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PERFORMANCES DE REPRODUCTION DES COBAYES (CAVIA PORCELLUS L.) SUPPLÉMENTÉS AUX ASTÉRACÉES OU À L'ALIMENT COMPOSÉ ENRICHÉ EN PROTÉINES

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Resume

Un essai a été mené de mai à octobre 2013 à la Ferme d'Application et de Recherche de l'Université de Dschang pour évaluer l'effet d'une supplémentation aux astéracées ou à un aliment composé enrichi en protéines sur les performances de reproduction des cobayes. A l'issue d'une phase d'acceptabilité de deux semaines deux de trois astéracées (*Galinsoga*, sp, *Bidens pilosa*, *Ageratum conyzoides*) ont été choisies pour être utilisées dans l'essai. 48 femelles adultes ont été distribuées au hasard dans un dispositif factoriel 3x2x3 (ration, origine, répétitions). Les rations expérimentales étaient constituées de *Penissetum clandestinum* + Aliment composé de base (T0), *Penissetum clandestinum* + *Galinsoga* sp+ *Bidens pilosa* (T1), et *Penissetum clandestinum* + aliment composé enrichi en protéines (T2). Les principaux résultats indiquent que *Galinsoga* sp a été significativement ($P < 0,05$) plus appréciée, suivie de *Bidens pilosa*. Les taux de fertilité, de prolificité, de sevrage et la taille de la portée n'ont pas été significativement ($P > 0,05$) affectés par la supplémentation. Le taux d'avortement, comparable ($P > 0,05$) entre T1 ($50,00 \pm 35,35\%$ pour Nord Ouest et $37,50 \pm 17,46\%$ pour Ouest) et T2 ($12,50 \pm 17,67\%$ pour Nord Ouest et $12,50 \pm 17,67\%$ Ouest), a été significativement ($P < 0,05$) plus élevé par rapport à T0 où l'avortement n'a pas été observé. Les nouveaux nés des reproductrices du lot T1 ont enregistré des poids à la naissance de $67,16 \pm 3,21$ g pour le Nord-Ouest et $78,66 \pm 5,80$ g pour Ouest. Ces valeurs sont significativement ($P < 0,05$) inférieures à celles obtenues dans les traitements T0 et T2. Il en est de même que pour le sevrage. Néanmoins le gain de poids de la naissance au sevrage a été comparable ($P > 0,05$) entre les traitements. Au terme de cette étude, il a été conclu que les astéracées et les aliments composés riches en protéines devraient être utilisés avec modération en alimentation des cobayes pour la reproduction.

Mots clés : Astéracées, cobaye, Cameroun, reproduction, protéines.

REPRODUCTIVE PERFORMANCE IN GUINEA PIGS (CAVIA PORCELLUS L.) SUPPLEMENTED WITH ASTERACEAE OR WITH PROTEIN ENRICHED COMPOUND FEED

Abstract

A trial was conducted from May - October 2013 at the Application and Research Farm of the University of Dschang, to evaluate the effect of supplementation with asteraceae or protein-enriched compound feed on Guinea pig reproductive performance. At the end of a two-week acceptability phase, two of three asteraceae (*Galinsoga*, sp., *Bidens pilosa*, *Ageratum conyzoides*) were selected for use in the trial. 48 adult females were assigned randomly in a factorial 3x2x3 (ration, origin, replicate) design. Experimental rations consisted of *Penissetum clandestinum* + basic compound feed (T0); *Penissetum clandestinum* + *Galinsoga* sp + *Bidens pilosa* (T1); and *Penissetum clandestinum* + protein-enriched compound feed (T2). The main results indicate that *Galinsoga* sp was significantly ($P < 0.05$) more palatable, followed by *Bidens pilosa*. Fertility, prolificacy, weaning rates and litter size were not significantly ($P > 0.05$) affected by supplementation. Abortion rate comparable ($P > 0.05$) between T1 ($50.00 \pm 35.35\%$ for North West and

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37.50 ± 17.46 for West) and T2 (12.50 ± 17.67% for North West and 12.50 ± 17.67% West) was significantly ($P < 0.05$) higher compared to T0 where no abortion was observed. The newborns of T1 lot breeders had birth weights of 67.16 ± 3.21 g for Northwest and 78.66 ± 5.80 g for West. These values are significantly ($P < 0.05$) lower than those obtained in treatments T0 and T2. The same is true for weaning. Nevertheless, weight gain from birth to weaning was comparable ($P > 0.05$) between treatments. At the end of the study, it was concluded that asteraceae and protein-enriched compound feed should be used in moderation in feed intended for guinea pigs for breeding purposes.

