel from one place to another place to provide

transportation service more than female camels, so that they have a higher probability of acquiring an infection. Frequent travel could also compromise their immune response to infection due to the stress of fatigue.

The present study is in agreement with the finding of Abera et al. (2014) who recorded higher infection rate in male (20.3%) than female (17.3%). Similarly, Bogale et al. (2012) in Delo-Mena district, Bale zone also reported on sex related differences in prevalence of camel trypanosomes, that a higher infection was found in males (20.25%) as compared to females (17.72%). However, other studies in Asia have reported sex related differences in prevalence in camels (Shah *et al.,* 2004) where females (15.68%) were observed to be more susceptible to the disease than males (11.76%) counterparts. The current study was also contradicted with report from the same continent, Pakistan who reported a higher infection was found in females (15.79%) as compared to males (9.84%). This record might be due to stress during pregnancy and lactation which could decrease resistance in female camel and render them more susceptible to infection (Bhutto *et al.,* 2010).

In the present study, there was no statistically significant difference observed between the prevalence of camel trypanosomes infection among the sites (PAs) of district ($P>0.05$). The prevalence was different among different sites of the district; the highest prevalence of the disease was observed in Bokola 15 (14.3%), followed by Dambi 9 (10.8%) and Maddo 6 (8.2%) whereas the lowest was recorded in Malab 4 (7.5%) and Laga-sure 5 (7.1%) during the study period. This might be due to the difference in management system and vector density.

The majority of Moyale district camel herders have 16-20 years of herding experience indicating that they start camel production relatively recently and they are traditionally cattle keepers and camels are a relatively new introduction. On average, a camel owner possesses 40 camels with range of 5-80 heads of camels. Recent starting of camel production may create gap in the herd and health management. In line with this, Megarsa et al. (2008) stated that late comers into camel business, such as Borana and Guji have less experience with dromedaries and acquired less adequate traditional knowledge and difference in camel herding strategies that has already been demonstrated to influence some production parameters may also result in variations in disease occurrence.

It was evident from this study that all of the herders are aware of camel *trypanosomosis* which they call 'Dhukkaana' in their vernacular. They described the disease accurately and ranked it as a disease of first priority in camels. This shows the camel *trypanosomosis* is very important disease in the area from the past to nowadays and continues to pose a significant impact on the livelihood of pastoral communities. All of the herders deeply explain the possible further transmission factors of the disease.

All of the interviewed herders knew the role of insects (biting flies) such as stomoxy and tabanid spp as mechanical transmitters of camel *trypanosomosis* which are abundant during rainy seasons. In addition, the informants were able to link increased cases of infection to a build-up of the biting fly population. It is known that biting flies play an important role in the transmission mechanisms of camel *trypanosomosis* (Evans *et al.,* 1995; FAO, 2000). They mentioned that camel contract the disease when travel to other place for long distance and get mixed with camels from neighboring herds of Golbo. This idea is supported by Bossche and Vale (2000), who reported that management factor and movement patterns of animals may lead to increased risk of developing infection. The herders added that congregation of camel herds around water and in pasture into close proximity facilitated efficient transmission of the disease by the biting fly. This idea is supported by Luckins (1988), who reported that local epidemics of infection occur where conditions exist for the spread of infection with T. evansi, such as when many animals are stabled together or close herded and particularly when the biting fly population is abundant during the wet season.

During this study, all herders were able to mention two or more of the typical clinical

signs and symptoms of camel *trypanosomosis*. The herders recognized camel *trypanosomosis* through signs of emaciation, stretching of neck, dullness and urine odour, while few of them observed other signs of camel surra in addition to these signs. Furthermore they describe the sign of fever, innapetance, weakness and depression. Similar suggestion was given by Bogale et al. (2012), who reported that camel *trypanosomosis* causes anorexia, weakness and emaciation that lead to low milk and meat yield, poor traction power, increased abortion and death. These results were an indication of an enormous wealth of knowledge herders possess on the diseases. In another study by Catley et al. (2001), loss of tail hair was also mentioned by herders as a sign of camel *trypanosomosis*. Moreover all of the herders mentioned that camel *trypanosomosis* causes abortion in pregnant animal. This is in line to the study in the Middle East and Africa which was reported that Camel *trypanosomosis* is one of the main causes of camel infectious abortion (Tibary *et al.,* 2006). Furthermore, herders added that camel *trypanosomosis* induced abortion at any stage of gestation. In line to this Zelalem et al. (2015) reported camel *trypanosomosis* cause abortion in all stages of pregnancy in camel.

With regard to their routes of movement, they mentioned that the majority of migrations of owners and their animals are seasonally to southern ward and northern ward of the district. They move to Southern ward of district during dry seasons ("Bonna and Adolessa") and Northern ward during wet seasons ("Haggaya and Ganna"). The reasons for that might be lack of water and grazing and biting insects in certain season and area according to the owners of camels. This movement put their animal on extra risk of contracting the disease from another district and neighboring of the Golbo, Gabra and Garri. This idea is in line with report of Macpherson (1995) who explained the transhumance by seasonal movement of livestock has profound effect on the epidemiology and spread of this disease in Africa. With regard to frequency of occurrence of disease most of the herders mentioned that the disease affects their herds only once a year and some of them mention that the disease affect their herds twice a year.

With regard to the temporal occurrence of the disease, majority of the herders mentioned that the disease mainly occur in major rainy season ("Ganna"). The herder added that they relate between seasonal outbreaks of infection and increase in number of insect flies responsible for disease transmission during the rainy season. This finding is in line to Surveys in various tropical areas have shown a definite correlation between seasonal outbreaks of Trypanosoma evansi infection and increase in number of flies responsible for disease transmission during the rainy season (Mahmoud and Gray, 1980; Njiru *et al.,* 2002). A good number of the herders reported occurrence of disease during dry season ("Bona") of the area. According to pastoralists, occurrence of the disease during the dry season was due to camels are usually in a low plane of nutrition and trek for long distances in search of water and pasture. This is likely to stress the animals and subsequently trigger clinical signs of trypanosomes in animals. A high prevalence of camel *trypanosomosis* occurring in the dry season has also been reported in semi-arid range lands in Kenya by Evans et al. (1995).

A greater proportion (73.3%) of camel herders responded that they mix camel with other livestock species particularly with goats and sheep during grazing. Animals that grazed together with camel may be a constant threat to camels and the presence of a large population of sheep and goats may have acted as a reservoir, since they have been shown to harbour T. evansi inapparently (Evans *et al.,* 1995). This suggestion is in consistent with that reported earlier by Mahmoud and El Malik, (1977), when they stated that as long as biting flies of Tabanids and Stomoxyins are abundant, one expects those goats, and sheep's harboring T. evansi; would constitute foci of infection (reservoir). Moreover, Boid et al. (1981) reported that, the existence of antibodies against T. evansi in sheep and goats pointed to their role as reservoirs for the disease.

Almost all (95%) of herders mentioned that no veterinary intervention was taken

when their camel become infected by the disease and their camel received poor attention from district veterinary services unlike other livestock species in the same area. A greater proportion (77.8%) of them buy drug from local market and administer drug by themselves. Additionally, the majority (75%) of herders mentioned that veterinary health post was very far away from their villages and on average it took them 3 hours to reach a nearby livestock health clinics and posts. These distance obstacles camel owners not to get necessary animal health intervention for sick camels. As a means to help their camels when they get sick owners employee traditional remedy option like the application of a concoction of herbs, mixed with soup and the branding of oedematous areas on sick animals using hot metal.

Conclusion

Camel *trypanosomosis* causes a significant impact on the camel production and economic growth of the study area by affecting health and productivity of camels so that it is a disease of major economic importance in the study area. The camel herders have no easy access to veterinary clinic and healthy post; and thus, mostly depend on traditional remedy which has some side effect on the health and welfare of animal. In this study, the occurrence of the disease was found to have seasonal trend mainly associated with rainy season with high population of biting fly during this season. The pastoralists mentioned that seasonal movement of camels in search of water and browse is one of the most important risk factors for the spread of camel *trypanosomosis*. The majority of pastoralist do not separate younger camel from adult once during herding and penning. The greater proportion of the pastoralists also did not practice the isolation of infected camel from healthy herds. The present study revealed that camel *trypanosomosis* is prevalent in Moyale district at relatively low levels during the dry season of the year, using parasitological techniques. There is a need of further study involving different seasons of the year along with the use of more sensitive diagnostic tests in order to establish effective control measures.

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CHALLENGES AND AGRICULTURAL EXTENSION NEEDS OF URBAN AND PERI-URBAN LIVESTOCK KEEPERS IN BENUE STATE, NIGERIA

*Chah J M, Goji D C and Anugwu I J
Department of Agricultural Extension, University of Nigeria, Nsukka

Abstract

The study sought to assess the challenges and agricultural extension needs of urban and peri-urban livestock keepers in Makurdi metropolis of Benue State, Nigeria. Six council wards were randomly selected out of the 11 council wards in the study area using simple random sampling technique. Proportionate sampling technique was used to select 120 farmers for the study. Structured interview schedule/ questionnaire and observations was used to collect data. Data collected were analysed using percentages, mean scores and factor analysis. About 57% of the respondents were male. The mean age of the farmers was 36.1 years. A good proportion (39.5%) of the respondents had no formal education and the mean number of years spent in school was 7.3 years. The major livestock kept by the respondents were poultry (76.3%), cattle (26.3%) and goats (6.1%). The major challenges encountered by farmers were grouped into financial, technical and site location constraints. The extension needs identified by the livestock farmers were mostly in livestock marketing (M=2.00), vaccine procurement (M=2.00), disease prevention (M=2.00), vaccine and disease management (M=2.00), among others. Extension agents should regularly disseminate information on livestock production to urban and peri-urban livestock keepers via training, demonstration sessions or other extension teaching methods.

Keywords: Animals, Constraints, dissemination, Farmers, Information, Production

LES DÉFIS ET LES BESOINS DE VULGARISATION AGRICOLE DES ÉLEVEURS URBAINS ET PERIURBAINS DU BÉTAIL DANS L'ÉTAT DE BENUE AU NIGÉRIA.

Résumé

L'étude vise à évaluer les défis et les besoins de vulgarisation agricole des éleveurs urbains et périurbains dans la métropole de Makurdi de l'État de Benue au Nigeria. Six circonscriptions électorales ont été choisies au hasard parmi les 11 circonscriptions électorales dans la zone d'étude en utilisant une technique simple d'échantillonnage aléatoire. Pour l'étude, la technique d'échantillonnage proportionnelle a été utilisée pour sélectionner 120 agriculteurs. Une entrevue structurée planifié / questionnaire et les observations ont été utilisées pour recueillir des données. Les données recueillies ont été analysées en utilisant une analyse de variances. Environ 57% des personnes interrogées étaient de sexe masculin. L'âge moyen des agriculteurs était de 36,1 ans. Une bonne proportion (39,5%) des personnes interrogées avaient une éducation classique et le nombre moyen d'années passées à l'école était de 7,3 ans. Le plus important cheptel tenu par les personnes interrogées était la volaille (76,3%), le bétail (26,3%) et les caprins (6,1%). Les principales difficultés rencontrées par les agriculteurs étaient regroupées en contraintes financières, techniques et du site de localisation. Les besoins de vulgarisation identifiés par les éleveurs se trouvaient principalement dans la commercialisation du bétail (M = 2,00), l'achat de vaccins (M = 2,00), la prévention des maladies (M = 2,00), la gestion des vaccins et des maladies (M = 2,00), entre autres. Les agents de vulgarisation devraient diffuser régulièrement des informations sur la production de bétail aux éleveurs urbains et péri-urbains grâce à la formation, des séances de démonstration ou d'autres vulgarisations des méthodes d'enseignement.

Les mots clés : les animaux, les contraintes, la vulgarisation, les éleveurs, l'information et la production.

*Corresponding author email: jane.chah@unn.edu.ng

Introduction

In sub Saharan Africa (SSA), urban areas accounted for 34% of the total population of 611 million in 2005, and will approach 440 million, or 46% of its projected total of 952 million, by 2020 (FAO, 2007). The urbanization in many African countries is because of the increase in rural-urban migration as people seek better livelihood sources in urban areas. Rapid urbanization has continued to present challenges in infrastructure development, services provision and food requirements to meet the needs of increasing urban populations (Ministry of Agriculture Kenya, 2010).

Unfortunately rapid urbanization has been accompanied with inequitable economic growth and has resulted in increased urban poverty with many low income households suffering from limited alternative livelihood, food insecurity among others (Ministry of Agriculture Kenya, 2010). It is because of the high incidence of the urban poverty that majority of the urban poor engage in urban agriculture as a response to limited alternative livelihood options and food insecurity (Armar-Klemesu, 2000).

In most developing countries, urban and peri-urban livestock rearing is becoming increasingly important, as urban demand for animal products rises (Morton and Matthewman, 1996). In Africa, livestock are important physical and financial capital for many urban households (FAO, 2007). Commercial urban livestock such as pig and poultry production, are profitable ventures that can generate significant income and guarantee a quick return on capital. In spite of its significant contribution to urban food security, livestock production among the urban and peri-urban poor is a sector that has not received the due attention it deserves (Ishagi *et al.,* 2002). The main focus of agricultural development initiatives has been on rural areas with the view that improved food production in rural areas can supply the expanding urban population. This has resulted to limited information on livestock production among urban and peri-urban livestock keepers. Furthermore, Information dissemination on livestock production has rarely been a priority for centralised extension services in developing countries (Morton and Matthewman, 1996). Although most national agricultural extension services are usually designed around the need to disseminate information on annual crops, the potential for increasing livestock production through the provision of information is growing in many developing countries (Morton and Matthewman, 1996).

In Nigeria, Benue State with a population over 4,219,244 inhabitants, is the 14th most populous state (http://wwwinformationnigeria.org/2009/o4/nigeira-by-population.html). In the state, Makurdi, Gboko and Oturkpo are important urban centers and account to over 70% of the population of the state (NPC, 2007). In these urban centers, livestock production is one of the major survival strategies embarked upon by the urban dwellers.

Information needs of farmers is critical especially as technologies become more complex According to Ol-adele (2010), information is one of the resources required for improvement of agricultural production that must be acquired and used to make informed decisions. However, such information can only be provided if the challenges and felt needs of the farmers are identified. Consequently, this study was designed to identify challenges and extension needs of farmers in livestock production in urban and peri-urban areas of Makurdi metropolis, Benue State, Nigeria.

Materials and Methods

The study was conducted in urban and peri-urban areas of Makurdi metropolis of Benue State, Nigeria. Makurdi was purposely selected for the study because it is the state capital and headquarter of Makurdi LGA, and so the influx of migrants into the city is higher than other urban centre in the state. It is situated between latitude 60221 and 70561 to the North and longitude 7037' and 905' East and has a total area of 325km2 (Wikipedia, 2012). Makurdi is made up of 11 council wards according to the 1991 census. In 2006, the population of the inhabitants was estimated to be 500,797 (NPC, 2007). Livestock farmers in the area constituted the population of the study.

Six council wards were randomly selected using simple random sampling technique thus: North Bank 1, Clerk Ward/Central Mission, Modern Market Ward, Agan Ward, Mbalagh Ward and Fiidi Ward. A list of livestock farmers was constituted for each ward by the ward head and the number of farmers varied from one ward to the other. However, the average number of livestock farmers in the 6 wards was 500. Using proportionate sampling technique 24% of livestock farmers were selected from each of the council wards. This gave a total sample size of 120 farmers. Questionnaire/ interview schedule was used to collect data. The instrument was prepared and pre-tested before use for data collection. Observations were also employed for data collection.

The extent to which factors such as lack of capital, lack of livestock feed, poor market prize, poor extension service, constitute a constraint to livestock production was ascertained using a three point Likert type scale of to no extent (0), to some extent (2) and to a great extent (3). The values when added up (0+1+2=3) and divided by 3 to gave a mean value of 1. Variables with mean values of < 1 were regarded as not being a major constraint while variables with mean values of ≥ 1 were regarded as major constraints. Respondents were also asked to list other factors not provided in the list that constrain their livestock production. Exploratory factor analysis was employed in grouping these constraint variables into major constraint factors. However, only variable with loading of 0.4 and above {(10% overlapping variance, Comrey (1962)} were used in naming the factors.

Respondents were asked to indicate whether they were aware of extension services and if they were visited by extension agents or not. The extent of need of extension service in the following areas: breeding, rearing, feed formulation and procurement, marketing were assessed using a three point Likert type scale of to: 'no extent' , 'some extent' and 'a great extent'. Values of 0, 1 and 2 were assigned to them respectively. The values were then summed up (0+1+2=3) and divided by 3 to get a mean value of 1. Variables with mean value of < 1 were regarded as non extension needs of the farmers while variables with mean values of ≥ 1 were regarded as extension needs of livestock farmers. The Statistical Product for Service Solution (SPSS) was used to analyse data.

Results

Socioeconomics characteristics of the respondents

Livestock production in the study area was predominantly performed by males (65.8%) (Table 1). The mean age of the respondents was 36.1 years. Majority (87.7%) of the respondents were married. The mean number of years spent in formal education was 7.3 years while the mean household size was 5 persons. The mean annual household income was N 296,000 ($1,644). About 60% of the respondents had access to credit facilities and sourced them mainly from commercial banks (60.5%). Majority (97.4%) of the respondents belonged to one or more social organizations.

Primary occupation

Data in Table 1 shows that 59.6% of the respondents were primarily farmers while 21.1% and 19.3% had civil/public service and trading as their primary occupation respectively.

Stock size

The mean stock size for the various livestock species kept by the respondents is presented in Table 2. Poultry had the highest mean stock size while horse had the least.

Reasons for keeping livestock

Majority of the respondents kept livestock for household consumption (98.2%), income generation (97.4%), source of protein (96.5%), cash reserve/substitution for cash (95.6%) and food security (94.7%) (Table 3)

Constraints to livestock production

The constraints to livestock production in the study area fell into three broad factors viz; financial, technical and site location problems (Table 4). Lack of capital, lack of livestock feed, and poor infrastructure were the major financial constraints to livestock production. The principal technical factors

Table 1: Percentage distribution of respondent based on socio-economic characteristics

Socio-economic characteristics	Percentage	Mean
Sex		
Male	65.8	
Female	34.2	
Age (years)		
20-25	12.3	
26-30	22.8	
31-35	21.9	
36-40	15.8	36.1
41-45	14.0	
46-50	5.3	
51-55	3.5	
56-60	4.4	
Marital status		
Single	8.8	
Married	87.7	
Divorced	0.9	
Widowed	2.6	
Household size		
1-5 persons	59.3	
6-10 persons	37.2	5
11-15 persons	1.8	
16 and above persons	1.8	
Educational level		
No formal education	39.5	
Primary school attempted	7.0	
Primary school completed	7.0	7.3
Secondary school attempted	0.9	
Secondary school completed	24.6	
OND/NCE	12.3	
HND/First Degree	8.8	
Estimated annual household income (Naira (N))		
10,000-100,000	19.3	
100,001-200,000	34.2	
200,001-300,000	21.1	296,000
300,001-400,000	4.3	
400,001-500,000	6.1	
500,001 and above	19.3	
Primary occupation		
Farming	59.6	

Socio-economic characteristics	Percentage	Mean
Civil/public service	21.1	
Trading	19.3	
Membership of social organization		
Yes	97.4	
No	2.6	
Access to credit		
Yes	59.6	
No	40.4	
Source of credit		
Institutional source	55.9	
Non institutional source	44.2	
Institutional source (n=38)		
Commercial bank	60.5	
Microfinance bank	13.2	
Agricultural bank	26.3	
Non institutional source (n=30)		
Thrift	53.3	
Money lenders	43.4	
Non Governmental Organizations	3.3	

1USD = N180

Table 2: Mean stock size of various livestock species in Makurdi

Livestock	Mean stock size (M)
Poultry	486
Sheep	34
Pig	29
Cattle	21
Goat	20
Turkey	18
Duck	14
Pigeon	10
Donkey	3
Horse	1

militating against livestock production in the study area were poor transport services, lack of market, insufficient replacement stock, lack of processing facilities and weak research-extension-farmer linkages. Theft, rejection by neighbours, lack of space and water were the major site location constraints.

Perceived agricultural extension needs of urban and peri-urban farmers in Makurdit

Awareness of extension services

Majority (98.2%) of the respondents were aware of extension services. About 98% of the respondents were visited by extension agents for one reason or another (Table 5). Thirty five percent of the respondents had extension agents visit between 1-5 times a year while 29.2%, 22.1%, and 13.3% had extension visits between 6-10 times, 11-15 times and 16-

Table 3: Percentage distribution of respondents according to importance of livestock

Reasons for livestock keeping*	Frequency	Percentage
Household consumption	112	98.2%
Income generation	111	97.4%
Source of protein	110	96.5%
Cash reserve	109	95.6%
Substitution for cash	109	95.6%
Food security	108	94.7%
Employment	83	72.8%
School fees	98	86.0%

**Multiple responses*

Table 4: Perceived constraints to livestock production

Constraints	Factor 1 (Financial problem)	Factor 2 (technical problem)	Factor 3 (site location problem)
Lack of capital	0.857	0.124	-0.138
Lack of livestock feed	0.752	0.039	-0.110
Inadequate breeding practices	0.705	0.016	0.147
Poor market prize	0.816	0.553	0.009
Poor extension services	0.816	0.553	0.009
Poor transport services	0.358	0.918	-0.017
Ignorance of breeding management	0.816	0.553	0.009
Unavailability of market	0.358	0.918	-0.017
Insufficient foundation and replacement stock	0.358	0.918	-0.017
High mortality rates of animal	0.816	0.553	0.009
Lack of market opportunities	0.816	0.553	0.009
Lack of processing facilities	0.073	0.487	-0.247
Weak research-extension –farmer linkages	-0.005	0.705	0.012
Inadequate training of farmers at all levels of production	0.056	0.933	0.056
Low reproductive rates (low calving and long calving intervals)	-0.013	-0.023	0.288
Theft	0.096	0.022	0.420
Rejection by neighbours	-0.105	-0.028	0.681
Lack of space	0.185	-0.071	0.829
Lack of water	-0.242	0.183	0.731

Extraction Method: Principal Component Analysis.
Rotation Method:Varimax with Kaiser Normalization

Table 5: Percentage distribution of respondents base on awareness and extension visits

Variable	Perentage
Awareness of extension services	
Yes	98.2
No	1.8
Extension visits	
Yes	98.2
No	1.8
Frequency of visits/annum	
1-5	35.4
6-10	29.2
11-15	22.1
16-20	13.3

Table 6: Mean distribution of respondents according to areas of need of extension services

Perceived extension needs	Mean (M)	Std. Deviation
Livestock breeding	1.98*	0.13
Livestock rearing	1.98*	0.13
Livestock feed formulation and procurement	1.97*	0.21
Livestock marketing	2.00*	0.13
Livestock processing	1.99*	0.09
Livestock waste management	1.99*	0.09
Livestock vaccine procurement	2.00*	0.00
Livestock disease prevention	2.00*	0.00
Livestock disease management	2.00*	0.00
Livestock housing	1.99*	0.09
Livestock procurement	1.99*	0.09
Livestock vaccine sale	2.00*	0.00

20 times a year respectively.

Areas of need of extension services

Table 6 indicates that the extent of the respondents' need of extension services were greatest in livestock marketing, vaccine procurement, disease prevention, vaccine and disease management (M=2.00) each, livestock housing, livestock procurement, processing and waste management (M=1.99) each, livestock breeding and livestock rearing (M=1.98) each, and livestock feed formulation (M=1.97).

Discussion

The high percentage of males involved in livestock production recorded in this study may be because livestock production in Nigeria is seen as the duty of the men. Thomsen (2005) opined that to some men, there is a certain prestige attached to keeping of poultry, especially large flocks of birds. This may be why men were more engage in livestock farming than women in the study area. The younger farmers who were more involved in livestock production suggest that youths are more eager, interested and enthusiastic to earn additional income from livestock farming. Similar results were reported

by Patange, et al, (2001) and Gangil and Dabos (2005) in Udhan Singh Nagar district, India. Also since majority of the respondents are married, family members could supply the labour requirements needed in livestock production as unavailability of labour to look after the flock is one of the major constraints in small ruminant production (Aphunu *et al.,* 2011). The low literacy level recorded for respondents in the study may affect farmer's level of production because poor educational level can hinder adoption of improved livestock production technologies (Akudugu *et al.,* 2012). The low annual household income could be a major constraint to livestock production among the respondents. This is surprising since a great proportion of the farmers had access to credit facilities which is expected to improve farmer's ability to purchase more inputs needed to increase livestock production. However, the 40.4% of the respondents who could not access credit may find it very difficult to raise enough capital for their livestock venture. This may explain why the mean annual income is low. The study recorded high level of social participation among respondents as majority belonged to one or more social organizations. These organizations could serve as ways through which farmers share their experiences on livestock production. This finding corroborates Ekong's (2003) assertion that rural inhabitants belong to groups which help them to satisfy innate need for belonging, affiliation and also in solving problems through collective efforts. A greater proportion of the respondents depended on agriculture for livelihood. Upton (2004) asserted that globally, agriculture provides major source of livelihood compared to any other industry, employing over 50% of the global population.

Poultry was the dominant livestock production activity in the study area. van't Hooft (2004) revealed that in Bolivia, the livestock most commonly reared by smallholders are poultry, guinea pigs, and sheep/goats. The reason could be because poultry are socio-culturally important with few religious taboos attached and low cost technology is needed to improve production considerably. Upton (2004) opined that minimal inputs are required to achieve an improved poultry production while land ownership is not a constraint, and production is environmental friendly.

Livestock consumption is one of the reasons for keeping animals in the study area. This finding agrees with the report of City Farmer (2006) that meat consumption is one of the reasons why farmers undertake urban livestock production activities. Robinson *et al.,* (2011) noted that meat consumption to some extent is still considered a luxury, reserved for special occasions among rural Nigerians. In urban areas however, meat perhaps is consumed more often due to the relatively higher level of income which results to preference to protein foods. Farmers also reared livestock for income generation. This could be because of low employment opportunities of most urban and peri urban farmers. Therefore, livestock rearing might have been opted by some of the farmers to earn a livelihood. The purpose of farmers rearing livestock in Maharashtra according to Birada *et al.,* (2013) was for commercial purpose followed by subsidiary purpose. They noted that the respondents were highly educated so they might be aware of the fact that livestock rearing provides additional income, improves their living conditions and provide additional employment to the family members. This is contrary to this study where up to 39% of respondents were illiterates and may be using income from livestock rearing as their major source of income. Generally, Bebe *et al.,* (2003); Moll (2005); Upton, (2004) found out that households with different levels of income have incentives to keep livestock because of the wide spectrum of benefits these provide, such as cash income, food, manure, draft power and hauling services, savings and insurance, and social status and social capital. Similarly Ndlovu, (2010) noted that food security is achievable by 2050 if only livestock production is made more efficient. The contribution of livestock to the world's food supply, family nutrition, incomes, employment, soil fertility, livelihoods, transport and sustainable agricultural production continues to be a subject of significant review and debate (Ellis and Freeman, 2004; Kitalyi *et al.,* 2005; Chilonda and Otte, 2006; Thornton *et al.,* 2006; Perry & Sones, 2007; Randolph *et*

al., 2007). Livestock also provide a safety net in times of need in the form of liquid assets and a strategy of diversification for food production (Freeman *et al.,* 2007). Livestock play multiple roles in the livelihoods of people in developing communities, especially the poor. The contribution of food from animal origin to the nutritional status of the world population is well documented (Bwibo et. al., 2003 Randolph et. al., 2007 and Ndlovu, 2010). Livestock products account for almost 30 percent of human protein consumption (Steinfield *et al.,* 2006).

Financial related constraints identified in this study were lack of capital, lack of feed and poor infrastructure among others. Capital is one of the most important factors of livestock activity (Mvena, 1999). Unavailability of funds can constitute a serious setback to livestock production and productivity. Kitalyi *et al.,* (2005) reveals that the ability of the poor farmers to acquire livestock is constrained by the capital and maintenance costs of the different species, which are typically highest for large ruminants. According to Dayo et al. (2009), livestock feeds constitute at least 60 percent of the total variable costs of livestock production in Nigeria. . Feed availability is a particular constraint for larger livestock species such as cattle, which are usually zero-grazed. Therefore low feed intake of the animals may lead to low reproductive rate. Low reproductive rate of livestock could imply the reduction in productivity and profit making of the livestock farmers. Zegeye (2003) indicates that feed shortage, poor genetic potential for reproductive traits, poor care and management practices are the major contributors to low livestock productivity. Kagira and Kanyar (2010) mentioned low genetic potential and lack of feed among others as constraints to urban livestock production in Kenya. Lack of capital can be a major constraint to livestock production especially among rural farmers.

Research-extension-farmer linkage, market, transport, breeding and processing technology are important in livestock production because of the roles they play in livestock production chain. Livestock marketing in Nigeria has traditionally taken the form of movement of animals (mainly cattle, sheep, and goats) from the livestock-producing areas, mainly in the north, to the southern terminal markets. However, limited or poor-quality roads and transportation increase costs, and decrease farmers' access to market. Livestock marketing and processing constraints in Nigeria include poor packaging facilities for products in the value chains, lack of cold storage facilities in abattoirs at wholesale and retail markets, and absence of standards for meat and other livestock and poultry products (Dayo et.al., 2009). The study of Chenyambuga et al, (2010) found out that lack of markets for livestock products was one of the most important constraints to livestock production around the Lake Victoria Basin. The bulky nature of primary produce can discourage production because many rural farmers have limited access to markets and good feeder roads (Dayo *et al.,* 2009).

Site location related variables recorded as major constraints to livestock production in the study area include lack of space, lack of water, rejection by neighbour and theft. Profitability, safety and convenience in livestock production are functions of site location. Water is very necessary in livestock production as the health and productivity of the livestock are dependent on it. However, the shortage of water in the study area, may be as a result of urban livestock competing with humans as the demand for water for this activity is not taken into account by the supply services. The findings of Swai *et al.,* (2007), Ohaga et. al., (2007) and Chenyambuga *et al.,* (2010) ranked water as the third major livestock (cattle) production constraints beside diseases and shortage of forages. On the other hand, the findings of Omoike (2006) in Aphunu *et al.,* (2011) revealed that the major problems of livestock rearing include among other things, the inadequate supply of water and pasture especially in the dry season, as well as problems arising from inadequate veterinary services and infrastructure

Rejection by neighbours may be attributed to perceive health hazards often associated with livestock production activities near residential areas. Zoonoses is one important aspect to consider in urban livestock keeping.

For example, anthrax, brucellosis, cysticercosis, trichinosis among others are reported to be transmitted from animals to humans through inappropriate management practices for urban pig farming (Santandreu *et al.,* 2000). The use of poultry manure which is not stored for long enough to prevent the contamination of food crops (e.g. leafy vegetables) and water is reported in Kumasi (Drechsel *et al.,* 2000). This practices is not good as it may lead to unhealthy conditions to humans. A series of factors, including economic conditions increase the risk of zoonoses (Mantovani, 2000), which makes the poor urban livestock keepers more vulnerable as they are forced to keep livestock in close proximity to humans due to limited space. Stock theft is another factor that constraint livestock production in the study area. Mashoko et al. (2007) reported stock theft as one of the constraints to periurban livestock production in Zimbabwe. This observation could be attributed to the free movement of animals in the study area. This could be because of inadequate veterinary services, such as lack of inspection of cattle and movement permits.

The low number of visits by extension to farmers per year recorded in this study is contrary to the Food and Agriculture Organization (FAO) recommendation that farmers are expected to receive at least one extension visit every week during a farming season, which translates to a minimum of 15 extension contacts in a farming season (Idrisa et. al., 2012). Thus from the number of extension visits, it is clear that there is poor extension service delivery in Markudi metropolis and the traditional extension role of providing information and promoting new technologies or new ways of managing livestock is threatened. This observed poor extension delivery may be responsible for the wide areas of extension needs indicated by the respondents. As indicated by Menong et al, (2013) farmers require information on diseases and pests management, technical knowledge and available markets. Marketing of livestock as one of the areas farmers indicated lack of information is necessary because it motivates the livestock farmer to produce more. There is an overriding need to empower livestock farmers with ways to compete in markets by reducing transaction costs, increasing access to both rural and urban markets and linking them to related industries such as food processing (Swanepoel *et al.,* 2010). Ozowa (nd) noted that all business activities involved in the movement of commodities from production to consumption is marketing. The farmer's market information needs are those that enable him make rational and relevant decisions. Market information services have the function of collecting and processing market data systematically and continuously, and of making it available to market participants in a form relevant to their decision making.

According to Morton and Matthewman (1996) peri-urban production in all its forms will create demands for information, as it involves people new to livestock production, or new techniques and because it involves a more systematic approach to processing and marketing. Information on disease management is critical in livestock production, because as farmers gain confidence that diseases are under control, they are prepared to invest more in animal production. Disease prevention through vaccination campaigns, reduction of mortality and morbidity losses, and meat hygiene have remained priorities (Morton and Matthewman 1996). This is understandable since human health is an important consideration. Extension should therefore provide necessary information for disease management since the working patterns of animal health staff tend not to be conducive to regular mass extension. Animal health services are usually focused on district clinics to which farmers can bring animals, or on call-outs to individual animals. Veterinarians and paravets are unlikely to have training in communication skills (Warburton *et al.,* 2011). Their professional reward systems usually revolve around concrete targets of animals treated/vaccinated or drugs supplied and are not conducive to the provision of 'pure' information. Extension is a type of education which is informal rather than formal. It is better provided by extension workers whose main task is to convey information in a meaningful form to farmers. One of the ways they do this is by training a group of farmers with the hope

that such farmers come in contact with other farmers.

Information is an essential ingredient in agricultural development programmes but Nigerian farmers seldom feel the impact of agricultural innovations either because they have no access to such vital information or because it is poorly disseminated (Arowolo *et al.,* 2013). The information provided is exclusively focused on policy makers, researchers, and those who manage policy decisions with scant attention paid to the information needs of the targeted beneficiaries of the policy decisions.

Conclusion

The most popular livestock kept in Makurdi metropolis was poultry and intensive system of production was used more to rear animals. Livestock were kept mostly for the purpose of household consumption. The major constraints to livestock production were financial, technical and site location constraints. Respondents indicated extension needs in the following areas: livestock marketing, vaccine procurement, disease prevention, vaccine and disease management. Others are livestock housing, livestock procurement, processing and waste management. Livestock breeding and livestock feed formulation. Extension agents should regularly disseminate information on livestock production to urban and peri-urban livestock keepers via training, demonstration sessions or other extension teaching methods. This will go a long way to alleviate the Challenges encountered by the urban and peri-urban livestock farmers in the state.

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DIAGNOSIS OF FOOT-AND-MOUTH DISEASE OF CLINICALLY INFECTED CATTLE USING ANTIGEN-DETECTION ELISA IN SOUTH EASTERN NIGERIA

Tchokote E Y[1]*, George O N[2], Ularamu H[3], Wungack H[3], Okorie-Kanu C O[4] and Adeyefa C A O[5]
[1]Department of Veterinary Medicine, Michael Okpara University of Agriculture Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria
[2]Department of Veterinary Services, Ministry of Agriculture and Natural Resources, No 3 Barrack Road, Calabar, Cross River State, Nigeria
[3]Foot and mouth disease Laboratory, National Veterinary Research Institute, P.M.B. 1, Vom, Plateau State, Nigeria
[4]Department of Veterinary Pathology Michael Okpara, University of Agriculture Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria
[5]Department of Veterinary Medicine, University of Ibadan, P.M.B. 001, Ibadan, Oyo State, Nigeria

Summary

Foot and mouth disease (FMD) viruses SAT1 and SAT2 were found concurrently causing disease in a dairy farm of 120 cattle and 19 calves in South Eastern Nigeria. Diagnosis was made using antigen detection ELISA (IZLER) a test with deviation from Liquid Phase Blocking ELISA (LPBE) and Solid Phase Competitive ELISA (SPCE). It provides information on presence of FMDV antigen in the specimen and tests for serotype A, Serotype O, Serotype SAT1, SAT2, and Pan FMD virus which are MAB for serotype C, SAT3 and Asia 1. Most common FMDV serotypes reported to cause infections in Nigeria have been consistently Types A, O, SAT1, SAT2. Affected animal were Friesian cattle crossbred with local N'dama breed of cattle. Clinical diagnosis was made using signs of oral and feet lesions causing severe anorexia and lameness respectively in affected animals and calves. Feet lesions were found to be similar to those in exotic animals with sloughing of hoof unlike in indigenous cattle that often are interdigital granulomatous lesions. Mortality among calves was about 60% (11 died out of 19). There was a striking lymphocytosis from haematology of affected animals; other blood parameters were within normal physiological range showing that there were no concurrent haemoparasitic or bacterial infections. Control of FMD in endemic area has to be adapted to local requirements. As such data on serotypes involved in outbreaks are required. To achieve this, clinical diagnosis has to be complemented with serological test and molecular techniques that requires primers, standard molecular laboratory equipment and well trained personnel. The primary challenge remains sample preservation and secure shipping for effective analysis and identification. The challenge of epileptic power supply remains obvious and most viral RNA is readily destroyed with constant freezing and thawing. Antigen ELISA is found as very good diagnostic alternative for FMD in endemic area.

Keywords: Antigen detection ELISA – Diagnosis – Foot-and-mouth disease – Nigeria.

Resume

Les virus de la fièvre aphteuse (FMDV) de type SAT1 et SAT2 étaient impliques dans l'infection affectant une ferme d'exploitation laitière de 120 bovins et 19 veaux au sud-est du Nigeria. Le diagnostic était fait à l'aide du test ELISA pour la détection d'antigènes présents dans les prélèvements. Cette analyse varie des autres tests ELISA pour le diagnostic de la fièvre aphteuse par le fait qu'il identifie la présence du virus infectieux contrairement aux autres qui neutralisent les anticorps produits par l'animal contre le virus infectieux. L'antigène ELISA produit par IZLER a les anticorps monoclonaux (MAB) pour la détection du virus de la fièvre aphteuse (FMDV) des serotypes A, O, SAT1, SAT2, et Pan FMDV (serotype C, Asia1 et SAT3). Le bétail affecté était le Frison (bovins Holstein) croisés avec la race locale N'dama. Le diagnostic clinique était fait à l'aide des lésions buccales liées à l'anorexie sévère observée et des plaies des sabots qui empêchaient à l'animal de se déplacer ou le faisait boiter. Les adultes et les veaux étaient affectes de la même façon mais les décès étaient enregistrés seulement dans la population jeune avec un taux de mortalité de 60% (11 veaux sur 19). Les lésions observées sur les pattes étaient semblable a celle décrites

*Corresponding author email: eugenyoungo@gmail.com

chez la race exotique de bétail ou l'éboulement total des sabots est observé contrairement au lésions observées chez la race locale ou plus souvent les plaies granulomatoses apparaissent à la fente des sabots. L'hématologie des animaux affectes a montré une forte croissance du taut de lymphocytes tandis que les autres valeurs cellulaire étaient dans la moyenne, montrant que les animaux soufraient uniquement de la fièvre aphteuse (FMD). La prévention de FMD dans les zones endémiques doit être liée à la réalité locale et pour cause l'information sur le type de virus implique dans l'épidémie doit être connu et enregistré. La difficulté majeure reste la préservation des échantillons et l'acheminement dans les laboratoires spécialisés avec le risque de perdre les traces du pathogène, la contamination et la propagation de l'infection. Le test d'antigène par ELISA reste la meilleure alternative pour le diagnostic du FMD en région endémique.

Introduction

FMD is a highly contagious viral disease of even-toed ungulates caused by a single stranded positive-sense RNA virus (Picornaviridae, genus Aphthovirus) and one of the most economically important diseases of livestock. Although often referred to as a single disease, there are seven immunologically distinct serotypes of the virus distributed around the world: serotypes O, A, C, Asia1 and South African Territories (SAT1, SAT2 and SAT3). Serotypes are indistinguishable clinically and may have different geographical distributions (Bastos and Sangare, 2001; Rweyemamu et al, 2008) and epidemiological characteristics (Hunter, 1998). Although mortality is rare in adult cattle, loss of productivity has been estimated to be as high as 25% in affected animals manifesting as reduction in milk production, loss of body condition and stunted growth in recovered animals. An important feature of FMD is that the virus may be recovered from the oropharynx for a varying period after an animal has been infected; if this period is longer than 28 days the animal is classified as persistently infected or a 'carrier'. The epidemiological role of persistently infected or 'carrier' animals is still controversial, but the possibility that they may become the focus of new outbreaks greatly influences control strategies and trade regulations (Nicholls et al 1983; Macpherson 1995).

Cattle are the single most important livestock species in Nigeria in terms of output of meat and milk and the capital value. They are primarily produced by the transhumant pastoralists who use the natural vegetation of communal range (Oyedipe, 2011). The demand for animal product goes increasing while production gap (gap between demand and supply) widens over the years. It is estimated that Nigeria spends up to USD 2 billion every year on importation of animal products (Oyedipe, 2011). Cattle production has been hampered by factors including inadequate nutrition, poor genetic quality of the indigenous breeds, poor growth rate, low reproductive capacity and non-infectious and infectious diseases (Sophie and Nick 2015). Over the years breeding policies in Nigeria have both focused on improvement of locally available breeds of animals as the N'Dama, most often with regards to resistance/tolerance to diseases; and introduction of exotic breeds to upgrade local stock and improve on production potentials.(Oyedipe, 2011) Located at 60 40'0"N 90 10'0" E.

In the presence of economically important and production limiting diseases such as FMD this policy is still confronted with great challenges.FMD is a primary cause of bovine lameness, which is a major challenge facing the dairy industry, pastoral activities, with negative impacts on milk production, fertility and longevity of animals (Sophie and Nick 2015). It affects animal growth rate, feed consumption and reproduction capabilities and as such the true picture of genetic performance of a given cattle breed cannot be assessed with such undergoing infections.

FMD is endemic in much of sub-Saharan Africa and FMD virus identification and characterization (Kitching, 1992) remain an important challenge to many of these countries because test could not be efficiently done locally (Bastos, 1998). Most often there is need to chip specimen to other countries for proper

diagnosis with the incumbent risk of disease spread and introduction of new serotypes to FMD free countries.

Materials and Methods

Clinical findings and sample collection

The owner complained of disease in de herd with dead of calves, lameness in young and adult, anorexia. Farm was visited 7days after observation of first symptoms by owner. Febrile stage was not observed; animals were anorexic and showed various degrees of lameness which was very severe in some young and older animals. Oral lesions were aged as described by Kitching and Mackay in 1995 most lesions were between 7 and 14 days old presenting granulation tissues (Figure 1).

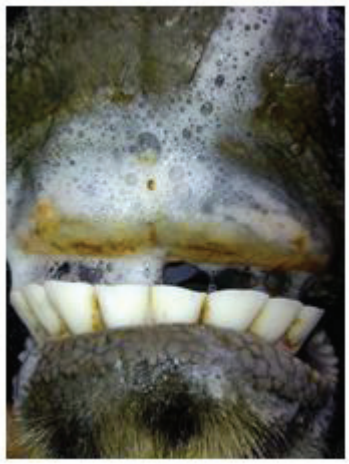

Figure 1: Healing oral lesions on the palate of cattle with FMD.

Figure 2: Partially Sloughed hoof in FMD infected. cattle

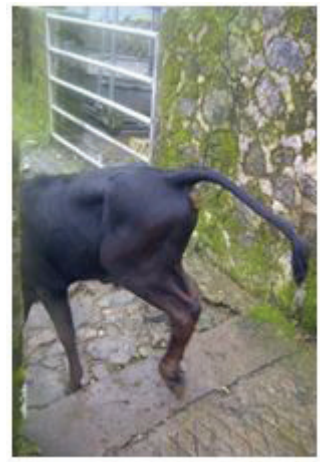

Figure 3: Lameness in calve affected with FMD. Animal is unable to bear weight on affected limb.

Feet lesions were still obvious, the hoof was partially sloughed in some animals (Figure 2 and Fig.3), very painful lesions in others causing severe lameness. Mortalities were recorded in calves and 11 out of 19 died during the course of the disease. Blood samples were collected from sick and apparently healthy animals aliquoted in EDTA bottles and remaining allowed to decant in slanted syringes at -40c, serum was harvested within 24hours post collection and stored at -200c till when needed. Saliva and scrapings of the mucosa of healing ulcers were collected in glycerol saline and preserved at -700c till when used. All samples were transported from the field to the laboratory on ice pack (Kitching & Donaldson, 1987). Samples were collected from animals with observable lesions.

Sample Analysis

Haematology: Under field condition diseases outbreaks may be complicated by other subclinical conditions. Animal blood picture will indicate if there are concurrent haemoparasitic or bacterial infections.

PCV: Tubes were filled by capillary diffusion to about 2/3 of its length, the outside carefully dried with a piece of gauze and the opposite end of the tube sealed with special clay. The sealed tubes were then placed in a high speed micro haematocrit centrifuge with the sealed edge near the outside rim, and spined at 2000 rpm for 5 minutes. The spun micro-haematocrit tube was then placed on

microhaematocrit reader and PCV read off in percentage.

Total Erythrocyte Count: The haemocytometer method was used for the determination of total red cell count. A chemically clean red cell pipette was used to draw blood to the 0.5 mark of the pipette. The later was now plunged into a test tube containing diluting fluid. Normal saline solution was used (0.85% Nacl). This was aspirated to the 101 mark of the pipette and blood and fluid mix properly by inversion of the tube. Thus aspirated blood was diluted at the proportion of 1:200. Diluted blood was discharged into haemocytometer counting chamber, after allowing several minutes for red cells to settle to a single layer. A cover slip was applied and total number of cells in five squares in the centre of the counting chamber was evaluated and this value was multiplied by 106 to have total erythrocytes per 1µl of blood (ax106/µl).

Total leukocyte count: Haemocytometer method was used. The procedure was the same as in total erythrocyte count except that; the diluting fluid was solution of glacial acetic acid tinted with methylene blue, the white cell pipette was used (it allows a 1:20 dilution instead of the 1:200 dilution in erythrocyte count), the cells are counted in the 16 squares within the larger ruled area in the corner and total number of cells counted multiplied by 103 to obtain total number of leukocytes per µl of blood (bx10/µl).

ELISA

Oral samples with cell debris were homogenized using mortar and pestle with small amounts of sterile sand then suspended dilution of normal saline (10%) then centrifuged at 2000rpm for ten minutes as described by Kit manufacturer Istituto Zooprofilattico della Lombardia e dell'Emilia Romagna (IZLER). Supernatant fluid was harvested and stored. Each specimen was diluted and dispensed in 12 wells of a row with two replicates for each type specific MAb and the pan-FMDV MAb. Plates were incubated to allow reaction with the test sample antigen if present with the corresponding MAb and the pan-FMDV MAb. Repeated cycles of washing were done to remove unbound material. Conjugates A and B were added in their respective wells and incubated. All incubations were done at room temperature; the substrate was added after another cycle of washing to remove unbound conjugate. The colorimetric reaction was then discontinued by adding a stop solution and colour density read using spectrophotometer at 450 nm wavelength. All test procedures were carried out following recommendations of kit manufacturer. Samples were classed as positive if the mean optical density (OD) reading, after subtraction of the background, was greater than 0·1 nm interpretation was made using the software provided by kit manufacturer (Table I). Samples with ambiguous reading were retested to confirm results using kits from the same source.

Laboratory Results

Differential white blood cell count of 10 randomly selected animals from the affected herd showed high lymphocytosis above 65%. Other haematological parameters (Pack Cell Volume (PCV), Total Erythrocyte Count, Haemoglobin Concentration (HB), Mean Corpuscular Volume MCV, and Mean Corpuscular Haemoglobin Concentration (MCHC) in Table II) were within the normal physiological range indicating that there were no concurrent disease conditions. The striking lymphocytosis was as a result of cell mediated immune response to viremia in FMD

Antigen detection ELISA results shows that FMD virus SAT1 and SAT2 as indicated by sample B in wells 9, 10, 11, 12. Using Solid phase Competitive ELISA for Serotype A, there was evidence of antibodies to FMD virus type A in the specimen (Table I). This finding indicates that the animals have previously been exposed to FMDV serotype A but the later was not the cause of ongoing illness.