Mots clés : asteraceae, guinea pig, Cameroon, reproduction, protein.

Introduction

Dans l'élevage des cobayes la disponibilité et la qualité des aliments demeurent les plus importantes contraintes (Nuwanyakpa *et al.*, 1997 ; Pamo *et al.*, 2005, Bindelle *et al.*, 2007a ; Metre, 2011 ; Niba *et al.*, 2012). Plusieurs facteurs concourent à cet état de fait entre autre : la rareté des sources de protéines indispensables à la bonne production, une longue saison sèche entraînant la mauvaise qualité des fourrages. La tâche n'est pas aussi aisée pour l'éleveur qui doit parfois parcourir de longues distances à la recherche de meilleurs fourrages. L'animal se contente souvent de quelques graminées moissonnées quotidiennement dans les arrière-cours, le long des routes ou tout près des rivières, des restes de cuisine, des résidus de récolte souvent carencés en nutriments essentiels tels que les protéines et les minéraux (Kouommenioc *et al.*, 2000 ; Bindelle *et al.*, 2007b ; Kouakou *et al.*, 2012). Cette insuffisance quantitative et qualitative des ressources alimentaires ne permet pas une bonne couverture des besoins nutritionnels. Dans cette situation, l'animal ne peut pas exprimer son potentiel génétique et les performances de production qui en découlent sont médiocres. Il s'en suit un retard de la croissance, une baisse de fertilité, des avortements, des petits avec des faibles poids à la naissance et une mortalité pré-sevrage élevée (Niba *et al.*, 2004).

Pour rehausser le taux de protéines de la ration et optimiser l'utilisation des aliments, les graminées pourraient être associées à des légumes ou à un aliment composé complet (Kouommenioc *et al.*, 2000 ; Pamo *et al.*, 2005, Kenfack *et al.*, 2006) ce qui n'est pas toujours

pratiqué par les éleveurs des cobayes en milieu rural. Pourtant des légumes comme *Galinsoga* sp, *Bidens pilosa*, *Ageratum conyzoides*, *Crassocephalum* sp et autres, appartenant à la famille des astéracées pourraient constituer une importante source des protéines surtout en saison sèche (Nguizani, 2001 ; Metre, 2012 ; Katunga *et al.*, 2012, Bacigale *et al.*, 2013). Des aliments composés ont déjà été utilisés mais ils se sont avérés avoir un faible taux de protéines pour couvrir les besoins nutritionnels de la reproduction (Niba *et al.*, 2008 ; Noubissi *et al.*, 2013).

L'objectif de ce travail est d'évaluer les performances de reproduction des cobayes supplémentés aux astéracées ou à un aliment composé enrichi en protéines, prenant en compte l'origine des cobayes.

Matériel et Méthodes

Site expérimental

Le présent travail a été effectué de mai à octobre 2013 à la Ferme d'Application et de Recherche (FAR) de l'Université de Dschang (5°26' Latitude Nord, 10°26' Longitude Est, 1420 m d'altitude). Les caractéristiques climatiques de ce site telles que décrites par Kenfack *et al.*, (2006) montrent que son climat est de type soudano-guinéen. Les températures moyennes annuelles oscillent entre 10°C (Juillet-Août) à 25°C (Février) avec une insolation annuelle de 1800 heures et une humidité relative variant entre 40 - 97%. Les précipitations varient entre 1500 et 2000 mm par an. La saison sèche va de mi-novembre à la mi-mars et la saison des pluies de mi-mars à mi-novembre.

Evaluation de l'acceptabilité des astéracées par les cobayes

32 cobayes (16 originaires du Nord Ouest et 16 de l'Ouest du Cameroun) étaient repartis au hasard suivant un dispositif factoriel comportant deux populations (NO et O), deux sexes et deux répétitions. Ces animaux ont reçu 200g de chacune de trois astéracées (*Galinsoga sp.*, *Bidens pilosa* et *Ageratum conyzoides*) pendant une période de deux semaines. Le but était d'adapter les animaux aux nouveaux fourrages et de déterminer leur préférence. Les tiges et feuilles de chaque astéracée étaient préfanées pendant 24 h et servies à la fois pour chaque lot. La consommation alimentaire journalière (gMS) a été évaluée. Deux astéracées qui étaient plus appréciées étaient utilisées pour évaluer leurs effets sur les performances de reproductions des femelles.