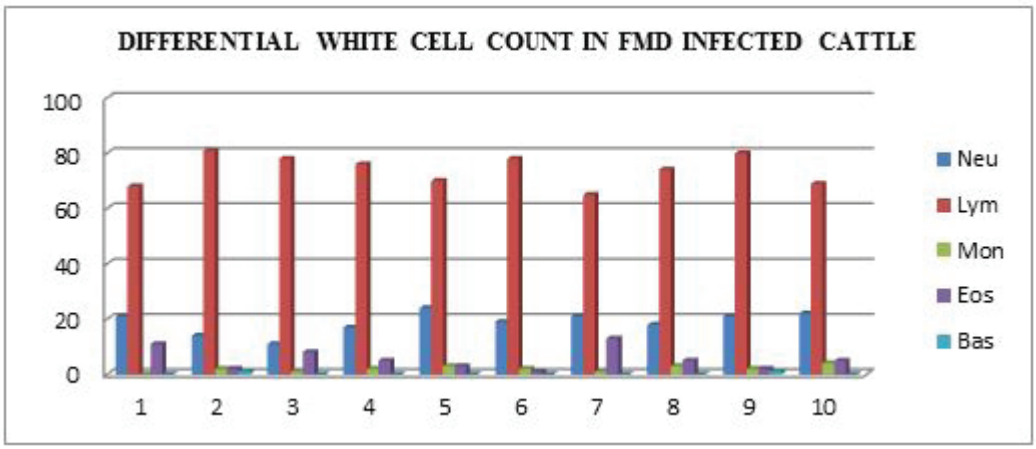

Figure 4: Differential White Cell Count in FMD infected cattle

Table I: Antigen Detection ELISA results for tested samples

FMD Antigen Detection O,A,SAT1 SAT2

Date: 180912

Plate 1 6 samples

O D	Type O Mab		Type A Mab 4D12		Type A Mab 5F6		Pan-FMDV Mab 1F10		SAT 1		SAT2	
	1	2	3	4	5	6	7	8	9	10	11	12
A	0.057	0.065	0.061	0.060	0.067	0.082	0.093	0.178	0.195	0.239	0.179	0.161
B	0.181	0.180	0.171	0.177	0.185	0.213	0.207	0.327	1.653	1.197	1.277	1.255
C	0.047	0.053	0.056	0.054	0.059	0.063	0.056	0.055	0.303	0.126	0.231	0.271
D	0.066	0.095	0.074	0.080	0.084	0.083	0.079	0.095	0.177	0.286	0.261	0.246
E	0.045	0.049	0.059	0.059	0.060	0.057	0.051	0.053	0.153	0.154	0.251	0.214
F	0.052	0.059	0.061	0.064	0.062	0.065	0.066	0.060	0.168	0.136	0.142	0.261
G	2.764	2.833	2.181	2.233	2.969	3.031	2.516	2.594	2.092	2.080	1.783	1.883
H	0.049	0.059	0.058	0.064	0.059	0.061	0.050	0.052	0.144	0.115	0.126	0.143

O D	Type O Mab		Type A Mab 4D12		Type A Mab 5F6		Pan-FMDV Mab 1F10		SAT 1		SAT2	
	1	2	3	4	5	6	7	8	9	10	11	12
A	0.003	0.011	0.000	-0.001	0.007	0.022	0.042	0.127	0.054	0.108	0.045	0.027
B	0.127	0.126	0.110	0.116	0.125	0.153	0.156	0.276	1.522	1.066	1.143	1.121
C	-0.007	-0.001	-0.005	-0.007	-0.001	-0.004	0.005	0.004	0.172	-0.005	0.097	0.137
D	0.012	0.041	0.013	0.019	0.024	0.029	0.028	0.044	0.046	0.156	0.127	0.112
E	-0.009	-0.005	-0.002	-0.002	0.000	-0.003	0.000	0.012	0.022	0.023	0.117	0.060
F	-0.002	0.005	0.000	0.003	0.002	0.005	0.015	0.008	0.037	0.007	0.007	0.127
G	2.710	2.779	2.120	2.172	2.900	2.971	2.465	2.543	1.961	1.949	1.849	1.749
H	-0.005	0.005	-0.003	0.003	-0.001	0.001	-0.001	0.001	0.013	-0.013	-0.009	0.008
	0.054		0.061		0.060		0.051		0.131		0.135	

Results	Type O Mab		Type A Mab 4D12		Type A Mab 5F6		Pan-FMDV Mab 1F10		SAT 1		SAT2	
	1	2	3	4	5	6	7	8	9	10	11	12
A	Negative	Negative	Negative	Negative	Negative	Negative	Negative	WeaK	Negative	WeaK	Negative	Negative
B	WeaK	WeaK	WeaK	WeaK	WeaK	WeaK	WeaK	Positive	Positive	Positive	Positive	Positive
C	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	WeaK	Negative	Negative	WeaK
D	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	WeaK	WeaK	WeaK
E	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	WeaK	Negative
F	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	WeaK
G	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID
H	VALID	VALID	VALID	VALID	VALID	VALID	VALID	VALID	Invalid	Invalid	Invalid	Invalid

Discussions and Recommendations

The result of this study highlights the complexity of FMD in the area based on multiple FMD virus serotypes being perpetuated in cattle populations. FMD remains a very important disease affecting beef and dairy production in the area. Its complex endemic nature stands as a constant drawback in attempt to improving production. The rapid diagnosis using this indirect sandwich ELISA (Roeder & Le Blanc Smith,1987) with the modifications described by Ferris and Dawson (1988) and OIE (2004) provides an edge for control base on specific virus serotype identification. The serological typing using Solid phase competitive ELISA is directive but remains ambiguous because a good number of samples have antibodies

to more than one serotypes and this cannot be conclusively attached to the ongoing infection. The importance of antigen detection in outbreak remain very important especially when an animal could be tested positive for more than one FMDV serotype as was observed in this case. Laboratory finding could be misleading if only serotype specific test was carried out, diagnosis would have incriminated serotype A as being the cause of ongoing disease, while only SAT1 and SAT2 were the actual cause of infection. The practical FMD diagnosis has been a constant challenge to countries where the disease is endemic primarily due sample transportation from the field and its preservation in local laboratories, lack of equipment, reagents and trained personnel to carry out prompt laboratory analysis. More importantly the relative lack of concern from the authorities may be because the disease does not achieve its economic importance through high mortality as such its adverse effects on food security and economic development both at the level of village pastoralist and the more organized production systems continues to be underestimated. Concerned farmers opt for individual or small groups' solutions such as using measles vaccine for humans in controlling FMD in cattle (the local pastoralist) or vaccinating the animals with FMD vaccine not recommended by authorities. Although attempt at controlling FMD will need a committed effort that is supported locally but that is rolled out across the whole of sub-Saharan Africa (Rweyemanu, 1984) if it is to have a chance to be successful. It is important to consider controlling the specific serotype in a given location after diagnosis. Different monovalent or polyvalent FMD vaccine can be recommended for use in specific location to progressively and effectively reduce FMD virus circulating load prior to developing suitable and sustainable control strategies that will allow traditional pastoralist/nomadic practices to continue.

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PERFORMANCE AND HAEMATOLOGICAL INDICES OF BROILER CHICKENS FED DIETS CONTAINING SUPPLEMENTS OF THREE PHYTOGENIC PLANTS.

Adegbenjo A A[1], Oluwatosin O O[1,2], Jegede A V[1,2], Oso A O[1,2], Fafiolu A O[1,2] and Ogunbanke E A[1].
[1]College of Animal Science and Livestock Production, 2Centre of Excellence in Agricultural Development and Sustainable Environment, Federal University of Agriculture, Abeokuta, Nigeria
[2]Animal Science and Livestock Production, Federal University of Agriculture, PMB 2240, Abeokuta, Nigeria.

Abstract

The effects of Azadirachta indica (neem), Spondias mombin and Chromolaena odorata leaf meals as natural feed supplements on performance and haematology of broilers were evaluated. Two hundred and sixty-four 1 day-old Arbor acre chicks were divided randomly into six treatments and four replicates. Treatment 1 was a negative control (containing no antibiotic nor phytogenic plant) while treatment 2 served as the positive control (containing Neoceryl). Diets 3 contained 5g/kg Azadirachta indica leaf meal. The birds in treatment 4 were given diets that contained 2.5 g/kg each of Azadirachta indica and Spondias mombin leaf meals. Diets 5 contained 2.5 g/kg each of Azadirachta indica and Chromolaena odorata leaf meals, while those in treatment 6 received diets containing the three test ingredients at 1.7 g/kg each. Data on performance and blood indices collected were analyzed using Analyses of variance in a Completely Randomized Design. Results at day 28 showed no significant difference ($P > 0.05$) in the feed conversion ratio while significant differences were observed for all haematological parameters across the treatments except basophil and monocytes. At day 56, significant differences ($P<0.05$) were observed across the treatments for final weight, daily feed intake, daily weight gain and feed conversion ratio. The values of packed cell volume, haemoglobin and red blood cells were significantly higher in the birds fed with the phytogenic plants. It was concluded that 2.5g/kg Azadirachta indica and Spondias mombin improved FCR at the finisher phase while combinations of the three phytogenic plants in feed increased the PCV and did not have a negative effect on thehealth status of the birds.

Keywords: Azadirachta indica, Spondias mombin, Chromolaena odorata, broilers, haematology, performance

LA PERFORMANCE ET LES PROFILS HEMATOLOGIQUES DES POULETS DE CHAIRS NOURRIS AUX RATIONS CONTENANT DES SUPPLEMENTS DE TROIS PLANTES PHYTOGÉNES.

Résumé

Les effets de l'Azadirachta indica (margousier), du prunier mombin et de la farine de feuilles de Chromolaena odorata comme compléments alimentaires naturels sur la performance et le profil hématologique des poulets de chair ont été évalués. Deux cent soixante-quatre poussins d'1 jour Arbor Acre ont été répartis au hasard en six traitements et quatre répétitions. Le traitement 1 était un témoin négatif (ne contenant ni antibiotique, ni plante phytogène) tandis que le traitement 2 était utilisé comme contrôle positif (contenant le Neoceryl). Les régimes 3 contenaient 5g / kg de farine de feuilles d'Azadirachta indica. La volaille dans le traitement 4 avaient reçu une alimentation qui contenait 2,5 g / kg de chacun des Azadirachta indica et de la farine de feuilles de Spondias mombin. Les régimes 5 contenaient 2,5 g / kg de chacun des Azadirachta indica et de la farine de feuilles de Chromolaena odorata, tandis que ceux du traitement 6 avaient reçu des régimes contenant les trois ingrédients d'essai à 1,7 g / kg chacun. Les données sur la performance et les profils sanguins recueillis ont été analysés à l'aide des analyses de variance dans un dispositif complètement aléatoire. Les résultats obtenus après 28 jours n'ont montré aucune différence significative ($P> 0,05$) dans le rapport de conversion d'alimentation alors que les différences significatives ont été observées pour tous les paramètres hématologiques à travers les traitements, sauf les basophiles et les monocytes. Au jour 56, des différences significatives ($P <0,05$) ont été observées dans les traitements

*Corresponding author email: dotunadegbenjo@gmail.com

pour le poids final, l'apport quotidien de l'alimentation, le gain de poids quotidien et le taux de conversion des aliments. Les valeurs de l'hématocrite, l'hémoglobine et les globules rouges étaient significativement plus élevées chez les oiseaux nourris avec les plantes phytogènes. Il a été conclu que 2,5g / kg d'Azadirachta indica et de Spondias mombin améliorés FCR à la phase de finition tandis que les combinaisons des trois plantes phytogènes dans l'alimentation ont augmenté l'hématocrite (PCV) et n'ont pas eu un effet négatif sur l'état de santé des poulets..

Mots clés : l'Azadirachta indica, le Spondias mombin, le chromolaena odorata, les rôtissoires, l'hématologie, la performance.

Introduction

Current commercial hybrids chicken with high performance require diets which would enable the maximum expression of their genetic potentials (Sadeghi and Tabiedian, 2005. Antibiotic growth promoters are a term used to describe any medicine that destroys or inhibits bacteria (Visek, 1978). They have been reported to increase growth rate and feed efficiency of poultry and other livestock as a result of their positive effect on gut health, nutrient utilization and feed conversion efficiency (Visek, 1978). Their use have also shown many disadvantages such as adverse side effect on health of birds, high cost and long residual properties and carcinogenic effect in humans (Butaye *et al.,* 2003). Moreover, there is the fear that the continuous and sub therapeutic use of in-feed antibiotics could lead to the development of antibiotic resistance which is raising serious issues of public health concern. Efforts are therefore being made towards ethno veterinary intervention in which case beneficial herbs and plants (phytogenic plants) that are natural and relatively safe are used to sustain and increase productivity of flock.

Phytogenic plants are plants that contain compounds whose active constituents naturally suppress the proliferation and / or are toxic to bacteria. These plants are cheap and renewable sources of pharmacologically active substances (Basile *et al.,* 1999). There is evidence in literature concerning the beneficial effects of using leaf meals from different sources in poultry production (Iheukwumere *et al.,* 2008; Egbenwade and Olorede, 2003; Fasuyi *et al.,* 2005). D'Mello et al. (1987) observed that some leaf meals do not only serve as protein sources but also provide some necessary vitamins, minerals and oxycarotenoids which cause yellow colour of broiler skin, shanks and egg yolk.

Neem tree, an example of medicinal plants, has a wide range of medicinal properties like antibacterial, antiviral, antifungal, antiprotozoal, hepatoprotective and various other properties (Kale *et al.,* 2003). Various parts of the tree have been reported to possess medicinal value and also found to contain active ingredients essential to the growth and performance of farm animals (Chakraborty *et al.,* 1989). Recent studies by Esonu *et al.,* (2006) have shown that its leaf meal could be of some value in the diet of laying hens both as feed ingredient and egg yolk colorant. There is the need to also evaluate its effects on haematological and serum biochemical constituents of poultry to further ascertain its physiological effects on metabolism at that level.

Chromolaena odorata has also been reported to have multipurpose medicinal properties (Iwu, 1993; Akinmoladun *et al.,* 2007). Dried leaves of Chromolaena odorata were used as mosquito repellant, as antimicrobial agent against Bacillus cereus and antifungal agent against Aspergillus niger (Moses *et al.,* 2010). Although, certain concentrations of Chromolaena odorata leaves have been reported to be poisonous to livestock as a result of high nitrate content in the leaves and young shoots (Sajise *et al.,* 1974), they contain high amount of crude protein, dry matter, vitamins and minerals (Apori *et al.,* 2000).

Spondias mombin has a wide range of antibacterial, antiviral and antifungal properties (Corthout *et al.,* 1992; Corthout *et al.,* 1994).

Haematological constituents reflect the physiological responsiveness of the animal to its internal and external environment which includes feed and feeding (Esonu *et al.,*

2001). Animal nutritionists agree that feed ingredients, including unconventional feed stuffs, affect animal physiology (Odunsi, 1991; Emenalum and Udedibie, 1998).). Analyzing the normal haematological parameters of chickens is essential for the diagnosis of various pathological and metabolic disorders. Results obtained from such analysis can be used as a diagnostic tool in order to assess the health status of an animal. These measurements provide hints and valuable information on the immunity status of an animal (Kral and Suchy, 2000).

This study therefore evaluated the effects of supplementing Azadirachta indica, Spondias mombin, and Chromolaena odorata leaf meals and their combinations as natural alternatives to in- feed antibiotic for broiler chicken. Performance, haematology and serum biochemistry of the experimental birds were used as criteria of response.

Materials and Methods

Experimental site

The study was carried out at the Poultry Unit of the Teaching and Research Farm Directorate, Federal University of Agriculture, Abeokuta, Nigeria (Latitude 7° 131 49.46"N and Longitude 3° 261 11.98"E). Average temperature of 28.5°C and mean annual rainfall of 1037mm existed during the experimental period (Google Earth, 2012).

Experimental diets

Six experimental diets were formulated. The negative control (T1), which contained no test ingredient and no antibiotics and the positive control (T2), contained antibiotics with no test ingredients but the birds were supplied with the normal vaccination schedule. The third dietary treatment (T3) contained 5g/kg of Azadirachta indica leaf meal. The fourth treatment (T4) contained 2.5g/kg of Azadirachta indica leaf meal and 2.5g/kg of Spondias mombin leaf meal.

The fifth treatment (T5) contained 2.5g/kg of Azadirachta indica leaf meal and 2.5g/kg of Chromolaena odorata leaf meal. The sixth treatment contained 1.7g/kg each of Azadirachta indica leaf meal, Spondias mombin leaf meal and Chromolaena odorata leaf meal.

Experimental birds and design

A total of 264 one day old Arbor acre broiler chicks were used for the experiment. The experimental design used was completely randomized. The chicks were weighed on their arrival and randomly allotted to 6 dietary treatments of 44birds per treatment. Each treatment was further divided into 4 replicates of 11birds. The birds were raised on a deep litter house that was well ventilated. Diets were formulated to meet the NRC (1994) nutrient requirements of broiler chickens. Feed and water were supplied ad libitum. The experiment which lasted for 56 days was divided into two periods of days 0 to 28 and 29 to 56 respectively.

Data collection

Proximate Analysis

Dry matter (DM) was determined by drying at80°C for 48 h (AOAC, 1990; 925.10); ash was measured in a muffle furnace at 510°C for 18 h.Crude protein of samples was determined by the Kjeldahl method and the ether extract by a Soxhlet apparatus. Oil (as ether extract) was extracted with petroleum spirit (b.p. 40 to 60°C) by the Soxhlet method (AOAC, 1990).

Feed intake and body weight of the birds were determined weekly and this was used to calculate feed conversion ratio at the end of each phase. A record of mortality was also taken.

Haematological measurements

At days 28 and 56,four birds were selected from each replicate and about 2mls of blood samples were collected from the brachial vein of each bird (Frandson, 1986) into a tube containing Ethylene Diamine Tetra Acetate (EDTA) and another 2ml was collected into a plain bottle.

The whole blood samples (from EDTA bottles) were used to determine haematological measurements. Packed cell volume (PCV), Haemoglobin (HB), and Red blood cell (RBC) were determined using

Wintrobes microhaematocrit, colorimetry-cyanomethaemoglobin method and improved Neubauer haemocytometer respectively. WBC was determined with a Wintrobe haematocrit tube according to the method of Schalm et al. (1975). WBC differentials were carried out on blood smears stained with May-Grunwald-Giemsa stain. Mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH) were computed according to Jain (1986).

Statistical analysis

The data collected were subjected to one way Analysis of Variance using Statistical Package (SAS, 2005). In all instances, differences were judged significant at P <0.05 using Duncan's Multiple Range Test (Duncan, 1955).

Results

Performance characteristics

The effect of phytogenic plants on performance characteristics of broiler chickens for days 0-28 and 29-56 respectively are presented in Table 3. Significant differences (P<0.05) were recorded in final weight, weight gain and feed intake at the starter phase (day 28) while at the finisher phase (day 56), significant differences were recorded in final weight, feed intake, weight gain, feed conversion ratio and mortality. Birds which were administered with antibiotics, (T2) had the highest (P <0.05) final weight of 432.50g. Treatment 4 (2.5 g/kg neem and 2.5g/kg Spondias) elicited the highest daily feed intake of 27.88g. Birds that received neither antibiotic nor phytobiotic supplement (T1) and those given neem and Chromolaena (T5) recorded daily weight gain of12.43 and 12.68g respectively, which are next to the highest weight gain observed in group that were given in-feed antibiotic (T2). Birds fed Treatments 3 (Neem only), 4 (Neem and Spondias) and 6 (combination of all three plants supplements) had the lowest daily weight gains of 11.65, 11.65 and 11.08g respectively. The feed conversion ratios observed across the treatments were not significant (P>0.05). No mortality was recorded throughout the first 28 days of the experiment.

At the end of the 56 - day feeding trial, birds fed with conventional antibiotics in feed recorded the highest final weight of 2125.00gwhile those fed 2.5 g/kg neem had the least final weight of 1662.50g. Birds on Treatments 4 (Neem + Spondias), 5 (Neem + Chromolaena) and 6 (Combination of the three) were statistically similar with mean values of 1812.50, 1800.00 and 1850.00g respectively. Birds fed Treatment 1 (-ve control) and treatment 2 (+ve control) had the highest daily feed intake of 154.00 and 149.50g respectively, while birds on treatment 4 (2.5 g/kg neem and 2.5 g/kg Spondias) and treatment 5 (2.5 g/kg Neem and 2.5g/kg Spondias) had the lowest feed intake of 118.25g and 117.25g respectively.

Birds fed antibiotics had the highest daily weight gain of 60.48g while those fed treatment 1 (negative control) had a daily weight gain of 57.54g. Birds on treatment 3, had the lowest weight gain of 46.24g. Values recorded for bird on treatments 4 and 5 were not statistically different. This result could be as a result of the reduced feed intake observed in the treatments fed phytogenic plants. The feed conversion ratio were significantly different (P<0.05) across the treatments with birds fed treatment 1 having the highest feed conversion ratio of 2.70. The feed conversion ratio of birds fed conventional antibiotics in feed (+ve control) and those fed with feed containing all the phytogenic plants (treatment 6) were not statistically different. The best feed conversion ratio was obtained for birds fed combination of 2.5g/kg Neem and 2.5g/kg Spondias.

Haematological parameters of broiler chickens

The haematological parameters of broiler chickens fed experimental diets are presented in Table 4. At day 28, birds in treatment 2, which were fed antibiotics, treatment 4 (Neem +Spondias) and treatment 6 (all three supplements) had the highest level of packed cell volume and haemoglobin while those on treatment 1 (negative control) and neem only recorded the lowest levels. Treatment 4 (2.5g/kg Neem and 2.5g/kg Spondias) and treatment 6, which were fed diets containing the three phytogenic plants, had the highest level of red blood cells. Birds on treatment 2 (positive

control), birds on treatment 3 (5g/kg Neem) and treatment 5 (2.5g/kg Neem and 2.5g/kg Chromolaena) were statistically similar while treatment 1 (negative control) had the lowest level of red blood cells. Treatment 3(5g/kg Neem) had the highest concentration of white blood cells. These values were not significantly different for those on Treatments 2, 4 and 6. Birds on treatment 5 had the highest concentration of white blood cells.

The highest level of heterophil was recorded in treatment 6 while treatment 3 had the lowest level. The highest level of lymphocyte was recorded in treatment 3 while the lowest level was recorded in treatment 2, that received antibiotics and treatment 6 that received the three phytogenic plants. The highest level of eosinophils was recorded for birds on treatment 4 and it is found to be zero along with birds on treatments 1, 3, 5 and 6. The level of basophils and monocytes across the treatment groups were not significantly different (P>0.05).

At the end of the finisher phase, birds in treatment 6 which received the three phytogenic plants had the highest level of packed cell volume with treatments 1, 2, 3 and 5 not statistically different. Birds on Treatment 4 had the lowest packed cell volume. The haemoglobin level recorded for all the treatments were not statistically different (P>0.05). Treatment 5 (Neem + Chromolaena) and treatment 6, which received a combination of the three phytogenic plants, had the highest value for red blood cells. Treatment 1 (negative control), treatment 2 (positive control) and treatment 3 (Neem) were statistically similar and treatment 4 (Neem +Spondias) had the lowest value of red blood cells.

Birds fed Treatment 3 (5 g/kg neem) had the highest level of white blood cells. The levels of white blood cells were not significantly different in Treatments 2 and 5. Treatment 4 however had the lowest level of white blood cells. The values of heterophils, lymphocyte, eosinophils, basophils and monocytes recorded in the treatments were not statistically different (P>0.05).

Table 1: Chemical composition of Azadirachta indica, Spondias mombin and Chromolaena odorata

	Dry matter (g/kg)	Ether extract (g/kg	Crude protein (g/kg	Crude fibre (g/kg)	Ash (g/kg	Nitrogen free extract (g/kg	Flavenoids (%)	Tannins (%)	Saponin (%)	Polyphenol (%)	Alkaloids (%)	Phytate	Cyanogenic glucocide
Azadirachta indica	939.9	35.3	181.6	113.3	130.7	539.1	0.39	0.63	0.56	0.35	2.84	ND	ND
Spondias mombin	910.6	19.8	91.9	5.4	48.8	834.1	3.00	0.14	0.26	ND	0.96	ND	ND
Chromolaena odorata	918.4	2.5	162.0	265.7	61.7	508.2	ND	0.37	1.98	ND	ND	0.54	0.13

ND- Not determined

Table 2: Gross composition of experimental diets

Ingredients	Starter Diet (g/kg)	Finisher Diet (g/kg)
Maize	530.00	550.00
Soybean Meal	250.00	180.00
Groundnut cake	110.00	130.00
Wheat offal	29.00	60.00
Fish Meal (72%CP)	20.00	20.00
Bone meal	20.00	20.00
Oyster shell	20.00	30.00
Common salt	30.00	2.50
*Vit.mineral Premix	2.50	2.50
Methionine	3.00	3.00
Lysine	2.50	2.50
Total	1000.00	1000.00
Determined Values (g/kg)		
Crude protein	204.50	169.10
Metabolizable energy (Kcal/kg)	2911.80	2929.60
Crude fibre	20.60	51.20
Ether Extract	81.60	66.80

**Vitamin, mineral, and additive contributions per kilogram of feed: vitamin A, 9,000 IU; vitamin D3, 2,500 IU; vitamin E, 20 IU; vitamin K3, 2.5 mg; vitamin B1, 1.5 mg; vitamin B2, 6 mg; vitamin B6, 3 mg; pantothenic acid, 1.2 mg; biotin, 0.06 mg; folic acid, 0.8 mg; niacin, 25 mg; vitamin B12, 12 µg; I, 2 mg; Se, 0.25 mg; Cu, 20 mg; Mn, 160 mg; Zn, 100 mg; Fe, 100 mg (all sources as sulfate, except for sodium selenite and potassium iodate).*

Table 3: Table showing the layout of the experiment

Treatment 1 (-Ve control)	Treatment 2 (+Ve control)	Treatment 3	Treatment 4	Treatment 5	Treatment 6
Basal Feed	Feed + Antibiotics + normal vaccination schedule	Feed + 5g/kg milled dried leaves of Azadirachta indica.	Feed + 2.5g/kg milled dried leaves of Azadirachta indica + 2.5g/kg Spondias mombin	Feed + 2.5g/kg milled dried leaves of Azadirachta indica + 2.5g/kg Chromolaena odorata	Feed + 1.7g/kg milled dried leaves of Azadirachta indica + 1.7g/kg Spondias mombin + 1.7g/kg Chromolaena odorata.

Table 3: Performance characteristics of birds fed experimental diet (Day 0-28 and 29-56)

Parameters	1 (-ve control)	2 (+ve control)	3 (AI)	4 (AI+SM)	5 (AI+CO)	6 (AI+SM+CO)	SEM	P-value
Day 0-28								
Initial weight (g/bird)	41.06	42.16	42.22	41.04	41.12	40.00	0.33	0.016*
Final weight (g/bird)	389.00^{ab}	431.50^{a}	367.75^{b}	366.75^{b}	395.75^{ab}	349.25^{b}	8.70	0.038*
Daily feed intake (g/bird)	26.28^{abc}	27.70^{ab}	26.13^{bc}	27.88^{a}	25.45^{c}	22.43^{d}	0.42	0.002*
Daily weight gain (g/bird)	12.43^{ab}	13.95^{a}	11.65^{b}	11.65^{b}	12.68^{ab}	11.08^{b}	0.31	0.009*
FCR	2.19	1.98	2.26	2.39	2.00	2.03	0.06	0.611
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Day 29-56								
Initial weight (g/bird)	389.00	431.50	367.75	366.75	395.75	349.25	8.70	0.085
Final weight (g/bird)	2000^{ab}	2125.00^{a}	1662.50^{c}	1812.50bc	1800.00^{bc}	1850.00^{bc}	39.70	0.050
Daily feed intake (g/bird)	154.00^{a}	149.50^{a}	122.75^{bc}	118.25c	117.25^{c}	131.00^{b}	3.37	0.000*
Daily weight gain (g/bird)	57.54^{ab}	60.48^{a}	46.24^{c}	51.64bc	50.15^{bc}	53.60^{abc}	1.31	0.040*
FCR	2.70^{a}	2.47^{abc}	2.66^{ab}	2.30c	2.35^{bc}	2.46^{abc}	0.05	0.042*
Mortality (%)	0.2^{b}	0.75^{b}	2.00^{ab}	1.75ab	2.25^{ab}	3.25^{a}	0.30	0.001*

^{abc} *Means on the same row with different superscripts were significantly different ($p<0.05$)*
Treatment 1: No antibiotics, Treatment 2: Antibiotics with normal vaccination schedule, Treatment 3: Azadirachta indica, Treatment 4: Azadirachta indica+ Spondias mombin, Treatment 5: Azadirachta indica+ Chromolaena odorata, Treatment 6: Azadirachta indica +Spondias mombin+Chromolaena odorata, FCR: Feed Conversion Ratio, SEM: Standard Error of Mean.

Table 4: Haematological parameters of broiler chickens fed the experimental diets (Day 0-28 and 29-56)

Parameters	1 (-ve control)	2 (+ve control)	3 (AI)	4 (AI+SM)	5 (AI+CO)	6 (AI+SM+CO)	SEM	P-value
Day 0-28								
Packed Cell Volume (%)	22.67^{b}	31.00a	28.67^{b}	34.00^{a}	28.00^{ab}	32.67^{a}	1.23	0.054
Haemoglobin (g/dl)	7.47^{b}	10.47^{a}	9.67^{ab}	11.20^{a}	9.60^{ab}	10.90^{a}	0.42	0.051
Red Blood Cell (x 1012/ L)	1.40^{b}	2.27^{ab}	2.27^{ab}	2.80^{a}	2.17^{ab}	2.57^{a}	0.14	0.028*
White Blood Cell (109/ L)	11.10^{bc}	11.97^{ab}	12.47^{a}	11.90^{ab}	10.30^{c}	11.87^{ab}	0.20	0.018*
Heterophil (%)	32.67^{bc}	35.00^{ab}	20.00^{d}	30.00^{c}	32.00^{bc}	36.00^{a}	1.32	0.053
Lymphocyte (%)	67.00^{b}	63.67^{c}	78.67^{a}	69.00^{b}	66.67^{b}	63.67^{c}	1.27	0.025*
Eosinophil (%)	0.00^{b}	0.33^{ab}	0.00^{b}	0.67^{a}	0.00^{b}	0.00^{b}	0.09	0.036*
Basophil (%)	0.00	0.67	0.67	0.00	0.67	0.00	0.14	0.824
Monocyte (%)	0.33	0.33	0.67	0.33	0.67	0.33	0.15	0.830
Day 29-56								
Packed Cell Volume (%)	27.00^{ab}	26.67^{ab}	26.67^{ab}	23.00^{b}	27.00^{ab}	28.10^{a}	0.60	0.050
Haemoglobin (g/dl)	8.67	8.30	8.70	7.87	8.77	9.17	0.18	0.415
Red Blood Cell (x 1012/ L)	1.87^{ab}	1.90^{ab}	1.67^{ab}	1.40^{b}	2.07^{a}	1.97^{a}	0.08	0.049*
White Blood Cell (109/ L)	11.37^{c}	11.70^{bc}	13.07^{a}	11.30^{c}	11.70^{bc}	12.87^{ab}	0.22	0.014*
Heterophil (%)	29.65	31.00	30.00	33.00	30.67	28.67	0.71	0.844
Lymphocyte (%)	69.00	67.67	68.00	67.00	68.67	71.00	0.56	0.306
Eosinophil (%)	0.00	0.33	0.00	0.00	0.33	0.00	0.08	1.000
Basophil (%)	0.67	0.00	1.00	0.00	0.00	0.00	0.11	0.048
Monocyte (%)	0.67	1.00	1.00	0.00	0.33	1.33	0.18	0.930

^{abc} Means on the same row with different superscripts were significantly different ($p<0.05$)
Treatment 1: No antibiotics, Treatment 2: Antibiotics with normal vaccination schedule, Treatment 3: Azadirachtaindica, Treatment 4: Azadirachta indica+ Spondias mombin, Treatment 5: Azadirachta indica+ Chromolaena odorata, Treatment 6: Azadirachta indica +Spondias mombin+Chromolaena odorata, FCR: Feed Conversion Ratio, SEM: Standard Error of Mean.

Discussion

Performance characteristics of broiler chickens

The final weights recorded were significantly different across the treatments. Birds that were administered with antibiotics had the highest final weight of 432.50g. This could be as a result of the positive effect of antibiotics on digestibility which is in line with the report by Landy et al. (2012). It is believed that the simultaneous action of some of the mechanisms through which antibiotics work generate the performance benefits observed in broilers and other domestic animals as reported by Bedford (2000). Low final weights recorded in birds that received neem leaf (367.75g), Neem + Spondias (395.75g) and combination of the three supplements (349.25g) could be partially attributed to the presence of some anti-nutritional factors that are naturally present in the phytogenic plants, such as tannins. Tannins can bind proteins in digestive tracts and reduce protein absorption, thus resulting in decreased growth performance.

Toghyani et al. (2011) showed that feeding yarrow (Achille amillefolium) to broilers did not result in any significant improvement of productive traits due to the presence of some anti-nutritional factors in yarrow such as tannins. Also, Biller et al. (1994) and Irobi (1997) reported that Chromolaena odorata leaves contained some toxic factors that could impede feed utilization. Treatment without antibiotics and those that contained Neem and Chromolaena were statistically similar in the terms of final weight recorded, (389.00g and 395.25g respectively) and followed closely the highest final weight of 431.50g obtained for the antibiotic treatment. The high final weight observed in birds not receiving any dietary treatment could be due to the proper management and high level of hygienic condition maintained throughout the experimental period.

Birds fed Neem and Spondias had the highest daily feed intake of 27.88g. Earlier reports have indicated that active ingredients in phytogenic plants were sometimes aromatic (Karan and Vishavjit, 2004), thus, they had effect on the feed intake of animals and increased feed palatability, thus increasing voluntary feed intake. Combination of all the three test plants in treatment 6 had a significant depressing effect on the feed intake. The three phytogenic plants present in this treatment are high in fibre, and the resulting rough and gritty texture may discourage high intake.

Birds administered with antibiotics had the highest daily weight gains. Visek (1978) reported that the use of antibiotics resulted in better nutrients utilization, which consequently led to higher weight gain. Weight gains of birds that received neither the phytogenic plants nor antibiotics and those fed Neem and Chromolaena recorded daily weight gains which closely followed the highest weight gain observed for birds on antibiotics. Dietary treatments containing neem only, those with neem and Spondias, along with the treatment containing the three plant supplements elicited the lowest daily weight gains. The low daily weight gains are most probably consequences of reduced feed intake obtained with these treatments.

The feed conversion ratio and mortality values observed across the treatments were significantly different ($P < 0.05$). These results are similar to the report by Abu-Darwish et al. (2008) that supplementation of Nigella sativa L. seeds in broiler studies improved feed conversion ratio. The results are also in agreement with the report that the use of various plant materials as dietary supplements, including herbs or extracts, may positively affect poultry productivity and subsequently production performance (Lee *et al.,* 2004). Hung et al. (1992) also reported that health growth promoters improved feed conversion ratio. No mortality was recorded throughout the first 28 days of the experiment. Fasuyi et al. (2005) also recorded no mortality in an experiment that involved the use of Siam weed (Chromolaena) leaf meal in layers' diet. Phytogenic plants have been reported to have raised the immune status of broilers, thus preventing mortality (Li *et al.,* 2009).

The result on final weight, feed intake and feed conversion ratio at day 56 did not agree with the results of Ademola et al. (2004) who reported no significant difference

(P>0.05) in average live weight, feed intake and feed conversion ratio of broiler chickens fed herbal supplements. Our results is more in consonance with that of Windisch et al. (2009), who observed that the application of dried herbs and spices decreased body weight by 1.5%. Moreover, birds that receive treatment 6 had the highest mortality with treatment 1 (negative control) and treatment 2 (positive control) having the lowest mortality. Values obtained for birds on treatments 3, 4 and 5 were not statistically different. Windisch et al. (2009) related the lack of efficacy of phytobiotics used in his study to the low dosage employed. We would rather adduce reasons of probable antagonism among active compounds of the three plants used in our study as the remote cause for the low performance and high mortality.

Haematological parameters of broiler chickens

At the end of the starter phase, birds in treatment 2, which were fed with antibiotics in diet, treatment 4 (2.5g/kg each of Neem and Spondias) and treatment 6 (1.7g/kg each of neem, Chromolaena and Spondias) had the highest level of packed cell volume and haemoglobin while treatment 1 (negative control) and treatment 3 (5g/kg neem) had the lowest values. The results of the Packed Cell Volume obtained across dietary treatments 2 to 6 were all within normal range of 22 to 35% reported by Jain (1993). The results of the haemoglobin level obtained across dietary treatments were all within normal range (7 – 13 g/dl) obtained by Bounous and Stedman (2000) of low Packed Cell Volume, Haemoglobin and Red Blood Cells often indicate that the oxygen carrying capacity of the animal's blood is low and that the animal is anaemic, but according to our results, the treatments did not have negative effect on the haematological parameters of the broiler chickens. Treatment 4 (2.5g/kg neem and 2.5g/kg Spondias) and treatment 6, which were fed diets containing the three phytogenic plants, had the highest level of Red Blood Cells. Birds fed Treatment 2 (positive control), treatment 3 (Neem) and treatment 5 (Neem + Chromolaena) were statistically similar while treatment 1 (negative control) had the lowest level of Red Blood Cells. The results of the values of Red Blood Cells obtained across treatments 2 to 6 were all within normal range of 1.57-2.99 (x 1012/ L) reported by Bonsu (2012).

The level of White Blood Cells observed for all the treatments were within the range of 1.63-34.83 (x 109/L) reported by Bonsu (2012). The levels of eosinophils, basophils and monocytes were also lower compared to earlier report by Pîrvu et al. (1984). The level of lymphocytes recorded for other treatments excluding treatment 3 were also in line with the report by Pîrvu et al. (1984) while higher levels of heterophils were recorded for all the treatments. Elevated White Blood Cells value may indicate an infection and cell mediated immunity. The higher White Blood Cells of birds on treatment 3 indicate a probable disease condition which might have stimulated the production of White Blood Cells to fight against the potential causative agent. The relatively lower WBC of the birds on treatments 2, 4 and 6 could be attributed to the inclusion of phytogenic plants and antibiotics which acted against potential disease threats before the body system could be stimulated to produce White Blood Cells.

At day 56, birds on treatment 6 and 4 had the highest and lowest level of Packed Cell Volume respectively. The reduction in the value of Packed Cell Volume at this age agrees with the findings of Jain (1986) and Gupta et al. (2002). These researchers reported that Packed Cell Volume decreased with age. However, the PCV values reported fall within the range of 26-45.2% reported for chickens (Mitruka and Rawnsley, 1997; Orawan and Aengwanich, 2007). White blood cell count increased in value at the finisher phase in all the treatments except for birds on treatments 2 and 4. Addass et al. 2012 and Etim et al (2014) reported that WBC increases with age. Higher WBC values at day 56 could be related to increase in immunological ability at this age compared to juvenile age as adduced to by Kabir et al. (2013) and Soetan et al. (2013). The haemoglobin concentration of the experimental diets did not differ significantly within the groups. This is in line with the work of Cosmas et al. (2015).

The level of eosinophils, basophils and monocytes were lower than the values reported by Ghergariu et al. (2000).

Conclusion

The findings of this study showed that feeding basal diet with 2.5g/kg milled dried leaves of Azadirachta indica and Spondias mombin in practical diets of broiler chickens gave best result in terms of FCR at the finisher phase. Furthermore, feeding combinations of Azadirachta indica, Spondias mombin and Chromolaena odorata improved the PCV at both rearing phases. The birds fed basal diet with 2.5g/kg each of Azadirachta indica and Chromolaena odorata at the starter phase were apparently in good state of health as far as the haematological indicators measured are concerned. Feeding basal diet alone or combinations of 2.5g/kg Azadirachta indica and 2.5g/kg Spondias mombin did not have negative effect on the health status of the birds at the finisher phase.

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Conflict of interest:

There is absolutely no conflict of interest with any individual or organization regarding the materials discussed in the manuscript

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PATTERN OF TICK INFESTATION ON ONE HUMPED CAMELS (*Camelus dromedarius*) IN SOKOTO, NIGERIA

Alayande M O[1], Mayaki A M[2], Lawal M D[1], Bandi N I[2], Ibrahim D D[1] and Talabi A O[2,3].
[1]Department of Veterinary Parasitology and Entomology,
[2]Department of Veterinary Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria
[3]Department of Veterinary Medicine and Surgery, College of Veterinary Medicine, Federal University of Abeokuta, Nigeria

Abstract

The pattern of tick infestation in one humped camels (*Camelus dromedarius*) was assessed in Sokoto metropolitan abattoir, Sokoto State, Nigeria where an average of 10 to 15 camels were slaughtered per day on an open concrete slaughter slab. A total of 200 randomly selected camels made up of 124 males and 76 females were aged by dentition determination technique and examined for tick infestations between February and September, 2015. All the camels examined in this study were infested with at least one species of ticks with some mixed infestations. *Hyalomma* species is the most common tick genus found on camels of both sexes; where it accounted for 73.4% and 71.1% of male and female camels respectively. In all, *Hyalomma* species accounted for 72.5% while *Amblyomma variegatum*, *Boophilus decoloratus* and *Rhipicephalus sanguineus* accounted for 20.0%, 14.0% and 19.0% respectively. *Hyalomma* species is also the most common genus found on camels of all age groups and accounted for 75.4% in 1 to 6 years age group, 70.9% in 7 to 12 age group and 71.4% in 13 to 18 age group. The species of *Hyalomma* identified in the study included *Hyalomma dromedarii* (50.7%), *H. rufipes* (17.0%), *H. impeltatum* (17.5%) and *H. truncatum* (14.8%). Prevalence of infestation was not seasonal, as ticks were found on the camels during the dry and wet seasons of the study period, with higher tick burden in the wet season. It was concluded that untreated tick-infested camel herds may pose a public health hazard to other animals and man in the environment; hence they should be factored into consideration during control programmes of ticks on other livestock animals.

Keywords: Camels, Pattern, Sokoto, Tick infestation

LE PROFIL D'INFESTATION PAR LA TIQUE SUR LES CHAMEAUX A UNE BOSSE (CAMELUS DROMEDARIUS) DANS LE DISTRICT DE SOKOTO AU NIGÉRIA.

Résumé

Le profil d'infestation par la tique sur les chameaux à une bosse (Camelus dromedarius) a été évalué à l'abattoir de la métropole de Sokoto, dans l'État de Sokoto, au Nigeria, où en moyenne de 10 à 15 chameaux sont abattus par jour sur une dalle ouverte d'abattage en béton. Un total de 200 chameaux choisis au hasard composés de 124 males et 76 femelles dont l'âge était déterminé par la technique de dentition ont été examiné pour l'infestation des tiques entre février et septembre 2015. Tous les chameaux examinés dans cette étude ont été infestés avec au moins une espèce de tiques et quelques infestations mixtes. L'espèce Hyalomma est la tique la plus répandu sur les chameaux des deux sexes ; où elle représente respectivement 73,4% et 71,1% des chameaux mâles et femelles. Au total, l'espèce Hyalomma représente 72,5%, tandis que l'Amblyomma variegatum, le Boophilus decoloratus et le Rhipicephalus sanguineus représentent respectivement 20,0%, 14,0% et 19,0%. L'Hyalomma est également l'espèce la plus répandue chez les chameaux de tous les groupes d'âge et représente 75,4% chez les chameaux de 1 à 6 ans, 70,9% de 7 à 12 et 71,4% de 13 à 18 ans. L'Hyalomma identifiée dans l'étude était composée de l'Hyalomma dromedarii (50,7%), le H. rufipes (17,0%), le H. impeltatum (17,5%) et le H. truncatum (14,8%). La prévalence de l'infestation n'était pas saisonnière, dans la mesure où on a trouvé des tiques sur les chameaux pendant les saisons sèches et humides de la période d'étude, avec une couverture de tiques la plus élevée pendant la

Corresponding author email: deletalabi@yahoo.co.uk

saison humide. Il a été conclu que les troupeaux de chameaux non traités des infestations de tiques peuvent présenter un danger de santé publique chez d'autres animaux et chez l'homme dans l'environnement ; elles doivent donc être pris en compte dans l'examen au cours des programmes de contrôle des tiques sur d'autres animaux d'élevage.

Mots clés : les chameaux, le mode, Sokoto, l'infestation par le tique.

Introduction

One humped camels otherwise known as Arabian or Dromedary camels are foot padded domestic animals belonging to the species *Camelus dromedarius* (Dirie and Abdulrahman, 2003). Camels play an important role in the culture and agriculture of many countries. It is an important working animal of the arid and semi-arid ecosystem because of its unique adaptive physiological characteristics (Rabana *et al.,* 2011). Camels are important source of meat, milk and their dungs are used for fires. Camels are popular as beast of burden and livestock among animal keepers, in Sahel savannah region of Northern Nigeria and other arid regions of Africa (Dirie and Abdulrahman, 2003; Nwosu *et al.,* 2003).

The breeding of camelids (*Camelus dromedarius* and *C. bactrianus*) is a regionalized activity mainly for reasons of climate, and is concentrated in the arid and semi-arid regions of Africa, especially from the edges of the Sahara and the Sahel to the eastern edge of the continent. It is also practiced from the Middle East and the Arabian Peninsula to the countries of the Commonwealth of Independent States, and in the People's Republic of China and Mongolia. In both regions, camelids play an important economic role as providers of meat and milk, and as draught animals. The world camelid population in 2002 was estimated to be 19,300,000, of which 78.4% are in Africa. Somalia, Sudan and Mauritania have 55% of the world camelid population (Saraiva, 2003). The one humped camel is widely believed to be a comparatively hardy animal (OIE, 2003) with its population increasing at the rate of 1.62% annually (Biu and Abbagana, 2007).

However, camel production is conversely affected by the occurrence of various diseases, inadequate veterinary services and feed shortage (Bekele, 2010). The common health problems of camels in Nigeria include helminthosis, traumatic injuries, tick infestation, footpad perforation, conjunctivitis, mange, abscesses, lameness, enteritis, abortion, coccidiosis, kneecap dislocation and bent neck syndrome (Mohammed *et al.,* 2007). The pattern of tick infestation in one humped camels (*Camelus dromedarius*) slaughtered at Sokoto metropolitan abattoir, Sokoto, was assessed in this study.

Materials and Methods

Study area: The study was conducted from February to September 2015, in Sokoto abattoir, Sokoto State, Nigeria, where livestock animals including camels are slaughtered. Most of the animals are sourced from local farmers and neighbouring villages. Averages of 10 to 15 camels were slaughtered per day on an open concrete slaughter slab. Sokoto is located between longitudes 11°30 and 13°50E and latitude 4° to 6°N with the two main seasons, the wet in June and the dry from November to May. It has an annual rainfall of maximum 550mm and 1,300mm, temperature of 28 - 48°C and mean monthly relative humidity 15-40% respectively for the year 2013 (Alayande *et al.,* 2012). Sokoto State is placed second with regards to livestock population in Nigeria (SSIPC, 2008).

Sample collection and Processing: Camels examined in this study were the one humped species (*Camelus dromedarius*). A total of 200 camels made up of 124 males and 76 females were selected randomly at post-slaughter, aged by rostral dentition (Bello *et al.,* 2013) and thoroughly examined for the presence of ticks by direct macroscopic observation. Ticks spotted were hand-picked with the aid of forceps by grasping the tick firmly over the scutum, twisted round by 3600,

carefully and gently pulled away from the skin and transferred into labelled sample bottles containing 70% ethanol. All samples were transported within hours to the Parasitology and Entomology Laboratory of Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto for processing. In the laboratory, the ticks were viewed using a stereo-microscope, and were identified to species level as described by (Walker *et al.,* 2014). The data generated were analyzed using descriptive statistics (percentages and tabulations).

Results

All the camels examined in this study were infested with at least one species of ticks with some mixed infestations. The distribution of different genera of ticks on both sexes of camels is presented in Table 1. *Hyalomma* species is the most common genus found on camels of both sexes; where it accounted for 73.4% and 71.1% of male and female camels respectively. *Boophilus decoloratus* is least in female camels. In all, *Hyalomma* species accounted for 72.5% while *Amblyomma variegatum*, *Boophilus decoloratus* and *Rhipicephalus sanguineus* accounted for 20.0%, 14.0% and 19.0% respectively.

The prevalence of different genera of ticks on different age ranges of camels is presented in Table 2. *Hyalomma* species is the most common genus found on camels of all age groups and accounted for 75.4% in 1 to 6 years age group, 70.9% in 7 to 12 age group and 71.4% in 13 to 18 age group. *Boophilus decoloratus* is least in 1 to 6 years age group where it accounted for 13.0%.

The prevalence of different tick species infesting camels in Sokoto is presented in Table 3. A total of 647 ticks of various species were picked on the camels which included *Hyalomma* species (57.3%), *Amblyomma variegatum* (18.9%),

Table 1: Distribution of different genera of ticks on both sexes of dromedary camels in Sokoto

Sex	Number (%)	*Hyalomma*	*Amblyomma*	*Boophilus*	*Rhipicephalus*
Male	124 (62)	91 (73.4)	21 (16.9)	18 (14.5)	17 (13.7)
Female	76 (38)	54 (71.1)	19 (25.0)	10 (13.2)	21 (27.6)
Total	200 (100)	145 (72.5)	40 (20.0)	28 (14.0)	38 (19.0)

Values in parenthesis are percentages

Table 2: Prevalence of different ticks with age of camels in Sokoto

Age range	Number (%)	*Hyalomma*	*Amblyomma*	*Boophilus*	*Rhipicephalus*
1-6	69 (34.5)	52 (75.4)	12 (17.4)	9 (13.0)	15 (21.7)
7-12	110 (55.0)	78 (70.9)	19 (17.3)	15 (13.6)	19 (17.3)
13-18	21 (10.5)	15 (71.4)	9 (42.9)	4 (19.0)	4 (19.0)
Total	200 (100)	145 (72.5)	40 (20.0)	28 (14.0)	38 (19.0)

Table 3: Prevalence of different tick species on camels in Sokoto

Tick species	No. collected (%)
Hyalomma species	371 (57.3)
Amblyomma variegatum	122 (18.9)
Boophilus decoloratus	83 (12.8)
Rhipicephalus sanguineus	71 (11.0)
Total	647 (100)

Table 4: Hyalomma tick species found on camels in Sokoto

Hyalomma species	No. collected (%)
Hyalomma dromedarii	188 (50.7)
H. rufipes	63 (17.0)
H. impeltatum	65 (17.5)
H. truncatum	55 (14.8)
Total	371 (100)

Boophilus decoloratus (12.8%) and *Rhipicephalus sanguineus* (11.0%). Table 4 showed the species of *Hyalomma* identified in this study to include *Hyalomma dromedarii* (50.7%), *H. rufipes* (17.0%), *H. impeltatum* (17.5%) and *H. truncatum* (14.8%).