Evaluation de la reproduction

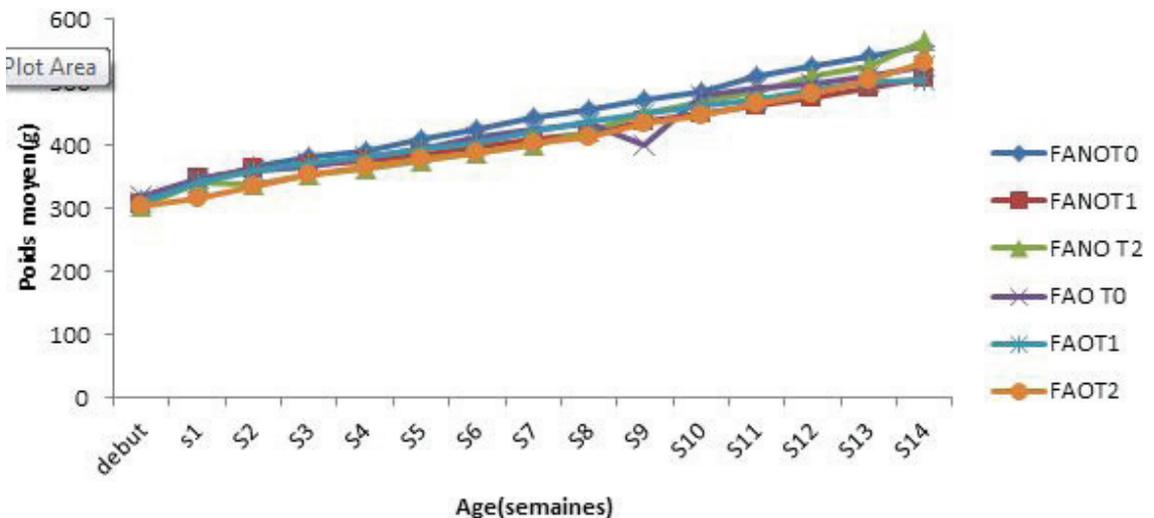
Durant cette phase, quarante huit (48) femelles adultes âgées d'au moins 5mois (dont 24 pour chacune de deux populations), pesant en moyenne $308,85 \pm 29,69g$ ont été reparties au hasard dans un dispositif factoriel comportant deux populations (NO et O),

trois rations, deux répétitions par facteur. Elles ont été mises en reproduction pendant 31 jours ensuite les mâles ont été retirés. Les rations quotidiennes étaient les suivantes: T0: *P.clandestinum* + composé de base (18% de PB), T1 : *P.clandestinum*+ *Galinsoga sp* + *Bidens pilosa*, T2 : *P.clandestinum* + aliment composé enrichi en protéines (24,18% de PB). La quantité de l'aliment composé servie était chaque semaine sur base de 5% du poids vif des femelles de chaque lot. La composition chimique de différents aliments utilisés déterminée selon les méthodes décrites par AOAC (1990) est donnée dans le tableau I.

Pour l'évaluation de la croissance pondérale, les poids des mères étaient pris à la mise bas, ensuite tous les 7 jours jusqu'au sevrage (21 jours). Les petits ont également été pesés à la naissance et hebdomadairement. Les paramètres de reproductions suivant ont été calculés : taux de fertilité(%), taux de prolificité (%) taux d'avortement(%), taux de sevrage(%), la mortalité pré-sevrage (%).

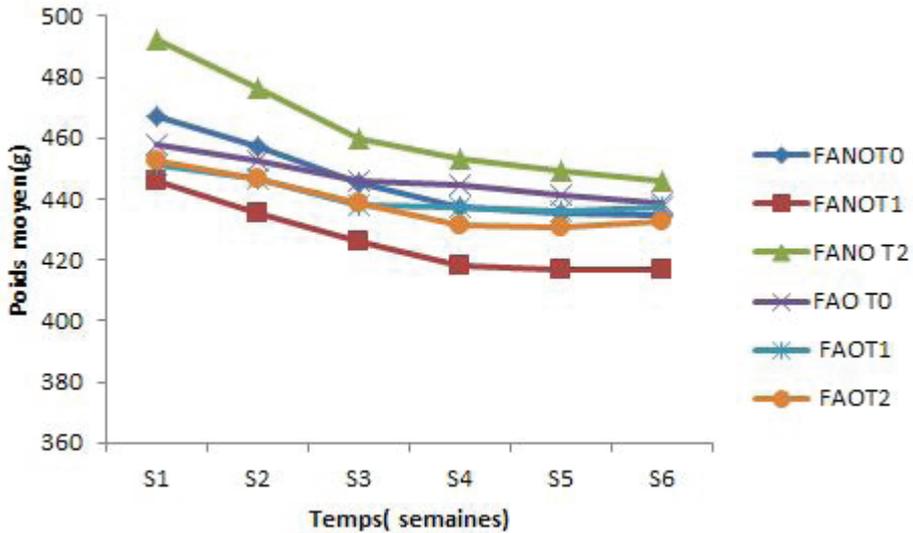
Analyse statistique

Les données sur l'acceptabilité et la croissance ont été soumises à l'analyse de la variance (ANOVA) suivant le dispositif



FANO : femelle adultes originaires du Nord Ouest, FAO : femelles adultes originaires de l'Ouest T0=*P.clandestinum*+ aliment composé de base, T1= *P.clandestinum* +*Galinsoga sp* et *Bidens Pilosa*, T2= *P.clandestinum* +aliment composé enrichi en protéiques

Figure 1 : Evolution hebdomadaire du poids vif des femelles durant la gestation



FANO : femelle adultes originaires du Nord Ouest, FAO : femelles adultes originaires de l'Ouest T0= Pclandestinum+ aliment composé de base, T1= Pclandestinum +Galinsoga sp et Bidens Pilosa, T2= Pclandestinum +aliment composé enrichi en protéiques

Figure 2 : Evolution pondérale des femelles reproductrices durant l'allaitement

factoriel. En cas de différence significative, le test de Turkey HDS au seuil de 5% a été utilisé pour séparer les moyennes. Le test de X2a été utilisé pour les données de reproduction. Les analyses ont été faites à l'aide du logiciel R Gue 3.0.2

Résultats

Acceptabilité de Galinsoga sp., Bidens pilosa et Agerantum conysoïdens chez les cobayes

La consommation journalière de Galinsoga sp, Bidens pilosa et Agerantum conysoïdens chez les cobayes est résumée dans le Tableau 2. Quels que soient l'origine, le sexe du cobaye, la consommation moyenne journalière de Galinsoga sp a été significativement ($P < 0,05$) plus élevée que celle de Bidens pilosa et d'Agerantum conysoïdens. Dans l'ensemble, Galinsoga sp a été la plus acceptée, suivie de Bidens et Agerantum.

L'évolution pondérale des femelles reproductrices

L'évolution hebdomadaire du poids vif des reproductrices durant la gestation et l'allaitement est illustrée par les Figures 1 et 2. Quelles que soient l'origine et la ration, aucune différence significative ($P > 0,05$) de poids en

fonction d'âge de gestation, n'a été observé chez ces femelles (Figure 1). Les courbes de la Figure 2 qui illustrent l'évolution pondérale durant l'allaitement indiquent que toutes les femelles ont perdu du poids pendant cette période. Cette perte a été plus importante chez les femelles du lot T1 originaires du Nord-Ouest. Toutefois il n'y a pas eu de différence significative ($P > 0,05$) entre les traitements pour le poids moyens post-partum quels que soient la ration et l'origine.

Paramètres de reproduction des femelles reproductrices supplémentées aux astéracées ou à l'aliment composé enrichi en protéines

Il ressort de ce tableau quelles que soient la ration et l'origine, les taux de fertilité, de prolificité, de sevrage et la taille de la portée n'ont montré aucune différence significative ($P > 0,05$) (Tableau 3). Par ailleurs les taux les plus élevés étaient observés chez les femelles du lot T0 (pour la fertilité et le sevrage), du lot T2 (pour la prolificité et la taille de la portée).