Discussion

The results obtained in this study which covered the two main seasons in Sokoto showed that all the camels examined were infested with at least one species of ticks with some mixed infestations and tick infestation is not seasonal but higher tick burden was observed in the wet season and all ages are affected. *Hyalomma* species is the most common tick found on camels in this study with a prevalence rate of 72.5% followed by *Amblyomma variegatum* (20%), *Rhipicephalus sanguineus* (19%) and *Boophilus decoloratus* (14%). This high prevalence of *Hyalomma* species is in agreement with the results of previous surveys in northern Nigeria.

Lawal et al. (2007) examined 1502 camels in Sokoto, out of which ticks were found in 86.88% of the animals with *Hyalomma dromedarii* as the most numerous tick species. In a survey of tick species infesting the camels in Borno State, Nigeria, Biu and Konto (2012) examined 96 camels and *Hyalomma dromedarii* was the most numerous tick species on the camels accounting for 88.1% of the ticks found. Other tick species found on camels in Borno State, Nigeria included *Boophilus decoloratus* (10.8%), *Amblyomma variegatum* (0.9%) and Rhipicephalus evertsi evertsi (0.3%).

In a survey of tick species infesting camels in Kebbi State, Nigeria, Yahaya et al. (2015) examined 40 camels and 80% of them were infested with five different tick species of which *Hyalomma dromedarii* accounting for 27.4% of the ticks picked on the animals. Other tick species found on camels in Kebbi State, Nigeria included *Boophilus decoloratus* (20.5%), Boophilus annulatus (19.1%), *Hyalomma* truncatum (21.9%) and *Amblyomma variegatum* (11.1%). Yahaya (2008) also examined 558 camels for ticks in Kano, Katsina and Zamfara States of Nigeria. The camels were infested with at least one species if ticks and *Hyalomma dromedarii*, *Amblyomma variegatum* and Rhipicephalus pravus had overall prevalences of 58.06%, 31.36% and 21.33% respectively. And outside Nigeria, Dia (2006) examined 67 camels in Burkina Faso where he found various species of *Hyalomma* infesting camels which include H. dromedarii, H. marginatum rufipes, H. impressum, *H. impeltatum* and H. truncatum.

Although there is variation in prevalence rate reported which may be a reflection of varying sample size of the studies but high occurrence of *Hyalomma* species was consistently been identified. This therefore shows that it is a major and the most common tick found on one humped camels. A breakdown of the *Hyalomma* species found in this present study showed that *Hyalomma dromedarii* is the most numerous (50.7%) and others include *H. rufipes* (17.0%), *H. impeltatum* (17.5%) and *H. truncatum* (14.8%). *Hyalomma* species is also the most common tick found on camels of all age groups and accounted for 75.4% in 1 to 6 years age group, 70.9% in 7 to 12 age group and 71.4% in 13 to 18 age group while *Boophilus decoloratus* is least in 1 to 6 years age group where it accounted for 13.0%. This probably indicated that there is no age susceptibility to *Hyalomma* species infestation in the camels.

The occurrence of *Hyalomma* species have been noted throughout Africa, Asia Minor and southern Europe where they were incriminated as vectors of several babesial, theilerial and rickettsial infections (Urquhart *et al.,* 1996). *Amblyomma variegatum* on the other hand are distributed mainly in Africa and are known to transmit heartwater disease, caused by the rickettsia, Ehrlichia (Cowdria) ruminantium, (Urquhart *et al.,* 1996) and dermatophilosis in cattle.

These tick borne diseases seriously limit livestock production and improvement in most of Africa regions (Talabi *et al.,* 2011) including the arid and semi-arid regions where camel is one of the major livestock of animal keepers. This assertion is reflected in the prevalence rate reported by Bamaiyi et al. (2011) for Anaplasma sp. (3.8%) and Theileria sp. (1.9%) from 105 camels examined in Maiduguri. Joshua et al. (2008) also in Maiduguri examined

113 camels and found Theileria camelensis and Trypanosoma evansi in 8.0% and 3.5% respectively. Naturally occurring babesiosis in dromedary camels was noted in the Riyadh region of Saudi Arabia. (Swelum *et al.,* 2014).

Camels may therefore be responsible for maintaining haemoparasites transmitted by these ticks and thereby serving as a source of disease transmission among livestock animals in Sokoto, hence, a potential reservoir to the surrounding ruminants located in close proximity with them.

In conclusion, untreated tick-infested camel herds may pose a public health hazard to other animals and man in the environment, hence they should be factored into consideration during control programmes of ticks on other livestock animals.

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EFFECTS OF CHANGING CLIMATE AND VEGETATION ON *TRYPANOSOMOSIS* BURDEN IN THE GAMBIA

Secka A, Gibba P*, Ceesay A, Bojang M, Jarju A and Gaye M.
International Trypanotolerance Centre, PMB 14, Banjul, The Gambia
*Department of Water Resources, Banjul, The Gambia

Abstract

The aim of this one year long longitudinal study was to update the current prevalence of *trypanosomosis* in cattle, tsetse density and challenge that could have been influenced by changes in climatic factors and land use.

A total of 3651 cattle blood samples were collected from 120 randomly selected cattle herds in both Kiang West and Niamina East Districts of The Gambia during six bimonthly sampling in 2011. The blood samples were examined using the dark ground buffy coat technique to establish the cattle *trypanosomosis* prevalence at both herd and animal levels. During the same period, a total of 317 biconical traps were set up and harvested for two consecutive days to calculate the tsetse density and challenge. Land cover/use map for the two study sites were compared with past reports to assess the changing vegetation cover. Records on rainfall, temperature and humidity were used to assess their trends over the past three decades. All data were analysed using linear regression, logistic regression, poisson and negative binominal regression models in STATA 11 and scatter plot graphs in MS Excel.

Results of the survey on tsetse abundance and *trypanosomosis* prevalence shows overall tsetse density (TTD), tsetse challenge, *trypanosomosis* prevalence animal level and herd level of 2.0, 13.9, 3.1% and 53% in Kiang West; 2.5, 16.5, 3.2% and 55% in Niamina East, respectively. The bimonthly TTD, tsetse challenge, *trypanosomosis* prevalence animal level and herd level at the study sites varied as follows: 0.05-10.15 TTD, 0.00-87.63 tsetse challenge, 1.0-5.9% *trypanosomosis* prevalence animal level and 20-100% *trypanosomosis* prevalence herd level. Comparing these values with published findings, it appears that *trypanosomosis* prevalence and TTD in Kiang West remains the same but the tsetse challenge has increased; whilst in Niamina East the *trypanosomosis* prevalence remain the same but both TTD and tsetse challenge are decreasing. The assessed climatic factors showed a significant increase during the past three decades, and the habitats of tsetse flies appear to have reduced.

It is concluded that the study areas have African Animal *Trypanosomosis* (AAT) problem ranking of Low to Medium with some hotspots of High to Very Severe tsetse burden. Recommendations for Farmers, PROGEBE and Policy makers include strategic cattle feeding, tsetse fly control, treatment of infected animals, capacity building and recruitment of additional livestock technicians.

Keywords: *trypanosomosis*, tsetse density, tsetse challenge, climate changes, The Gambia

LES EFFETS DU CHANGEMENT DE CLIMAT ET DE VÉGÉTATION SUR LE RISQUE DE LA TRYPANOSOMIASE EN GAMBIE

Résumé

Le but de cette étude longitudinale d'un an a été de mettre à jour la prévalence actuelle de la trypanosomiase chez les bovins, la densité glossine et le défi qui pourrait être influencé par l'évolution des facteurs climatiques et l'utilisation des terres.

Un total de 3651 échantillons de sang du bétail a été prélevé sur un troupeau de 120 bovins choisis au hasard dans les deux districts de Kiang Ouest et de Niamina Est de la Gambie pendant six échantillonnages bimensuels en 2011. Les échantillons de sang ont été examinés à l'aide de la technique de la couche leucocytaire de fond sombre pour établir la prévalence de la trypanosomiase chez le bétail tant au niveau du troupeau qu'au niveau des animaux. Au cours de la même période, 317 pièges biconiques ont été mis en place et récoltés pendant deux jours consécutifs pour calculer la charge et la densité glossine.

Corresponding author email: seckaarss@gmail.com

La carte de couverture et l'utilisation des terres des deux sites d'étude ont été comparés aux rapports précédents pour évaluer le changement de la couverture végétale. Les données sur les précipitations, la température et l'humidité ont été utilisés pour évaluer les tendances au cours des trois dernières décennies. Toutes les données ont été analysées par régression linéaire, régression logistique, le modèle de poisson et la régression binominale négative dans le STATA II et les graphiques de nuage de points dans MS Excel.

Les résultats de l'enquête sur l'abondance des glossines et la prévalence de la trypanosomiase montrent la densité des glossines (DG), la charge de glossine et le niveau de prévalence de la trypanosomiase chez l'animal et le troupeau respectivement de 2,0, 13,9, 3,1% et 53% à Kiang West ; 2,5, 16,5, 3,2% et 55% à Niamina Est. La DG bimestrielle, la charge de glossine, la prévalence de la trypanosomiase chez l'animal et le troupeau dans les sites d'étude varient comme suit : de 0,05 à 10,15 DG, de 0,00 à 87,63 densité glossines, la prévalence de la trypanosomiase chez l'animale de 1,0 à 5,9%, et 20-100% de prévalence de la trypanosomiase chez le troupeau. En comparant ces valeurs avec les résultats publiés, il semble que la prévalence de la trypanosomiase et la DG dans le Kiang West reste le même, mais la charge de glossine a augmenté ; tandis que dans le Niamina Est, la prévalence de la trypanosomiase reste la même, mais les deux DG et la charge glossine sont en baisse. Les facteurs climatiques évalués avaient montré une augmentation significative au cours des trois dernières décennies, et les habitats des mouches tsé-tsé semblent avoir réduits.

Il a été conclu que les problèmes de trypanosomiase animal africaine dans les zones d'étude sont classés de faible à moyen avec quelques zones sensibles dont le degré va du point élevé à une couverture glossine très sévère. Les recommandations pour les agriculteurs, PROGEBE et les décideurs comprennent une alimentation stratégique des bovins, la lutte contre la mouche tsé-tsé, le traitement des animaux infectés, le renforcement des capacités et le recrutement de techniciens d'élevage supplémentaires.

Mots clés : la trypanosomiase, la densité glossine, la difficulté glossine, les changements climatiques, la Gambie

Introduction

Climate change resulting from accumulation of greenhouse gasses leads to global warming, sea level rise, change in rainfall patterns, and frequency of extreme events around the world. Climate change also has negative impact on human and animal health, food and water security, and diversity in the ecosystems. Territories of The Gambia with rainfall of less than 800 mm were 36% of the land coverage in 1940ties, but have increased to 93% in 1965 and the average minimum monthly temperature across the country has also increased by 0.40° C or higher per decade (Government of The Gambia, 2007). However, climatic factors that have bearings on tsetse flies population as well as changes in vegetation and land cover/ usage across certain areas in The Gambia from 1981 to 2010 might have altered during these three decades.

The vegetation of the Gambia has suffered a huge decline in riverine forest, closed canopy woodland and corresponding increase in open woodlands, floodplains and farmland. Consequently the area of the country covered by forest and closed-canopy woodland, including primary and secondary tsetse habitat fell from 60% in 1946 to 3% in 1993 (Bourn *et al.,* 2001). This has been caused mainly by increase in human population that created increased demand for residents, cultivation land and fire wood.

Trypanosomosis is one of major disease constraint affecting livestock production in sub- Saharan Africa. It has been estimated that about 37% of the continent, 11 million square km involving 40 countries, is infested with tsetse flies the vectors of *trypanosomosis* (FAO/WHO/OIE, 1982). Forty five million of 175 million heads of cattle from 37 African countries thrive within tsetse infested belt stretching from South to West Africa (Gilbert *et al.,* 2001). They estimated an increase of 50 million head of cattle if tsetse was eradicated. The Gambia could therefore increase her cattle productivity through controlling tsetse flies and *trypanosomosis*.

The N'Dama cattle breed which is known to be trypanotolerant predominates

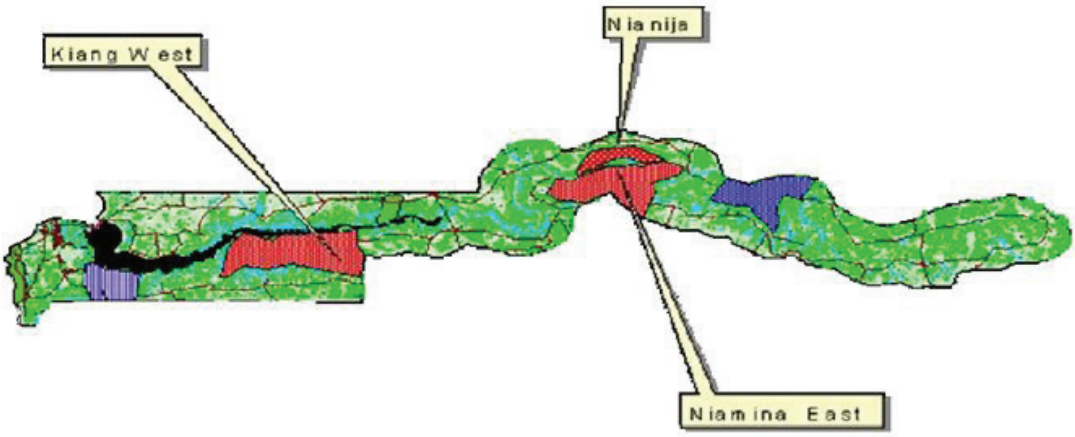

Figure 1: PROGEBE primary sites in The Gambia *http://www.progebe.net/index.php*

in the national herd structure. However, they could succumb to chronic *trypanosomosis* under stressful physiological conditions such as lactation, hunger and work (Agyemang *et al.,* 1992). Five levels of African Animal *Trypanosomosis* Problem ranking: Zero, Low, Medium, High and Very Severe have been established in The Gambia (Snow and Rawlings, 1999). Cattle *trypanosomosis* prevalence is mainly affected by tsetse fly population. Tsetse challenge has been found to be strongly correlated with the incidence of trypanosome infection in susceptible Zebu (Watcher *et al.,* 1994).

The Regional Project on Sustainable Management of Endemic Ruminant Livestock in West Africa (PROGEBE), 2008-2015, was interested at updating the current prevalence of *trypanosomosis* in cattle, tsetse density and challenge that could have been influenced over the years by changes in climatic factors and land use so that appropriate remedial actions could be taken when required.

Materials and Methods

Study sites

The two study sites were Kiang West and Niamina East Districts. Kiang West District is located in Lower River Region, and Niamina East District in Central River Region South (Figure 1). These districts constitute two of the three PROGEBE primary sites.

Field sampling and laboratory test

Field sampling consisted of blood collection from selected cattle herds. Collected non-coagulated whole blood samples were examined under the microscope to detect trypanosome infected cattle using darkground buffy coat technique as described by Murray *et al.,* 1977. Six field sampling and laboratory analyses were conducted during weeks two and three in February, April, June, August, October, and December 2011.

A sampling frame for cattle herds in both Kiang West and Niamina East districts was developed in January. This frame consists of the list of all herds, owners' name and location. This list was extracted from the Endemic Ruminant Livestock census conducted in 2009 by PROGEBE-Gambia at the three PROGEBE sites. There were 137 cattle herds in Kiang West district, but for every sampling period we drew a random sample of 10 herds from 105 herds with herd size of at least 40 heads. There were also 96 cattle herds in Niamina East, but a regular random sample of 10 herds were drawn from 63 herds that have at least 40 cattle.

After getting the consent of the herd owners to participate in this research activity, blood samples were collected from the jugular vein of 18 - 31 cattle per herd. Thus 1,849 cattle blood samples were obtained from 60 herds in Kiang West district during the six sampling periods. In Niamina East district 1,802 cattle blood samples were also collected from 60

herds during the six sampling periods. Since the cattle were not tagged, the sampled cattle were serially numbered on their skin using vaporised paint. The age, sex and breed of each sampled cattle was also recorded.

A total of 317 biconical traps where set around the grazing area of 120 sampled cattle herds in both Kiang West and Niamina East districts during the sampling period. Cattle grazing sites are mostly determined by the season. During the dry season cattle mostly graze on farmlands, rice fields, along streams and woodland. However, during the rainy season cattle mostly graze on woodland and communal rangelands. These different feeding areas were targeted for setting up of the traps.

Caught tsetse flies were harvested daily for two days per each setup conical trap. The harvested flies were sorted, identified, counted and dissected to determine trypanosome infection rates. Tsetse fly counts and trypanosome infection rates were used to determine the tsetse density (total flies caught/ (number of traps x 2)) and tsetse challenge (number of infected flies/number dissected) in sampled areas.

Records on annual mean rainfall, average temperature (minimum and maximum) and humidity collected by the Department of Water Resources from 1981 to 2010 at Kerewan and Sapu meteorological stations was used to assess the trends of these parameters over the past three decades. Both meteorological stations are adjacent to Kiang West and Niamina East districts, respectively. The 2009 Land cover/use map for the two study sites developed by the National Environment Agency was also compared with past reports to assess the land use changes.

Trypanosome infection dataset was analysed using linear regression and logistic regression; poisson and negative binominal regression models for tsetse counts in STATA 11 statistical package; and scatter plot graphs in Microsoft Excel for climatic factors.

Results

Trypanosomosis prevalence at herd level

Trypanosomosis prevalence at herd level shows the percentage of herds that have at least one laboratory confirmed trypanosome infected cattle. It gives an indication of how many herds are infected at specific periods, and the extent of disease morbidity across herds. The *trypanosomosis* prevalence at herd level was highest in Niamina East in December and lowest in April, but the overall herd prevalence is similar in both districts (Figure 2). The herd prevalence in Niamina East was higher than Kiang West for three sampling periods (June, October, and December), but Kiang West had higher values in April and August. The *trypanosomosis* prevalence at herd level was significantly higher ($p < 0.05$) in Niamina East in December than Kiang West. *Trypanosomosis* morbidity at herd level was very high as more than 50% of the sampled herds were infected. Trypanosome infected and non-infected sampled herds are shown in Figures 3 and 4.

Trypanosomosis prevalence at animal level

Prevalence at animal level looks at the infection rates among all sampled animals from each district at each sampling period. It assesses the disease severity at the animal population level without taking into account herd clustering. This parameter also allows comparison to be made with other studies. Results showed that the bimonthly prevalence of *trypanosomosis* at animal level for Kiang West reached its peak in April whilst Niamina East peaked in December, but the overall prevalence for both districts are almost equal (Figure 5).

Although the prevalence in Kiang West was higher in February, April and August; the high trend reversed in June, October and December for Niamina East. This period coincides with the time when almost half of the herds in Niamina East have moved out to other districts and neighbouring southern part of Senegal (Casamance). The reduced cattle population exposed to tsetse flies could have led to the observed higher prevalence rates

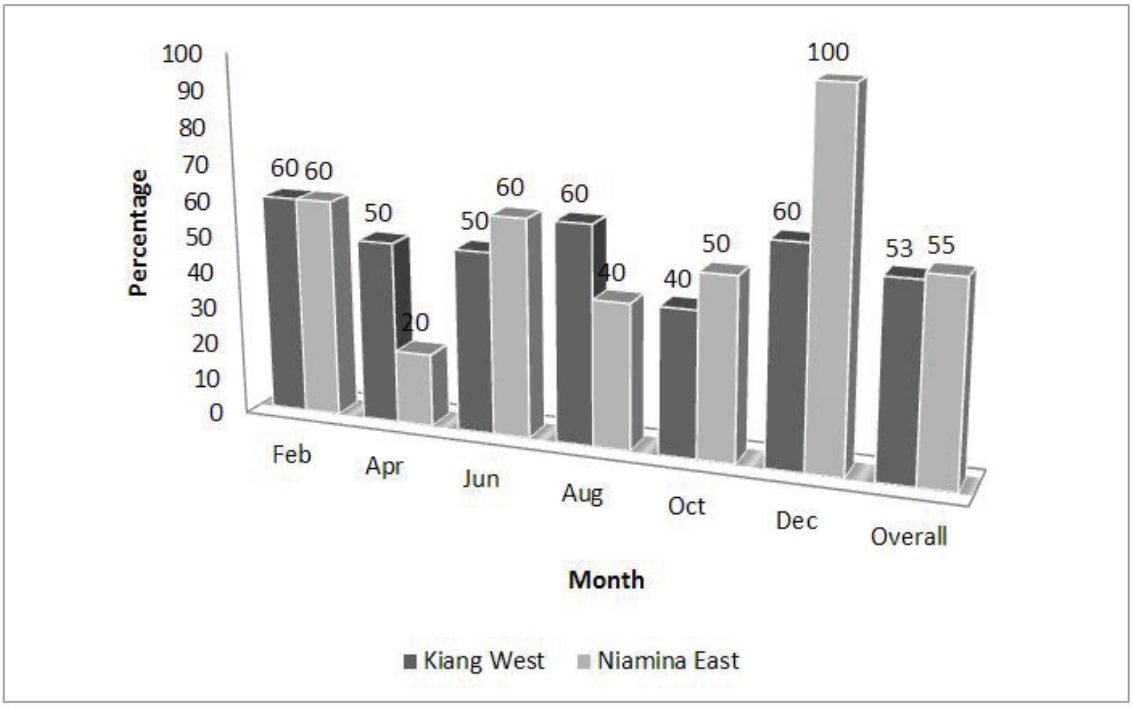

Figure 2: Bimonthly and overall *trypanosomosis* prevalence at herd level

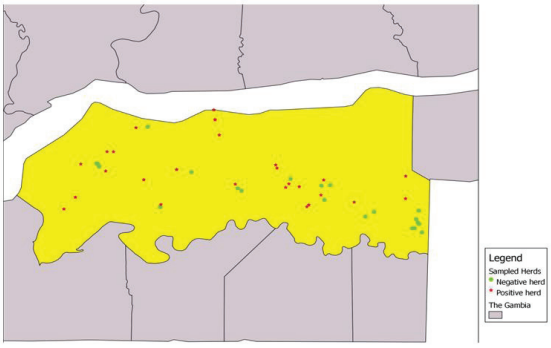

Figure 3: Spatial distribution of trypanosome infected and non-infected herds in Kiang West District

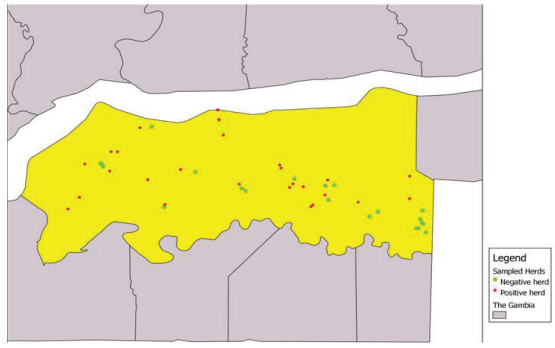

Figure 4: Spatial distribution of trypanosome infected and non-infected herds in Niamina East District

compared to the period January to May of each year when many cattle herds move into this area in search of pasture and water.

The trend of prevalence at both herd and animal level in both districts were very similar, and tends to show that both the number of infected herds and infected animals increases proportionately. In Niamina East, the two prevalence levels were highest in October and December; whilst Kiang West also had the highest for both prevalence levels in April and August. The larger number of sampled animals (3651) compared to sampled herds (120) brought down the prevalence at animal level to units whilst the herd level was in tens.

There was no significant difference in trypanosome infection rate by months ($p > 0.05$), age ($p > 0.05$), and sex ($p > 0.05$). However, there was a significant difference in trypanosome infection rates by Packed cell volume (PCV) values ($p < 0.05$) and district ($p < 0.05$). Thus infections in Niamina East were significantly higher than in Kiang West; and all infected cattle had significantly lower PCV than

non-infected cattle. This finding confirms that *trypanosomosis* indeed reduces the PCV value of infected N'Dama cattle.

Three species of trypanosomes were found to have infected a total of 116 detected cases of *trypanosomosis*. They are Trypanosome congolense, T. brucei and T. vivax. There were three cases of mixed infection involving T. congolense and T. vivax. Within the remaining 113 single species infection, there were one case of T. brucei, 49 cases of T. congolense and 63 cases of T. vivax. Hence T. brucei accounted for 1% of cases, T. congolense took 43%, and finally T. vivax had 56%. Trypanosome vivax appears to be the most prevalent species affecting cattle in these study sites.

The animal *trypanosomosis* prevalence within 66 trypanosome infected herds out of 120 sampled herds in both study sites during the study period varied from 3.2% to 18.5%. Fifty nine percent of these herds have less than 5% prevalence, 29% have prevalence between 5 and 10%, and the remaining 12% fall between 11 and 18.5%. Table 1 lists villages of herds with highest trypanosome infection rates.