Les taux d'avortement des reproductrices des lots T1 et T2 étaient comparables ($P > 0,05$) et significativement ($P < 0,05$) supérieurs à celui des femelles du lot

Tableau 1 : Composition chimique de différents aliments utilisés

Echantillons	MS (%)	Protéine Brute (%MS)	Lipides (%MS)	Cellulose Brute (%MS)	Cendres (%MS)	EM (Kcal/Kg MS)
<i>P clandestinum</i>	93,77	12,76	3,66	26,03	16,09	1184,56
<i>Galinsoga sp</i>	87,78	18,92	4,23	24,24	20,65	1187,72
<i>Bidens pilosa</i>	90,24	18,48	4,85	24,06	15,47	1448,91
Aliment de base	96,37	18,97	7,40	15,47	7,76	2664,55
Aliment enrichi en protéine	95,41	24,18	8,01	14,31	6,80	2839,55

Tableau 2. Consommation moyenne journalière(g) de *Galinsoga sp*, *Bidens pilosa* et *Ageratum consyoidens* chez les cobayes

Origine	Age	Sexe	<i>Galinsoga sp</i>	<i>Bidens pilosa</i>	<i>Ageratum consyoidens</i>
NO	adulte	□	50,56±0,98 ^a	37,73±1,16 ^b	18,16±1,06 ^c
		□	50,58±0,44 ^a	34,84±0,48 ^b	23,13±1,85 ^c
		□□	50,57±0,71 ^{aA}	36,29±0,82 ^{bA}	20,64±1,45 ^{cA}
O	adulte	□	49,13±0,84 ^a	35,36±0,16 ^b	23,18±0,05 ^c
		□	49,02±0,97 ^a	34,11±0,05 ^b	17,11±2,54 ^c
		□□	49,08±0,90 ^{aA}	34,73±0,11 ^{bA}	20,64±1,29 ^{cA}

^{a,b,c} : les moyennes portant des lettres différentes sur la même ligne sont significativement différentes ($P<0,05$) A: les moyennes (□□) portant des lettres identiques dans la même colonne sont comparables ($P<0,05$) pour le même âge NO : Nord Ouest, O : Ouest

Tableau 3 : Paramètres de reproduction des femelles en fonction de l'origine et de la ration

Paramètres	origine	Rations		
		T0	T1	T2
Taux de fertilité	NO	100 ^a	50±35,35 ^a	87,5±17,67 ^a
	O	100 ^a	62,5±17,67 ^a	87,5±17,67 ^a
Taux de prolificité	NO	112,5±17,67 ^a	116,66±23,57 ^a	133,33±47,14 ^a
	O	112,5±17,67 ^a	116,66±23,53 ^a	112,25±17,67 ^a
Taux d'avortement	NO	0 ^b	50±35,35 ^a	12,5±17,67 ^a
	O	0 ^b	37,5±17,46 ^a	12,5±17,67 ^a
Taux de sevrage	NO	100 ^a	87,5±17,67 ^a	100 ^a
	O	100 ^a	90,00±14,14 ^a	63,33±14,71 ^a
Taux de mortalité pré-sevrage	NO	0 ^a	12,5±17,67 ^a	0 ^a
	O	0 ^a	10,00±14,14 ^a	36,66±4,71 ^b
Taille de la portée	NO	1,12±0,07 ^a	1,16±0,23 ^a	1,33±0,47 ^a
	O	1,12±0,27 ^a	1,16±0,23 ^a	1,12±0,17 ^a

^{a,b} : les moyennes portant des lettres différentes sur la même ligne sont significativement différentes ($P<0,05$) NO : Nord ouest, O : Ouest T0=Pclandestinum+ aliment composé de base, T1= Pclandestinum +Galinsoga sp et Bidens Pilosa, T2= Pclandestinum +aliment composé enrichi en protéines