Seasonal effect on trypanosomosis prevalence at animal level

There are basically two seasons in The Gambia i.e. rainy and dry season. The rainy season spans from June to October (5 months), whilst the longer dry season starts in November and end in May (7 months). There was no significant difference ($p > 0.05$) in trypanosome infections between seasons and districts. Furthermore, the dry season was subdivided into early dry season (Nov-Feb) and late dry season (Mar-May), and then the trypanosome infections analyzed against the three seasons and two districts using logistic regression. There was no significant difference in infection rates between seasons and districts.

Tsetse density and challenge

The sampling month, number of set traps, number of caught flies in two days, tsetse density (TTD), number of dissected flies, tsetse infection rates, and tsetse challenge in Kiang West (KW) and Niamina East (NE) districts are shown in Table 2. The highest and lowest TTD in Niamina East were observed in February and April, respectively; whilst in Kiang West the highest and lowest were observed in December and June, respectively. The overall TTD, tsetse infection rate, and tsetse challenge were slightly higher in Niamina East than Kiang West.

The total number of tsetse flies caught from the two study sites in February, October and December were significantly higher ($p<0.05$) than the other months. Although the number of caught flies in Kiang West was twice that of Niamina East, no significant difference ($p>0.05$) was observed in the number of caught tsetse flies between both districts. This could be attributed to the higher number of traps set in Kiang West due to its larger area.

Climatic parameters trend over the past three decades

Data on climatic parameters gathered by the Department of Water Resources (DWR) during the period 1981 to 2010 was analysed. The three parameters of interest that were analysed are average annual humidity, rainfall, and temperature. These parameters were collated from records of Kerewan and Sapu meteorological stations situated very close to the study sites. Kerewan station is adjacent to Kiang West district and Sapu station is adjacent to Niamina East district. Scatter plots of the annual averages for relative humidity (average of minimum and maximum humidity), rainfall, and temperature (average of minimum and maximum temperatures) for both Kerewan and Sapu are shown in Figures 6 to 8. Despite several fluctuations in the values of these parameters over the years, the positive linear regression coefficients and direction of the regression lines indicates an increasing trend during these past three decades.

Land use/cover at the two study sites

The 2009 land cover/use for Kiang West and Niamina East was mapped by the National Environment Agency (NEA) of The Gambia. The area, proportion and difference for the two districts are shown in Table 3. Kiang West district has higher proportions of Thick

Table 1: Location of herds with the highest Animal *Trypanosomosis* Prevalence

Kiang West District	Niamina East District
Burong (9.7% in June)	Busura (11.1% in December)
Joli (16.1% in December)	Kerr Omar Daago (16.1% in October)
Kuyang (16.1% in April)	Kudang (16.1% in June)
Mandina (16.1% in December)	Macca (16.1% in December)
	Thirty mile (18.5% in August)

Table 2. Dynamics of Glossina morsitans submorsitans population at the two study sites

Month	District	No. of set traps	Caught tsetse flies in 2 days	TTD	Tsetse infection rate (%)	Tsetse challenge	*AAT problem ranking
Feb	KW	38	58	0.76	4.3	3.30	Low
	NE	15	217	7.23	0	0.00	Low
Apr	KW	47	15	0.16	33.3	5.33	Low
	NE	13	8	0.31	NA	NA	Low
Jun	KW	39	4	0.05	0	0	Low
	NE	19	30	0.79	NA	NA	Low
Aug	KW	33	104	1.58	3.1	4.90	Low
	NE	16	12	0.38	33.3	12.65	Low-Medium
Oct	KW	30	88	1.47	6.3	9.33	Low
	NE	18	179	4.97	9.2	45.88	Medium-High
Dec	KW	33	670	10.15	8.6	87.63	High-Very Severe
	NE	16	49	1.53	5.3	8.05	Low
Overall	KW	220	939	2	6.9	13.90	Low-Medium
	NE	97	495	2.5	6.6	16.54	Low-Medium

**based on Tsetse survey technique (Snow and Rawlings, 1999)*

Savannah, Open Woodland and Mangroves, but Niamina East also has higher proportion of upland cultivation. Hence the primary breeding sites of tsetse flies are indeed more abundant in Kiang West than Niamina East.

Discussion

The spatial locations of sampled herds based on their GPS coordinates in Figures 3 and 4 show the distribution of the trypanosome infected herds. Based on spatial distributions, infected herds in Kiang West are widespread, but tends to cluster in at least two foci in Niamina East District. This distribution provides a guide for the scale of needed intervention to control *trypanosomosis*. Hence in Kiang West where the infected herds are widespread, trypanosomes control interventions should target wider areas compared to Niamina East where the infected herds are in clusters.

Several cattle *trypanosomosis* prevalence surveys have been conducted across the country during the past decades. Comparing the findings in 2011 to the earlier reports, there appears to be no major difference in *trypanosomosis* prevalence over the past two decades as indicated in Table 4.

Many studies reported tsetse densities and challenges in the two study sites (Table 5). Whilst the TTD values appear to be similar in Kiang West, the 2011 TTD for Niamina East is

Table 3: Areas and proportions of different land uses/covers in both study sites

Land cover/use	Kiang West		Niamina East		Difference
	Area (hectare)	Proportion (%)	Area (hectare)	Proportion (%)	
Barren land	80.53	0.11	158.63	0.4	- 0.31
Thick Savannah Land	10,694.88	15.19	1,944.19	5.2	10.02
Open Woodland	25,045.99	35.56	6,618.25	17.6	17.98
Shrub land/grass	11,601.35	16.47	6,179.57	16.42	0.06
Palms	54.73	0.08	5.71	0.02	0.06
Orchard	11.48	0.02	6.58	0.02	0.00
Mangroves	7,347.80	10.43	58.26	0.15	10.28
Riverine forest	1,227.29	1.74	620.65	1.65	0.09
Perenial swamps	8,871.94	12.60	6,610.03	17.56	-4.96
Seasonal swamps	1,025.39	1.46	428.24	1.14	0.32
Ponds	6.89	0.01	661.97	1.76	-1.75
Rice cultivation	771.44	1.10	522.94	1.39	-0.29
Rice fallow fields	395.57	0.56	895.53	2.38	-1.82
Upland cultivation	2,824.08	4.01	12,264.59	32.58	-28.57
Settlements	464.11	0.66	665.41	1.77	-1.11
Forest Parks	KW National Park		Njassan Forest Park		Positive difference (KW>NE)
Total	70,423.46	100.00	37,640.55	100.00	

Source: derived from NEA 2009 Land Use/Land Cover map

Table 4: Reported Cattle *trypanosomosis* prevalence rates in Kiang West and Niamina East districts

Survey period	Keneba/ Kiang West	Sambelkunda/ Niamina East	Source
1986-1988	5.0%	NA	Agyemang et al. 1992 Acta Tropica 50
1986-1987	0.45%	4.84 ± 4.31%	Snow et al. 1996 Veterinary Parasitology 66
1986-1990	0.9%	3.2%	Claxton et al. 1992 Acta Tropica 50
2011	3.1%	3.2%	

smaller than preceding years. The 2011 tsetse challenge for KW is higher than preceding years, but in NE the tsetse challenge in 2011 is lower than preceding years. The reported four studies (excluding Rawlings *et al.,* 1993) looked at 1 to 4 villages within the two districts particularly where ITC animals are located (i.e. Keneba in KW; Sambelkunda, Misira and Touba in NE), whilst the 2011 results covered the entire districts. Keneba in KW has been regarded as Medium tsetse challenge, whilst the loop in NE as High tsetse challenge. The observed differences could be largely attributed to differences in the sampled sites, and perhaps to changes in the vegetation cover and climatic factors.

The overall tsetse challenge in Kiang West and Niamina East districts were 13.90 and 16.54, respectively. Based on the overall TTD, Tsetse Challenge and *trypanosomosis* prevalence for Kiang West (2.0, 13.9 and 3.1%) and Niamina East (2.5, 16.9 and 3.2%), and

Table 5. Reported Tsetse densities and challenges in Kiang West and Niamina East districts

Survey period	Keneba/ Kiang West		Sambelkunda/ Niamina East		Source
	TTD	Tsetse challenge	TTD	Tsetse challenge	
1986-1987		0.90±1.07		62.25	Snow et al. 1996 Vet 66
1989-1990	≥ 5		≥ 20		Rawlings et al. 1993 Bull Ent Res 83
1986-1990		4.7		60.8	Claxton et al. 1992 Acta Tropica 50
1986-1989	2.68		29		Watcher et al. 1994 Parasitology109
2011	2.0	13.9	2.5	16.5	

using the African Animal *Trypanosomosis* (AAT) problem ranking (Snow and Rawlings, 1999) in Table 2, the two districts could be ranked as Low-Medium AAT Problem ranking. However, the tsetse challenges for Niamina East in October (45.88) and Kiang West in December (87.63) are High and Very Severe, respectively (Table 2). The tsetse burden is generally low from February to June, but shoots up from August to December.

There have been huge variations in the obtained bimonthly TTD across trap sites in both districts as they vary between 0.1 to 98.5 TTD in infested areas. Within Kiang West district, the highest bimonthly TTD was observed in Mandina (98.5 in December), followed by Jannehkunda (5.9 in October), Karantaba (5.4 in August), Jali (3.6 in December) and Joli (3.2 in August). Similarly, in Niamina East district the highest was observed in Mamudfana (25.5 in February), followed by Njiekunda (16.5 in February), Mamudfana (11.4 in October), Kudang (5.4 in October) and Sambelkunda (4.3 in February). However, it should be noted that

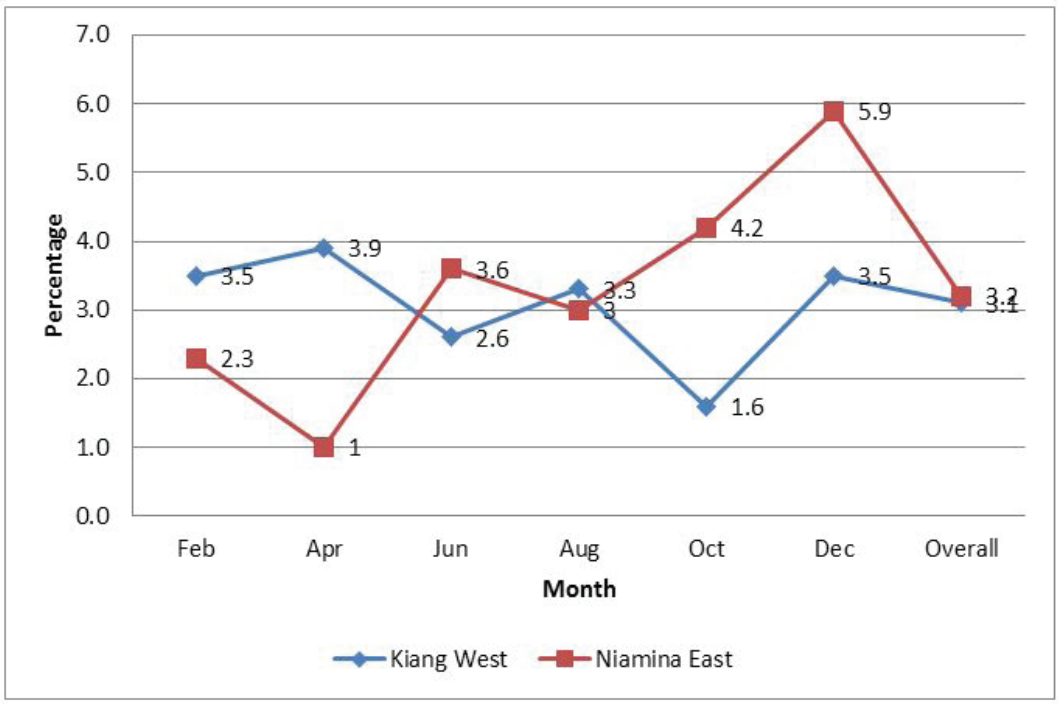

Figure 5: Bimonthly and overall *trypanosomosis* prevalence at animal level

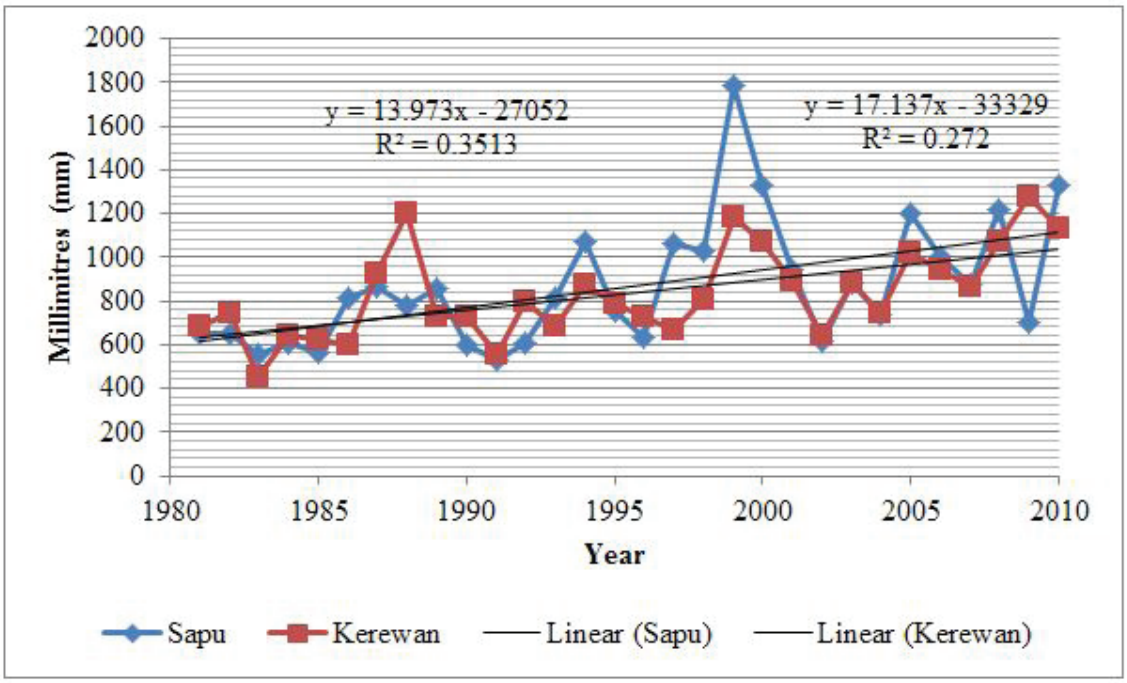

Figure 6: Annual mean rainfall over three decades at Sapu and Kerewan

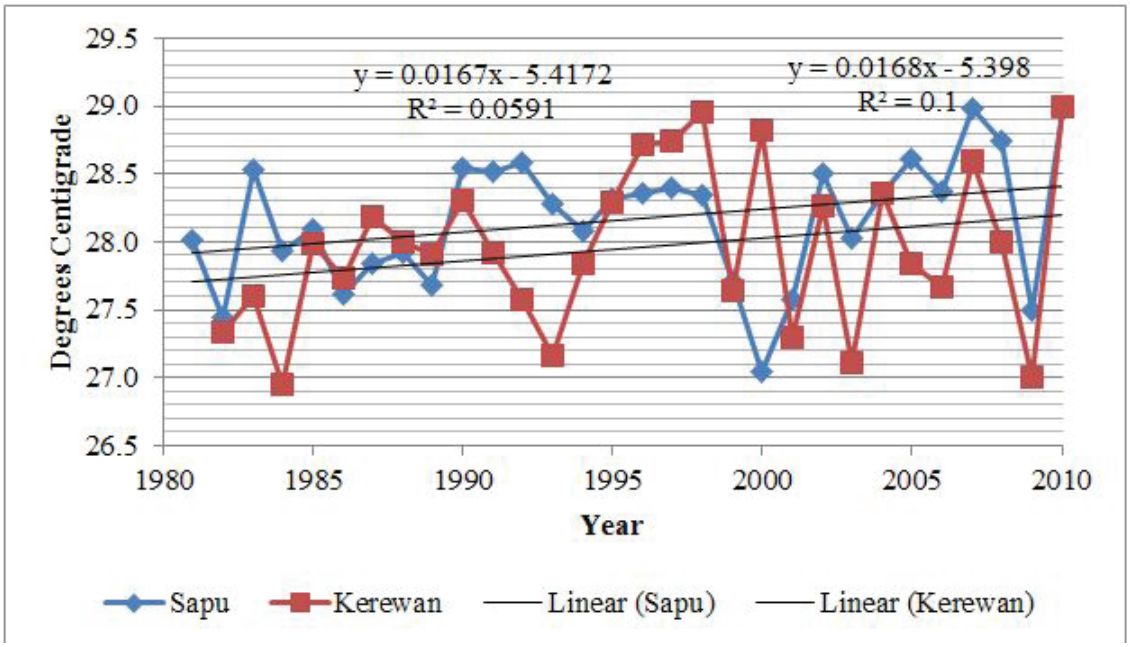

Figure 7: Annual mean temperature over three decades at Sapu and Kerewan

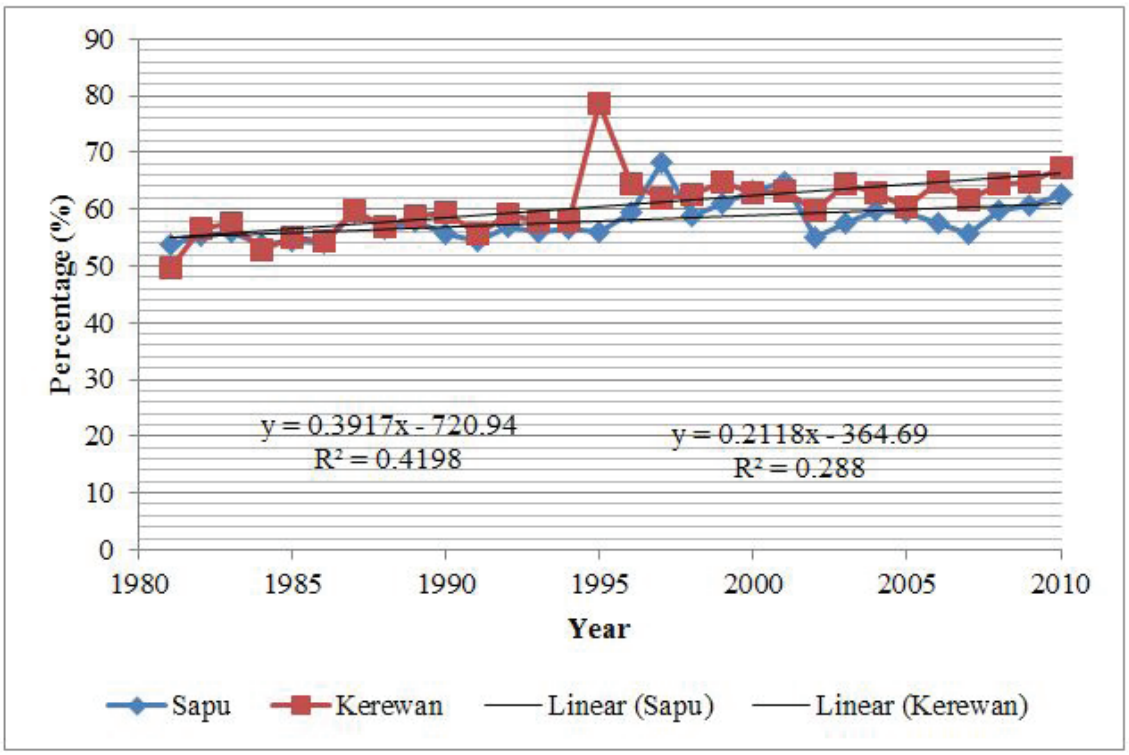

Figure 8: Annual mean relative humidity over three decades at Sapu and Kerewan

villages in the loop of Niamina East district (Kununku, Touba, Sambelkunda, Missira and Bani) are areas of high tsetse density and trypanosome prevalence based on experiences from continuous monitoring of ITC herds living in this loop.

Data analyses showed a significant ($p < 0.05$) increase in all three climatic variables (rainfall, temperature and relative humidity) over the past three decades in both stations. There was also no significant difference ($p > 0.05$) between stations in rainfall and temperature. However, relative humidity was significantly ($p < 0.05$) lower at Sapu than Kerewan.

The highest rainfall (1782 mm) was recorded at Sapu station in 1999 and the lowest (453mm) was recorded at Kerewan station in 1983. Sapu station also recorded the highest temperature (29° C) in 2007 and relative humidity (68%) in 1997. Kerewan had the lowest temperature (27° C) in 2000 and the lowest relative humidity (50%) in 1981. All the findings in the two stations are extrapolated to the two study sites i.e. Kerewan station extrapolated to Kiang West whilst Sapu station is extrapolated to Niamina East.

The findings tend to support the general notion of climate change phenomenon that are perceived in the form of global warming demonstrated by increasing temperature, rainfall and relative humidity locally. Increasing temperatures imparts negatively on tsetse populations whilst increasing rainfall and humidity favour the breeding of tsetse flies.

In the absence of land cover/use information at the study sites during the past three decades, two reports on The Gambia's vegetation are compared to the 2009 land cover/use of Kiang West and Niamina East Districts. According to Bourn et al. (2001) parts of the country covered by forest and closed-canopy woodland, including primary and secondary tsetse habitat, fell from 60% in 1946 to 3% in 1993. The proportion of Savannah land in 1988 of the whole country was reported as 40.2% (Ridder, 1991). The present proportions of Savannah land in Kiang West and Niamina East Districts estimated at 15 and 5%, respectively, are much less than the country proportions reported in 1991.

Conclusion

Although the bimonthly and overall TTD, Tsetse challenge and cattle *trypanosomosis* prevalence in 2011 are Low to Medium, there are still some hotspot areas in both districts with high and very severe *trypanosomosis* prevalence and tsetse infestation.

An increasing trend in climatic factors (rainfall, temperature and humidity) has been observed during the period 1981-2010 at two meteorological stations covering the two study areas. This trend of climatic factors could potentially favour the reproductive cycle and survival of tsetse flies, but extremely high/low temperatures could also cause high mortality rates. The observed decreasing tsetse habitats (thick savannah and open woodland) could negatively impact on tsetse population and N'Dama cattle tolerance to *trypanosomosis* especially during the late dry season when pastures have depleted immensely.

Finally on the basis of our findings, Africa Animal *Trypanosomosis* (AAT) remains a threat to livestock production in the two study areas that vary from Low, Medium, High to Very Severe. However, the increasing climatic trend and decreasing vegetation did not match with clear cut decreasing tsetse density/challenge and trypanosome prevalence in cattle as found in this study.

The following are recommended for different actors:

Farmers

- Lactating, pregnant and weak cattle should be supplemented especially during the dry season when feed becomes scarce in order to boost their tolerance to withstand the negative effects of *trypanosomosis*
- Infected cattle showing signs of anaemia or weakness should be promptly treated by competent livestock assistants using good quality trypanocidals for effective treatment and to slow down development of trypanosome drug resistance
- Farmers in Kiang West should be more vigilant on the lookout and treatment of infected cattle from February to April (late dry season), whilst those in Niamina East should be on alert from October to December (early dry season)

Progebe

- Train more auxiliaries on the diagnosis and treatment of *trypanosomosis* disease to fill the gap of insufficient livestock assistants posted in the project sites in collaboration with Department of Livestock Services (DLS)
- Build farmers' capacity on the collection, conservation and utilization of animal feeds to help them strategize supplementation of target cattle for increase productivity
- Assist farmers set up and maintain insecticide impregnated targets at tsetse fly hotspots/high risk areas to control tsetse fly numbers in collaboration with International Trypanotolerance Centre (ITC) and DLS. The targets should be mounted during the high risk period: February to May in Kiang West, and October to December in Niamina East hotspot areas

Policy Makers/Ministry of Agriculture

- More livestock assistants need to be trained and recruited to implement disease control strategies at village to district level. Presently, there are very few livestock assistants in the field that are unable to meet the demand of livestock farmers to control disease outbreaks and treat clinical cases
- Surveillance of tsetse-*trypanosomosis* burden should be implemented periodically to assess the risk and then formulate and implement control strategies in collaboration with ITC and DLS

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ASSESSMENT OF TICKS ON CATTLE ENTERING NIGERIA THROUGH A MAJOR TRANS-BOUNDARY ANIMAL ROUTE IN OGUN STATE

Oyewusi I K[1], Ganiyu I A[1], Akande F A[1], Takeet M I[1], Anifowoshe I O[1], Famuyide I M[1], Sogebi E A O[1], Adeleke G A[2], Olugbogi E I[1] and Talabi A O[1].
[1]College of Veterinary Medicine, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria
[2]Department of Animal Production, College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro, Nigeria.

Abstract

Ticks cause great economic losses of livestock in several ways including their ability to act as potential vector for haemoprotozoan, rickettsial and helminth parasites; they suck blood resulting in reduction in live weight and anaemia. Ticks and tick-borne diseases are widely distributed throughout the world, particularly in tropical and sub-tropical countries where they seriously limit livestock production and improvement in much of Africa. Cattle entering Nigeria by hoof along a major trans-boundary route were assessed and found infested with a mean tick count of 66.3±35.8 per animal confirming that the trans-boundary areas are points of entry of parasites into the country. 57.7% of the animals had a very high level of tick infestation. Adult ticks identified include Amblyomma spp. (49.6%), Rhipicephalus (sub genus Boophilus) spp. (93.6%), Rhipicephalus spp. (33.9%) and Hyalomma spp. (12.1%). A total of 16,440 ticks were counted in the course of the study. Rhipicephalus (subgenus Boophilus) spp. is the most predominant tick species found in this study. These ticks were found around the ear, dewlap, brisket, udder/scrotum, anal/genital region, legs and tail region of the animals. It was concluded that cattle entering Nigeria from Burkina Faso, Benin republic, Niger republic, Mali, Togo, and Cote d'ivoire were infested with these adult ticks which also acted as a vector for protozoa and rickettsial parasites. The Nigerian government should establish effective quarantine centres to screen and treat animals entering the country. With irrigation and planting of improved grasses and crops for zero-grazing, more farmers can be encouraged to invest in intensive system of cattle management.

Keywords: Ticks, cattle, transboundary, prevalence

L'EVALUATION DES TIQUES SUR LE BÉTAIL ENTRANT AU NIGERIA PAR LA PRINCIPALE ROUTE TRANSFRONTALIÈRE DANS L'ÉTAT D'OGUN.

Résumé

Les tiques causent de grandes pertes économiques dans l'élevage de plusieurs façons, y compris leur capacité à agir en tant que vecteur potentiel pour les parasites haemoprotozoan, les rickettsies et les helminthes ; ils sucent le sang entrainant la réduction du poids vif et l'anémie. Les tiques et les maladies transmises par les tiques sont largement distribuées dans le monde entier, en particulier dans les pays tropicaux et subtropicaux où ils limitent sérieusement la production et l'amélioration du bétail dans une grande partie de l'Afrique. Les bovins entrant au Nigéria par les principaux corridors transfrontaliers contrôlés ont été dépisté d'une infestation moyenne de tiques évaluée à 66,3 ± 35,8 par animal. 57,7% des animaux avaient un très haut niveau d'infestation des tiques. Les tiques adultes identifiées sont composées de l'Amblyomma spp. (49,6%), le Rhipicephalus (Boophilus sous genre) spp. (93,6%), le Rhipicephalus spp. (33,9%) et l'Hyalomma spp. (12,1%). 16,440 tiques ont été comptées au cours de l'étude. Le Rhipicephalus (Boophilus subgénero) spp. est l'espèce la plus prédominante trouvée dans cette étude. Ces tiques ont été trouvées autour de l'oreille, du fanon, la poitrine, la mamelle / scrotum, la région anale / génitale, les jambes et la queue des animaux. Il a été conclu que les bovins entrant au Nigéria venant du Burkina Faso, de la République du Bénin, de la République du Niger, du Mali, du Togo et de la Côte d'Ivoire ont été infestés par ces tiques adultes qui agissent également comme un vecteur pour les protozoaires et les parasites rickettsioses. Le gouvernement nigérian devrait établir des centres de quarantaine efficaces pour dépister

Corresponding author email: deletalabi@yahoo.co.uk

et traiter les animaux entrant dans le pays. Avec l'irrigation et la plantation de graminées et de cultures pour zéro-pâturage améliorées, plus d'agriculteurs peuvent être encouragés à investir dans un système intensif de gestion du bétail.

Mots clés : les tiques, le bétail, le transfrontalier, la prévalence

Introduction

The ruminant animal population of Nigeria consists of 13.9 million cattle, 22.1 million sheep, and 34.5 million goats1. The role of cattle in Nigerian economy is important since the livestock sector accounts for 4.5% to 5.0% of the gross domestic products2, to which cattle supplies about 50% of meat needs3 and virtually all milk. The African continent is faced with the challenge of satisfying a dramatic increase in demand for livestock products, in particular for milk and meat. The areas with the greatest potential for significant increases in livestock population and livestock productivity are the sub-humid and the non-forested parts of the humid zones4. The major constraints to increased livestock production include lack of genetic selection, low productivity of indigenous stock, inadequate nutrition (quantitative and qualitative) and high incidence of animal diseases3; the greatest constraint being the losses as a result of animal diseases5.

Pastoralism is a ruminant animal-rearing practice where animals are grazed over varying distances depending on availability of fodder and water in a livestock livelihood pastoral production system known as Transhumance Pastoralism. Transhumant Pastoralists are the main livestock producers in Nigeria and are found as nomadic, semi-settled and settled livestock producers in different ecological and socioeconomic settings6. In the nomadic system, people and animals are constantly moving in search of pasture and water or to avoid disease epidemics and tribal conflicts7.

Trans-boundary animal diseases (TADs) are those diseases that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and in which control/management requires cooperation among several countries8. In cattle, these diseases include Foot and Mouth Disease (FMD), Rinderpest (RP), Haemorrhagic septicaemia (HS), Contagious Bovine Pleuro-pneumonia (CBPP), Lumpy skin Disease, Mad Cow disease (BSE) and Rift valley fever (RVF)9.

Trans-boundary animal diseases constitute only a small minority of the infectious diseases that afflict livestock. All of the infectious diseases cause some of the above adverse socio-economic consequences to a greater or lesser extent, and in fact the cumulative production and economic losses that they cause is probably much greater than that of the so called trans-boundary animal diseases10.

However, what set the trans-boundary diseases apart are the suddenness, acuteness and widespread nature of the losses that they can produce. Also, the rapidity with which they can spread in susceptible livestock populations, renders individual farmers and private veterinary services relatively powerless to take effective action to avoid or overcome outbreaks of these diseases10. The responsibility for prevention, control and elimination of trans-boundary animal diseases therefore falls squarely on the shoulders of the public sector, notably government veterinary services, and may require high public investment. Furthermore, these endeavours are only likely to be successful if government veterinary services are very well organised and prepared for these tasks10.

The recent incidences of emerging and re-emerging trans-boundary animal diseases led to very heavy losses all over the world. The outbreaks are associated with huge economic and social impact in many countries11.

In Nigeria, Foot-and-Mouth Disease, *Trypanosomosis*, Dermatophilosis with fly and tick infestations were identified as a major constraint to livestock production12. The presence of these diseases also constrains the introduction of exotic upgraded cattle with a view to improving the livestock industry13. Increasing worldwide movement

of commodities, animals and people is also responsible for the globalization of pathogens14.

A significant amount of cattle enter Nigeria on daily basis by hoof along the trans-boundary areas. In planning a national animal disease control programme therefore, transhumance pastoralism must be monitored or controlled13. Hence this study aimed to assess the load of tick infestation on cattle entering Nigeria through a major trans-boundary route, Imeko-Atokun, Ogun State.

Materials and Methods

Study Area: The study was carried out along a major trans-boundary route, Imeko-Atokun route in Yewa division of Ogun State, Nigeria. Imeko is located at a coordinate of 7026'10.14" North and 2050'20.85" East while Atokun is located at a coordinate of 7018'43.17" North and 3004'06.41" East and bound to the west by the Republic of Benin, with which the region shares 155 kilometres of International boundary, within Latitude 60 15' N and 70 58' N in a deciduous/derived Savannah zone of Nigeria15.

Sample Collection: A total of 248 heads of cattle were sampled from 62 herds of cattle entering Nigeria from neighbouring West African Countries (Burkina Faso, Benin Republic, Niger Republic, Mali, Togo and Cote d'Ivoire) by hoof along the Imeko-Atokun route and then examined for the presence of ticks (adults and nymphs) between February and April 2015. Four animals with ticks per herd of cattle were randomly assessed for load of tick infestation and collection. Ticks (adults and nymphs) on each of the selected animals were identified, counted and collected into labelled universal bottles containing 10% formalin. Care was taken to avoid mutilation of ticks' mouthparts during removal to aid identification, and to minimise discomfort to the animals.

Load of tick infestation was assessed by categorizing tick population on the animals into three levels i.e. low, moderate and high infestation levels16. Animals having 1-25 ticks were designated as low infestation level, while animals having 26-50 and those with 51 ticks and above were characterized as moderate and high infestation levels, respectively.

Laboratory identification of ticks: Collected tick samples were sorted and identified based on major features especially body shape, sizes, mouth parts (capitulum), colour, dorsal shield (scutum) and festoons as described by17 in the Veterinary Parasitology Laboratory of the College of Veterinary Medicine, Federal University of Agriculture, Abeokuta, Nigeria.

Table 1: Total count of ticks on infested cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	Total tick count	Range of total tick count per cattle	Mean tick count per cattle
Burkina Faso	60	3328	12-136	55.5±33.5
Benin Republic	40	2792	34-186	69.8±33.0
Niger Republic	36	3276	18-130	91.0±34.9
Mali	56	3450	10-186	61.6±33.9
Togo	24	1462	10-124	60.9±32.8
Cote d'Ivoire	32	2132	12-186	66.6±38.3
Total	248	16440	10-186	66.3±35.8

Table 2: Load of tick infestation on cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	Load of tick infestation		
		Low infestation frequency {n(%)}	Moderate infestation frequency {n(%)}	High infestation frequency {n(%)}
Burkina Faso	60	14(23.3)	21 (35.0)	25(41.7)
Benin Republic	40	0(0.0)	14(35.0)	26(65.0)
Niger Republic	36	2(5.6)	5(13.9)	29(80.6)
Mali	56	3(5.4)	24(42.9)	29(51.8)
Togo	24	4 (16.7)	5(20.8)	15 (62.5)
Cote d'Ivoire	32	1 (3.1)	12 (37.5)	19 (59.4)
Total	248	24 (9.7)	81 (32.7)	143 (57.7)

Low= 1-25 ticks; Moderate= 26-50 ticks and High= 51 ticks and above

Table 3: Prevalence of Amblyomma spp. in tick infested cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	No of animals with *Amblyomma spp*	Total *Amblyomma spp* count	Mean *Amblyomma spp* count per cattle	Prevalence of *Amblyomma spp* (%)
Burkina Faso	60	37	1068	28.9±13.9	61.7
Benin Republic	40	26	572	22.0±10.5	65.0
Niger Republic	36	9	250	27.8±10.8	25.0
Mali	56	22	496	22.5±9.0	39.3
Togo	24	12	244	20.3±10.1	50.0
Cote d'Ivoire	32	17	340	20.0±9.9	53.1
Total	248	123	2970	24.2±11.6	49.6

Table 4: Prevalence of Rhipicephalus spp. (sub-genus Boophilus) on tick infested cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	No of animals with *Boophilus spp.*	Total *Boophilus spp.* count	Mean *Boophilus spp.* count per cattle	Prevalence of *Boophilus spp.* (%)
Burkina Faso	60	47	1758	37.4±24.5	78.3
Benin Republic	40	40	1626	40.7±33.3	100
Niger Republic	36	36	2798	77.7±35.1	100
Mali	56	54	2536	47.0±33.0	96.4
Togo	24	24	926	38.6±20.2	100
Cote d'Ivoire	32	31	1376	44.4±38.3	96.9
Total	248	232	11020	47.5±34.0	93.6

Table 5: Prevalence of Rhipicephalus spp. in tick infested cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	Number of animals with *Rhipicephalus spp*	Total *Rhipicephalus spp* count	Mean *Rhipicephalus spp* count per cattle	Prevalence of *Rhipicephalus spp*(%)
Burkina Faso	60	16	398	24.9±8.0	26.7
Benin Republic	40	20	482	24.1±8.8	50.0
Niger Republic	36	6	174	29.0±7.1	16.7
Mali	56	18	360	20.0±8.8	32.1
Togo	24	9	258	28.7±11.1	37.5
Cote d'Ivoire	32	15	366	24.4±9.7	46.9
Total	248	84	2038	24.392	33.9

Table 6: Prevalence of Hyalomma spp. in tick infested cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	Number of animals with *Hyalomma spp*	Total *Hyalomma spp* count	Mean *Hyalomma spp* count per cattle	Prevalence of *Hyalomma spp* (%)
Burkina Faso	60	10	104	10.4±3.1	16.7
Benin Republic	40	7	112	16.0±4.6	17.5
Niger Republic	36	4	54	13.5±6.6	11.1
Mali	56	4	58	14.5±1.9	7.1
Togo	24	2	34	17.0±1.4	8.3
Cote d'Ivoire	32	3	50	16.7±5.0	9.4
Total	248	30	412	13.7±4.6	12.1

Results

Total count of ticks on infested cattle entering Nigeria

A total of 248 cattle were checked for the presence of tick infestation along the trans-boundary route. The total count of ticks on infested cattle entering Nigeria is presented in Table 1. All the sampled animals were infested with adult ticks and a total of 16, 440 were counted. The range of total count per cattle were 12-136, 34-186, 18-130, 10-186, 10-124 and 12-186 for cattle that came into Nigeria from Burkina Faso, Benin Republic, Niger Republic, Mali, Togo and Cote d'Ivoire, respectively (Table 1). The mean tick count per cattle in this study was 66.3±35.8. The highest mean tick count per cattle of 91.0±34.9 was recorded in animals that came into the country from Niger Republic while the lowest count per cattle (55.5±33.5) was recorded in animals that came into the country from Burkina Faso.

Load of tick infestation on cattle entering Nigeria

The load of tick infestation on cattle entering Nigeria is presented in Table 2. The load was highest (80.6%) in animals that came into the country from Niger Republic while the lowest infestation (41.7%) was recorded in animals that came into the country from Burkina Faso. A significant amount (57.7%) of tick infested cattle entering the country had high infestation loads. Ticks identified in the course of this study include Amblyomma spp., Rhipicephalus spp. (Sub genus Boophilus), Rhipicephalus spp. and Hyalomma spp. (Tables 3, 4, 5 and 6).

Prevalence of Amblyomma spp. in tick infested cattle entering Nigeria

The prevalence of Amblyomma spp. on tick infested cattle entering Nigeria is presented in Table 3. The highest mean Amblyomma count

Table 7: Frequency of mixed tick infestation in cattle entering Nigeria

Herd Origin	No of tick – infested cattle sampled	Number of animals with single tick infestation {n(%)}	Number of animals with two tick infestation {n(%)}	Number of animals with three tick infestation {n(%)}	Number of animals with four tick infestation {n(%)}
Burkina Faso	60	30 (50.0)	17 (28.3)	6 (10.0)	7 (11.7)
Benin Republic	40	4(10.0)	20(50.0)	15(37.5)	1(2.5)
Niger Republic	36	22(61.1)	10(27.8)	4(11.1)	0(0.0)
Mali	56	24(42.9)	23(41.1)	8(14.3)	1(1.8)
Togo	24	9(37.5)	7(29.2)	8(33.3)	0 (0.0)
Cote d'Ivoire	32	9 (28.1)	12 (7.5)	11 (34.4)	0 (0.0)
Total	248	98 (39.5)	89 (35.9)	52 (21.0)	9 (3.6)

per cattle (28.9±13.9) was recorded in animals entering from Burkina Faso, while the lowest mean count of 20.0±9.9 was recorded in animal coming in from Cote d'Ivoire. The prevalence of Amblyomma spp. in tick infested cattle coming into Nigeria is 49.6%.

Prevalence of Rhipicephalus spp. (sub-species Boophilus) in tick infested cattle entering Nigeria

The prevalence of Rhipicephalus spp. (sub-species Boophilus) in tick infested cattle entering Nigeria is presented in Table 4. The highest mean Rhipicephalus spp. (sub-species Boophilus) count per cattle (77.7±35.1) was recorded in animals entering from Niger Republic, while the lowest mean count of 37.4±24.5 was recorded in animal coming in from Burkina Faso. All tick infested cattle coming into Nigeria from either Niger Republic or Benin Republic had Rhipicephalus spp. (sub-species Boophilus) species as one of the species of ticks infesting it. The prevalence of Rhipicephalus spp. (sub-genus Boophilus) in tick infested cattle coming into Nigeria was 93.6%.

Prevalence of Rhipicephalus species in tick infested cattle entering Nigeria

The prevalence of Rhipicephalus spp. in tick infested cattle entering Nigeria is presented in Table 5. The highest mean of Rhipicephalus count per cattle (29.0±7.1) was recorded in animals entering from Niger Republic, while the lowest mean count of 20.0±8.8 was recorded in animal coming in from Mali. The prevalence of Rhipicephalus spp. in tick infested cattle coming into Nigeria is 33.9%.

Prevalence of Hyalomma spp. in tick-infested cattle entering Nigeria

The prevalence of Hyalomma spp. in tick infested cattle entering Nigeria is presented in Table 6. The highest mean Hyalomma count per cattle (17.0 ± 1.4) was recorded in animals entering from Togo, while the lowest mean count of 10.4 ± 3.1 was recorded in animal coming in from Burkina Faso. The prevalence of Hyalomma spp. in tick infested cattle coming into Nigeria is 12.1%.

Frequency of mixed tick infestation in cattle entering Nigeria

The frequency of mixed tick infestation in cattle entering Nigeria is presented in Table 7. Animals coming in from Burkina Faso had the highest (11.7%) number of cattle with all four tick species found in this study; that is Amblyomma spp., Rhipicephalus (Sub-genus Boophilus) spp., Rhipicephalus spp. and Hyalomma spp.; 3.6% of all infested cattle entering Nigeria were parasitized by these four genera of ticks, while those coming in from Niger Republic, Togo and Cote d'Ivoire had any three of these four tick species.

Discussion

This study showed that all the cattle that were randomly sampled from those entering Nigeria through a trans-boundary

route were infested with ticks, which may carry various types of disease causing pathogens. This may support the report that the trans-boundary areas are points of entry of parasites into the country13. 57.7% of the animals had a very high load of tick infestation. A total of 16,440 ticks were counted in the course of this study and Amblyomma spp., Rhipicephalus (Sub-genus Boophilus) spp. and Hyalomma spp. accounted for 18.1%, 79.4%, and 2.5% of the total ticks respectively. All these genera belong to Ixodidae (hard ticks) family while no genus in Argasidae (soft ticks) family was encountered throughout the study period.

The invasion of Ixodid ticks significantly increases the risk of animal tick-borne diseases especially babesiosis, theileriosis and anaplasmosis with a mortality count higher than any other tick-borne animal disease18. Tick borne diseases and tick-associated dermatophilosis are major health and management problems of livestock in the developing countries19. The presence of these diseases also constrains the introduction of exotic upgraded cattle with a view to improving the approximately livestock industry. A report estimated annual world-wide losses associated with tick-borne diseases to be in the range of 18 billion US dollars20.

Rhipicephalus (Sub-genus Boophilus) spp. was the most predominant tick species found in this study with a prevalence of 93.6% out of 16,440 ticks counted on all the animals from different locations of this study. This is in accordance with previous work elsewhere in Nigeria21 and has been associated with high favourable environment especially in area with rainfall more than 800mm. Also it has been reported that the distribution of this tick is restricted to the northern and western part of Africa. This also explains the highest number of Rhipicephalus (Sub-genus Boophilus) spp. recorded in cattle from Niger Republic due to its location in Northern part of Africa. Rhipicephalus (Sub-genus Boophilus) spp transmit Babesia bigemina, Anaplasma marginale and Anaplasma centrale, which are known to be endemic in Nigeria21. Being boophilids, one-host ticks that entirely develop on cattle after the eggs hatch; their population is expected to be relatively constant throughout the year in this setting, presenting a constant threat of bovine anaplasmosis and babesiosis.

In this study, the overall mean tick load recorded (66.3±35.8) was considered to be relatively high in the light of the hand-picking method of tick control practiced by herdsmen21, which most likely reduced the actual number of adult ticks on the cattle sampled. Nevertheless, all the tick genera of veterinary importance were recorded, although with different abundance in the study area, with potentially large implications in terms of pathogen transmission.

Complete eradication of these ticks is extremely difficult because of the persistence of ticks, especially the multi-host ticks. On the other hand, continuous treatment with acaricides to reduce the tick population favours the development of resistance22. Since the control of ticks by acaricides is the most common method of tick control world-wide, strategic use of these acaricides during the period of high tick burden based on the life-cycle and epidemiology of the ticks is hereby recommended.

Transhumance is an integral part of traditional livestock farming method for many African countries23. Hence, traditionally, the Fulani pastoralists were regarded as living a primarily nomadic existence. From this study, many herds of cattle enter Nigeria through the trans-boundary route with the sole purpose of taking animals to distant market, where they attract better income. All the animals brought into the country are sold before the herdsmen move back to their country of origin. The unrestricted movements of these animal herds have resulted in spread and introduction of diseases to non-endemic areas. It also makes it difficult to devise or institute an improvement programme for the animals8.

The control of diseases may not be feasible when animal movement is not controlled24. The major method of spread of many animal diseases is by movement of potentially infected livestock and meat and other animal products. With the substantial increases in animal movements across state and international boundaries, of animals and

their products, nomadism and transhumance contribute very substantially to the spread of infectious animal diseases. These all place a great strain on countries in maintaining effective quarantine barriers along international borders.

In Nigeria and other countries in sub-Saharan Africa, the mobility and dispersion of nomadic pastoralists present significant financial and logistic constrains to veterinary services for vaccination of livestock25. This has indirectly resulted in decline in government veterinary services and other infrastructure, resulting in uncontrolled livestock movements, poor diagnostic capacity and the inability to react quickly and effectively to disease outbreaks. Farmers are usually not compensated for losses due to diseases and thus often tend to sell healthy-looking livestock to reduce their financial losses when there is a disease outbreak on the farm as a proportion of the apparently healthy animals may be in early stages of infection where clinical signs are not yet apparent; this behaviour of farmers may significantly contribute to the spread of diseases.

Conclusion and Recommendation

In conclusion, this study showed that cattle entering Nigeria from Burkina Faso, Benin Republic, Niger Republic, Mali, Togo and Cote d'Ivoire were infested with ticks which include Amblyomma spp., Rhipicephalus spp. (Sub-genus Boophilus), Rhipicephalus spp. and Hyalomma spp.

The Nigerian government should establish effective quarantine centres to screen and treat animals entering the country. Most, if not all, of the herdsmen inherited the nomadic culture with its attendant low productivity. With irrigation and planting of improved grasses and crops for zero-grazing, more farmers can be encouraged to invest in intensive system of cattle management.

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PREVALENCE, BACTERIAL ETIOLOGY AND RISK FACTORS OF SUBCLINICAL MASTITIS IN DAIRY GOATS IN NYERI COUNTY OF KENYA

Ndirangu P N[1], Maichomo M W[1], Wesonga H O[1] and Malonza V M[2]
[1]Kenya Agricultural & Livestock Research Organization, Veterinary Sciences Research Institute, P.O. Box, 32 00902, Kikuyu
[2]Kenya Agricultural & Livestock Research Organization, Biotechnology Research Institute, P.O. Box 362-00902, Kikuyu

Abstract

A cross-sectional survey was conducted in April 2014 in Nyeri County to determine the prevalence of subclinical mastitis, its risk factors and bacterial causes with their antibiotic sensitivities in dairy goats. California Mastitis Test (CMT) was performed on 61 randomly selected lactating goats while risk factors and farmers' knowledge, awareness, perceptions and practices (KAPP) were determined via observation during farm visits and administration of 25 questionnaires. Bacterial causes of mastitis were determined through culture of milk samples and bacteriological identification. In vitro antibiotic sensitivity was evaluated for 14 Staphylococci and 4 Streptococci by subjecting them to 8 common antibiotics using disc diffusion method. Prevalence of subclinical mastitis at goat level was (33%) which was significantly associated with grazing system, stage of lactation and milk yield ($P<0.05$). The most isolated bacterium was Staphylococci (34%), followed by Streptococci (6%). Staphylococci had 100% sensitivity to gentamycicn, kanamycin, streptomycin and chloramphenicol antibiotics, but demonstrated resistance against sulphamethoxazole and co-Trimoxazole. Streptococci were sensitive to eight antibiotics with only slight resistance against sulphamethoxazole. The high prevalence of subclinical mastitis revealed in Nyeri calls for concerted control measures. The high isolation rate of Staphylococcus species signals the need for improvement of the hygienic standards of these goats during milking and within their pens. Very low antibiotic resistance in the area indicates that most commonly used antibiotics for mastitis are effective.

Key words: Dairy goats, subclinical mastitis, prevalence, etiology, Kenya

LA PRÉVALENCE, L'ÉTIOLOGIE BACTÉRIALE ET LES FACTEURS DE RISQUE DES MAMMITE SUBCLINIQUES CHEZ LES VACHES LAITIÉRES DANS LE COMTÉDE NYERI AU KENYA

Résumé

Une enquête transversale a été réalisée en avril 2014 dans le Comté de Nyeri pour déterminer la prévalence de la mammite subclinique, ses facteurs de risque et les causes bactériennes avec leurs sensibilités aux antibiotiques chez les chèvres laitières. Le Test California Mastitis (TCM) a été réalisé sur 61 chèvres en lactation choisies au hasard alors que les facteurs de risque et les « les connaissances des agriculteurs, la sensibilisation, les perceptions et pratiques (CSPP) ont été déterminées par l'observation au cours des visites à la ferme et de l'administration de 25 questionnaires. Les causes bactériales de mammite ont été déterminées par la culture d'échantillons de lait et l'identification bactériologique. La sensibilité aux antibiotiques in vitro a été évaluée pour les 14 staphylocoques et les 4 streptocoques en les soumettant à 8 antibiotiques courants en utilisant la méthode de diffusion sur disque. La prévalence des mammites subcliniques au niveau de la chèvre était de (33%) ce qui a été associé de manière significative avec le système de pâturage, le stade de lactation et de production de lait ($P <0,05$). La bactérie la plus isolée était le staphylocoque (34%), suivie du Streptocoques (6%). Le staphylocoque avait 100% de sensibilité aux antibiotiques suivant : la gentamycine, la kanamycine, la streptomycine et le chloramphénicol, mais a démontré la résistance contre sulfaméthoxazole et co-trimoxazole. Les streptocoques étaient sensibles à huit antibiotiques avec seulement une légère résistance contre le sulfaméthoxazole. La forte prévalence de la mammite subclinique révélée à Nyeri appelle à des mesures de contrôle concertées. Le taux

*Corresponding author email: peterndirangu97@yahoo.com

d'isolementélevé d'espèces Staphylococcus trouve la nécessité d'améliorer les normes d'hygiène de ces vaches pendant la traite et dans leurs enclos. Une très faible résistance aux antibiotiques dans la région indique que les antibiotiques les plus couramment utilisés pour la mammite sont efficaces.

Mots clés: vaches laitières, mammite subclinique, la prévalence, l'étiologie, le Kenya

Introduction

The dairy goat sector in Kenya is young and growing rapidly. Dairy goat population in the country is 251,100 goats found in the higher rainfall areas of Central, Eastern and Rift Valley regions (MOLD, 2011 ??2014). Mastitis remains one of the most common diseases of dairy goats, causing the biggest economic loss (Shivairo *et al.,* 2013). The disease commonly occurs in subclinical form (Persson and Olofsson, 2011) where it cannot be detected by clinical or physical examination such as visual inspection, palpation and organoleptic tests. According to Shearer and Harris (2003), subclinical mastitis is important since it is 15 to 40 times more prevalent than clinical form and it usually precedes clinical mastitis. It is of longer duration, difficult to detect, adversely affects milk quality and yield and constitutes a focus of infection within the herd.

Some of the tests used for tentative diagnosis of sub-clinical mastitis in goats include California Mastitis Test, Somatic Cell Count and Whiteside Test (Persson and Olofsson, 2011; Bourabah *et al.,* 2013; Najeeb *et al.,* 2013). Confirmatory diagnosis requires culture and isolation of the germ responsible for the intrammamary infection. The bacteria commonly isolated from mastitic goat milk are Staphylococci, Streptococci, Escherichia coli, Pseudomonas species, Corynebacterium speies, Bacillus species, Micrococcus species and Klebsiella species among others (Ndegwa *et al.,* 2002; Persson and Olofsson, 2011; Najeeb *et al.,* 2013).

Effective prevention and therapy of mastitis requires precise bacteriological diagnosis along with sensitivity testing of the microbial agents against various antimicrobials (Malinowski *et al.,* 2002). Resistance of bacterial species to antimicrobials is increasing thus complicating mastitis treatment and the presence of such bacteria in goat milk deteriorates its quality and its consumption by children may transfer antibiotic resistance to the normal micro-flora resulting into super infection (Najeeb *et al.,* 2013).

Worldwide information on intrammamary infections and pathology in goats remain insufficient and marginal compared to that of bovine mastitis. In Kenya only a few studies have been done on the prevalence of mastitis and disease situation in dairy goats as compared to cows (Ndegwa *et al.,* 2000; Ndegwa *et al.,* 2002). Since goat milk is routinely consumed in many areas of Kenya this gap in information can offer a good opportunity for the transmission of different zoonotic diseases (Gebrewahid *et al.,* 2012). Further, there are currently only few reports on antimicrobial resistance of mastitis pathogens isolated from dairy goats worldwide (Da Silva *et al.,* 2004) as well as in Kenya. Knowledge on mastitis causative agents, mode of transmission and their antibiotic sensitivity status is crucial for judicious choice of mastitis control programs in dairy goats. The objectives of this study were to determine the prevalence of mastitis in lactating does, identify its bacterial causes and associated risk factors as well as antibiotic resistance profiles in Nyeri County.

Materials and Methods

Study area

The study was conducted in Nyeri County, which is located in the Central region of Kenya and covers an area of 3,337 KM2. It is made up of six sub-counties; Nyeri Town, Othaya, Tetu, Kieni, Mathira and Mukurwe-ini. The study was carried out in four sub-counties namely Nyeri Town, Tetu, Mathira and Mukurwe-ini which were purposively selected based on presence of dairy goat rearing. Nyeri County has a wide temperature range between 12oC (June and July) and 27oC (January-March, September-October) with high precipitation all

year round. It has an altitude ranging from 400 to 5,600M above sea level and annual rainfall of 500-1,500 mm. The main method of livestock husbandry is small scale as increased human population has reduced land sizes to less than one acre for most households (Mbindyo, *et al.,* 2013).

Experimental design

A cross-sectional survey was conducted in the month of April 2014 to monitor mastitis and provide data on its risk factors in the goat populations in Nyeri County. Stratified random sampling procedure, first of farms within the selected sub-county followed by random sampling of lactating does within the farms/herds was employed.

Farm visits and Questionnaire survey

Selected farms were visited where observations were made, milk samples collected and farmers interviewed. Study farms were randomly selected from the list of dairy goat farmers (sampling frame) provided by the livestock production officers and Dairy Goat Association of Kenya (DGAK) representatives. These are small scale farms where dairy goats are kept indoors. Structured questionnaires were used to gather information on risk factors of mastitis and farmers' knowledge, awareness, perceptions and practices with regard to mastitis in goats. Individual goat forms were also filled at the time of milk sample collection to capture data on goat characteristics such as breed, stage of lactation, daily milk production, mastitis status and teat defects among others. Lactation stages were divided into three: early (0-3 months), mid (>3-7 months) and late (>7 months). Status of milking hygiene and environment was also recorded.

Milk sample collection

A physical examination was performed on the udder of lactating does . This involved observation and palpation of udders to check for differences in symmetry and sizes, indurations and fibrosis, milk consistency and colour changes, and any visible abnormalities. Signs of inflammation and skin lesions on the udder and teats were observed and recorded. Prior to milk sample collection udders and teats were cleaned with water and dried. The teats were then disinfected with 70% ethyl alcohol. The first two streams of milk were discarded before collecting 20 ml of milk from each half of the udder into appropriately labeled sterile universal bottles. Milk samples were transported in cool boxes with ice to the laboratory for bacteriological analysis. Subclinical mastitis was diagnosed by use of California Mastitis Test (CMT) on apparently normal milk.

California Mastitis Test for subclinical mastitis

Physically normal milk samples from each half of lactating doe were tested for subclinical mastitis using California Mastitis Test (CMT). The CMT results were scored as 0 (no gel), trace (very slight gel), 1 (slight gel), 2 (medium gel) and 3 (heavy gel) (Quinn *et al.,* 1999). In this study, CMT scores of 0, traces and 1 were considered as negative while CMT scores of 2 and 3 were taken to be positive and strong positive for subclinical mastitis respectively, as described by Bourabah et al (2013).

Bacterial isolation and identification

Milk samples were subjected to bacteriological examination in the laboratory irrespective of their CMT scores by following standard procedures (Quinn *et al.,* 1999; National Mastitis Council, 1990). About 10uL of milk from each half was streaked onto blood agar enriched with 5% defibrinated ovine red blood cells. Streaking was done quantitatively by making at least four streaking zones per milk sample. The plates were then incubated aerobically overnight at 37oC. Samples not yielding a positive growth were re-incubated and read the following day. Each plate was examined macroscopically for abundance of growth and scored 0,1,2,3 or 4 and morphology of the colonies together with hemolytic characteristics. Identification of the isolates was done through Gram stain and microscopic examination for Gram-staining reaction, morphology and arrangement of the stained bacterial cells. This was followed by biochemical test namely catalase test (used for differentiating Gram-positive cocci and

rods) and indole test (for differentiating Gram-negative cocci). The small to medium sized colonies that yielded Gram-positive cocci (with clustering or in chains) and tested positive for catalase were identified as Staphylococcus while those that tested negative were identified as Streptococci. The short Gram-negative rods that tested positive for catalase were identified as Corynebacteria (Holt *et al.,* 1993). The Gram-negative cocci that tested positive on being subjected to indole test were identified as Escherichia coli (E.coli).

Antibiotic Susceptibility Test

Antimicrobial sensitivity test was conducted on bacterial cultures that yielded pure colonies and with a growth score of 3 or 4. The isolates were tested against an ally of 8 antibiotics using the Kirby-Bauer disk diffusion method (NCCLS, 1999). Commercially available antibiotic disks (Hilmedia, India) were used which included ampicillin (AMP, 25 mcg), tetracycline (TET, 25 mcg), co-trimoxazole (COT, 25 mcg), streptomycin (S, 10 mcg), kanamycin (K, 30 mcg), Gentamycin (GEN, 10 mcg), sulphamethoxazole (Sx, 200 mcg) and chloramphenicol (C, 30 mcg). Each isolate was first diluted in sterile saline solution to a 0.5 Mcfarland standard before being transferred onto blood agar plates. The diluted isolate was poured onto the respective plates and spread uniformly on the entire agar surface using a sterile wire loop. Each antibiotic impregnated disk was applied onto the surface of the inoculated plate by using sterile forceps. The plates were incubated overnight at 37oC. The results were read by measuring the respective zones of inhibition for each antibiotic and interpretation and classification made as susceptible or resistant following the guidelines of the National Committee for Clinical Laboratory Standards (NCCLS 1999). The sensitivity status was determined by three scale system as sensitive (S), intermediate (I) and resistant (R) based on the performance standards (diameter of zones of inhibition) for antimicrobial disk susceptibility tests (Quinn *et al.,* 2000). The intermediate was also considered positive in this study.

Data management and statistical analysis

Collected data were entered in MS-excel 2007 spread sheet and cleaned using scatter plots to identify outliers. Statistical analysis was carried out using the same software to generate various descriptive statistics. Prevalence of subclinical mastitis was calculated at two levels; goat prevalence referred to the number of CMT-positive goats divided by total number of goats investigated and at udder half level described as number of CMT-positive halves divided by the total number of halves examined. Further, the prevalence (%) of the bacterial type was estimated as the ratio of the number of positive samples to the total number of samples collected for bacteriological analysis. Stata (version-11) soft ware was used to evaluate for statistical significance (Chi-square test, x2 at 95% CI) and to carry out probit regression analysis to determine the associations between prevalence of mastitis in goats and its risk factors.

Results

Milking management in goats and farmers knowledge, awareness, perception and practices

In this study, 30 farms were visited, 25 questionnaires administered to goat farmers and 122 milk samples collected from 61 goats. Out of 25 farmers interviewed 8(32%) reported that they had encountered goat mastitis in their farms. In addition, 17/25(68%) observed that mastitis mostly occurred among old does while 8/25(32%) observed that mastitis in goats had no age specificity. Further, 15/25(60%) reported that mastitis occurred during the wet season, 1/25(4%) during dry season and 1/25(4%) said that mastitis could occur during both seasons. On management of mastitis in goats, 4/25(16%) of those interviewed reported that when one goat has mastitis in their herd it is milked first, 12/25(48%) milked the mastitis goat last while 9/25(36%) did not follow any order while milking. Further, 15/25(60%) of the respondents reported that they wash their hands and doe's udder before milking where all of them used warm water. In addition, 21/25(84%) used a towel for drying the udders where among these only one farmer was using a single towel for each milking doe. Use of milking jelly was

reported by 24/25(96%) of farmers where among these 12/24(50%) used the medicated type. All of the farmers interviewed did not use post-milking teat dips on the lactating does nor did they have pen-side mastitis diagnostic kits on their farms.

Teat abnormalities, prevalence of mastitis and its risk factors in goats

Of the 61 lactating goats (does) randomly selected, 10, 21, 12, and 18 goats were from Nyeri Central, Tetu, Mathira-East and Mukurwe-ini sub-counties respectively. Visual inspection and palpation of the goats' udders coupled with macroscopic examination of milk revealed no abnormalities, thus there was no case of clinical mastitis diagnosed. However, teat lesions were detected in some does which included extra teats 1/61 (1.6%), fibrosis/hardening 2/61 (3.3%) and pendulous teats 1/61 (1.6%) with total defects being 4/61 (6.6%). Such does had no sound teats for milk production.

The overall prevalence of subclinical mastitis at goat level was 20/61 (33%) where 8/61 (13%) of the goats examined had bilateral subclinical mastitis affecting the two halves of the udder and 12/61 (20%) had unilateral infection on only one half of the udder. The highest point prevalence of 9/21 (43%) was recorded in Tetu sub county, followed by Mukurwe-ini (6/18;33%), Nyeri Central (3/10; 30%) and Mathira East (2/12; 17%). At udder half level a total of 31 out of 122 halves investigated gave CMT score of 2 or 3 giving an udder half prevalence of 25%. All the goats diagnosed with subclinical mastitis were treated using intrammamary antibiotic infusions/tube. Further, out of the 20 goats with subclinical mastitis 16(80%) were reared under complete zero grazing system, 3/20 (15%) under semi-zero grazing system and 1/20 (5%) under free grazing. The differences of mastitis prevalence in the three grazing systems were statistically significant (P=0.049 i.e. P<0.05). In relation to breeds, 16/20 (80%) of goats with subclinical mastitis were german alpines, 3/20(15%) were crossbreeds and 1/20 (5%) were saanen, and these differences were not statistically significant (P=0.09).

With regard to stage of lactation, 8/20 (40%) of goats with mastitis were in early, 8/20 (40%) in mid and 4/20 (20%) were in late stage of lactation. On evaluating level of milk production as a risk factor to occurrence of mastitis in dairy goats, 11/20 (55%) of the goats diagnosed with subclinical mastitis were producing more than 2 litres of milk per day, 6/20 (30%) producted 1-2 litres/day and 3/20 (15%) produced less than 1 litre/day. The effects of stage of lactation and level of milk production on occurrence of mastitis in goats were both statistically significant (P<0.05).

Hygienic status of milking environment

Inspection of the milking environment revealed that 32/61 (52.5%) of the does were milked under poor and 29/61 (47.5%) under good hygienic conditions. Further, 12/20 (60%) of goats with subclinical mastitis were being milked under poor and 8/20 (40%) under good hygienic conditions. The milking hygiene was scored as poor in cases where does were milked without udder washing, milkers hands not washed, water used not boiled and warm, milking jelly not applied, udders not dried with a towel and milking place was wet and dirty.

Isolated bacteria from goat milk

On carrying out bacteriological culture, 58/122(47.5%) of the milk samples yielded significant bacterial growth, 3/122 (2.5%) were contaminated and 61/122 (50%) had no growth. On scoring of the plates using the criterion of abundance of growth 61/122 (50%) had a score of 0, 3/122 (2.5%) were contaminated, 28/122 (23%) a score of 1, 13/122 (10.5%) a score of 2, 10/122 (8%) a score of 3 and 7/122 (6%) a score of 4. The bacterial isolate with highest isolation was Staphylococci 41/122(34%), followed by Streptococci 7/122 (6%), bacillus 4/122 (3%), corynebacterium 2/122 (1.6%) and E. coli 1/122 (0.8%).

Antibiotic sensitivity of isolated bacteria

Antibiotic sensitivities of 14 Staphylococci and 4 Streptococci isolates are shown in tables 1 and 2 respectively. Staphylococci had 100% sensitivity to gentamycicn, kanamycin, streptomycin and

Table 1: Antibiotic sensitivity patterns of 14 Staphylococcus isolates from goat milk

Antibiotic	Resistant (0 mm)	Intermediate (1-19mm)	Sensitive (20mm and>)	Total sensitive (n/%)
Ampicillin	1(7%)	2	11	13(93%)
Tetracycline	1(7%)	5	8	13(93%)
Co-Trimoxazole	7(50%)	4	3	7(50%)
Streptomycin	0	2	12	14(100%)
Kanamycin	0	0	14	14(100%)
Gentamycin	0	2	12	14(100%)
Sulphamethoxazole	10(71%)	4	0	4(29%)
Chloramphenicol	0	2	12	14(100%)

Table 2: Antibiotic sensitivity patterns of 4 Streptococcus isolates from goat milk

Antibiotic	Resistant (0 mm)	Intermediate (1-19mm)	Sensitive (20mm and>)	Total sensitive (n/%)
Ampicillin	0	0	4	4(100%)
Tetracycline	0	1	3	4(100%)
Co-Trimoxazole	0	3	1	4(100%)
Streptomycin	0	0	4	4(100%)
Kanamycin	0	0	4	4(100%)
Gentamycin	0	0	4	4(100%)
Sulphamethoxazole	1(25%)	2	1	3(75%)
Chloramphenicol	0	1	3	4(100%)

chloramphenicol antibiotics. However, the highest resistance was demonstrated against sulphamethoxazole and co-Trimoxazole. Streptococci were sensitive to all the eight antibiotics with only slight resistance against sulphamethoxazole.

Discussion

In this study clinical mastitis was not diagnosed among the goats investigated. Other studies have reported similar findings in Kenya (Ndegwa et al, 2000; Ndegwa et al, 2002) and other parts of the world (Ebrahimi *et al.,* 2007). This observation can be explained by the fact that dairy goats with clinically observable mastitis are either immediately treated or culled.

Prevalence results of subclinical mastitis described in this study were determined using CMT method where goats with CMT score of 2 and 3 in at least one half of the udders were considered positive. CMT scores of 0, traces and 1 were regarded as negative. This was due to the consideration that somatic cell count (SCC) of milk from uninfected goats is higher compared to normal milk from cows and sheep (Contreras *et al.,* 2007). A similar criterion was also used to determine the prevalence of subclinical mastitis in goats in Algeria by Bourabah et al. (2013). The use of CMT in this study revealed presence of subclinical mastitis in goats at a prevalence of 33%. In Kenya only a few studies have been conducted on sub-clinical mastitis in goats. For example Ndegwa et al. (2000) reported 28.7% intra-mammary infection among Kenyan dairy goats reared in Central Kenya highlands. The prevalence reported here is also similar to 33.9% reported in Algeria (Bourabah *et al.,* 2013). However, the prevalence was lower than 40.9% reported for dairy goats in Ethiopia (Wakwoya *et al.,* 2006).

The high prevalence reported in Ethiopia may be because in that study a CMT score of +1 was considered positive for mastitis while in the current study and that conducted in Algeria only a CMT score of +2 and above was considered positive for subclinical mastitis. The variance could also be attributed to environmental, breed and management system differences. The high prevalence of subclinical mastitis reported in this study can be attributed to the poor milking hygiene in the farms as well as lack of good mastitis management practices. For example, only one farmer out of the 25 interviewed was using a single towel for each doe to dry the udder, less than half of the farmers did not use medicated milking jelly and none of the farmers practiced post-milking teat disinfection or sanitizer. This is in agreement with the findings reported by Ndegwa et al. (2000) where does that were not routinely washed before milking had higher intra-mammary bacterial infections than those washed and dried with individual towels.

The results of the study further showed that the form of grazing system had a significant influence on the prevalence of mastitis in goats where the highest proportion of goats with subclinical mastitis were being reared under complete zero-grazing system. A possible explanation for the higher prevalence in housed lactating does than those under free grazing is the increased contamination of goat pens with animal discharges such as urine, leaked milk, manure and others where all these when warmed by body heat provide an excellent environment for rapid and explosive bacterial growth in houses compared to open enclosure. These bacteria then contaminate the udder and teats. Ndegwa et al. (2000) reported that poor housing was significantly associated with udder infection status of the doe. Therefore, as a result of this finding frequent cleaning and drying of goat houses and open enclosures is of paramount importance in order to reduce intra-mammary infections. Further the current study revealed that subclinical mastitis was higher among does with high milk production and those kept under poor hygienic conditions than in does with reduced milk production and good hygienic conditions. A similar finding was reported by Megersa et al. (2010) in Ethiopia. Mastitis was also found to be prevalent in does at early and mid stages of lactation which is different from what is reported by other authors. Reports of the relationship between mastitis prevalence and stage of lactation is variable with some showing increased prevalence (Ndegwa *et al.,* 2000; Megersa *et al.,* 2010) or no difference (McDougall *et al.,* 2002).

The questionnaire survey showed that mastitis was most commonly observed among the old does with higher parity and during the wet season. Other studies have also reported similar findings (McDougall *et al.,* 2002; Megersa *et al.,* 2010). This may be due to prolonged exposure to mastitis causing pathogens in the old multiparous does compared to primiparous or those with less parity. When the duration of exposure to infection is long and spontaneous cure rate is low then the disease prevalence increases. Furthermore, mastitis prevalence is high during the wet season due to the favorable micro-environmental conditions for maintenance and transmission of the mastitis causing pathogens. In the wet season most goat dwellings become wet and spoiled by goat excretions which subsequently soil the udder halves and teats, thus allowing the pathogens to enter the teats and cause udder infection (Ingalls, 2003). The survey also showed that most farmers in the study area had inadequate knowledge on good mastitis control practices. Thus farmer education will go a long way in lowering mastitis in dairy goats reared in this region.

The genera of bacteria reported in the current study are in agreement with those reported by other authors in Kenya and other parts of the world. For example, Staphylococcus species was the most prevalent bacterial isolate obtained in this study and similar results were reported by Ndegwa et al. (2000), Ndegwa et al. (2002), Mbindyo et al. (2013) and Shivairo et al. (2013) in Kenya. Studies from other parts of the world have shown Staphylococci to be the most commonly isolated pathogen in goat milk (Stuhr *et al.,* 2010; Persson and Olofsson, 2011; Bourabah *et al.,* 2013; Najeeb *et al.,* 2013). Indeed in a review on mastitis of dairy small ruminants by Bergonier et al. (2003) concluded

that staphylococci are the main aetiological agents of intra-mammary infections in small ruminants. Streptococci were the other major mastitis causing bacteria reported in this study. Isolation of this bacterium from goat milk has also been reported in Kenya (Ndegwa *et al.,* 2000; Ndegwa *et al.,* 2002) and elsewhere (Ibrahimi et al. 2007; Najeeb *et al.,* 2013). Corynebacterium species, E. coli and Bacillus species reported here have also been reported by other authors (Bourabah *et al.,* 2013; Najeeb *et al.,* 2013; Shivairo *et al.,* 2013). However, in a study carried out in Central Kenya by Ndegwa et al. (2002) the three bacterial species were not isolated from dairy goat milk. This variation may be explained by the fact that prevalence and relative importance of different etiological agents of mastitis differ in different geographical regions.

The study has shown that most staphylococci and streptococci isolates from the study area were sensitive to the eight antibiotics they were tested against. Therefore, there is very low antibiotic resistance in the area thus most of the commonly used antibiotics for mastitis can be effective. A similar finding was reported by Wakwoya et al. (2006) for bacterial isolates from Ethiopian goat milk. Further, 100% sensitivity of Staphylococcus species to streptomycin and gentamycin was also reported by Ebrahimi et al. (2007). Moderate resistance was demonstrated in this study to sulphamethoxazole, co-Trimoxazole, tetracycline and ampicillin. Thus before use of these antibiotics for mastitis therapy in dairy goats antibiotic sensitivity tests are required. In addition, this finding triggers the need for prudent use of antibiotics in the area in order to guard further development of resistance against the commonly used antimicrobials.

Conclusions

1. Subclinical mastitis is prevalent in dairy goats in Nyeri County and therefore appropriate control strategies are required such as proper milking hygiene practices and educating the dairy goat farmers.
2. The risk factors associated with mastitis in goats in Nyeri County were poor milking hygiene, inadequate knowledge on good mastitis management practices among farmers, grazing system where it was highest under complete zero grazing, stage of lactation where it was most prevalent during early and mid lactation, and milk yield where it was common in high yielders.
3. Staphylococci and streptococci are the causative agents of the majority of sub-clinical cases of mastitis in dairy goats.
4. There is very low antibiotic resistance in the area thus most of the commonly used antibiotics for mastitis are effective.

Importance of the findings 'Impact'

The findings of this study have shown that mastitis occurs in dairy goats in sub-clinical form which necessitates use of tests to detect. Further farmers' knowledge on the disease is low thus hindering effective control and therefore farmers' education should be an integral part of dairy goat mastitis control program. Factors putting goats at the risk of contracting mastitis were identified and information is useful in formulating appropriate and improved control strategies. Bacteria causing the disease in Nyeri were identified and the antibiotics that are effective in treatment determined hence these drugs can be used by animal health service providers in Nyeri without undertaking antibiotic sensitivity tests.

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

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

The Editor in Chief
January 2013

Aims and scope

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

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 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 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.
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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.

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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, 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:

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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.
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4. Every line on the text should be numbered.
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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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