Tableau 4 : Poids vif à la naissance et au sevrage des jeunes cobayes

Paramètres	origine	sexe	Rations		
			T0	T1	T2
Poids vif naissance (g)	NO	□	87,75±10,07 ^a	66,33±6,42 ^b	94,5±13,69 ^a
		□	93,00±10,36 ^a	68,00±0,00 ^b	80,00±16,91 ^a
		□□	90,37±10,10 ^a	67,16±3,21 ^b	87,25±15,30 ^a
	O	□	95,10±6,91 ^a	72,68±10,20 ^b	96,00±6,42 ^a
		□	96,25±5,41 ^a	84,66±1,41 ^b	74,50±11,56 ^b
		□□	95,67±6,16 ^a	78,66±5,80 ^b	85,75±8,99 ^a
Poids au sevrage(g)	NO	□	178,50±12,58 ^a	146,66±17,55 ^b	182,00±10,48 ^a
		□	169,50±5,31 ^a	126,00±0,00 ^b	165,40±10,43 ^a
		□□	173,79±8,94 ^a	136,33±8,75 ^b	173,70±10,40 ^a
	O	□	170,50±3,39 ^a	166,33±12,81 ^a	173,00±7,81 ^a
		□	164,35±9,21 ^a	114,33±6,36 ^b	165,50±19,09 ^a
		□□	167,42±6,30 ^a	140,33±9,50 ^b	169,25±13,00 ^a

^{a, b} : les moyennes portant des lettres différentes sur la même ligne sont significativement différentes ($P<0,05$) NO : Nord ouest, O : Ouest
T0=Pclandestinum+ aliment composé de base, T1= Pclandestinum +Galinsoga sp et Bidens Pilosa, T2= Pclandestinum +aliment composé enrichi en protéiques

Tableau 5 : Gain de poids des jeunes cobayes de la naissance au sevrage

Paramètres	origine	sexe	Rations		
			T0	T1	T2
Gain total(g)	NO	□	90,75±17,14 ^a	81,33±12,09 ^a	71,39±6,95 ^a
		□	76,33±9,66 ^a	58,00±0,00 ^b	85,41±6,98 ^a
		□□	83,54±13,40 ^a	69,66±6,04 ^a	78,39±6,33 ^a
	O	□	77,66±4,16 ^a	93,66±28,86 ^a	77,00±5,23 ^a
		□	68,00±6,73 ^a	71,50±7,78 ^a	91,00±10,60 ^a
		□□	72,83±5,44 ^a	82,58±18,32 ^a	84,00±7,91 ^a
GMQ(g)	NO	□	4,36±0,84 ^a	3,87±0,57 ^a	3,39±0,33 ^a
		□	3,63±0,46 ^a	2,76±0,00 ^b	4,06±0,33 ^a
		□□	3,99±0,46 ^a	3,31±0,28 ^a	3,75±0,33 ^a
	O	□	3,69±0,17 ^a	4,46±1,37 ^a	3,66±0,25 ^a
		□	3,23±0,32 ^a	3,40±0,37 ^a	4,33±1,78 ^a
		□□	3,46±0,24 ^a	3,93±0,87 ^a	3,99±1,01 ^a

^{a, b} : les moyennes portant des lettres différentes sur la même ligne sont significativement différentes ($P<0,05$) NO : Nord ouest, O : Ouest
T0=Pclandestinum+ aliment composé de base, T1= Pclandestinum +Galinsoga sp et Bidens Pilosa, T2= Pclandestinum +aliment composé enrichi en protéiques

T0. Le taux de mortalité pré sevrage a été significativement ($P<0,05$) élevé chez animaux du lot T2.

Croissance pré sevrage

La supplémentation à Galinsoga sp et Bidens Pilosa a affecté significativement le poids des jeunes à la naissance (Tableau 4). Les petits du lot T1 ont enregistré des poids

significativement ($P < 0,05$) inférieurs à ceux des lots T0 et T2, qui ont été comparables ($P > 0,05$). Il en est de même pour le poids au sevrage. Toutefois, les femelles ont tendance à être plus lourdes à la naissance mais cette tendance change au sevrage où les mâles prennent le dessus.

Par ailleurs, aucune différence significative ($P > 0,05$) n'a été observée pour gain total (GT), le gain moyen quotidien (GMQ) des petits de la naissance au sevrage (Tableau 5). Le gain total le plus élevé a été obtenu chez les mâles du lot T1 originaires de l'Ouest tandis que le plus faible a été observé chez les femelles du même lot mais originaires du Nord Ouest. Le GMQ le plus élevé a été observé chez les femelles du lot T1, originaires du Nord Ouest.

Discussion

La consommation moyenne journalière de *Galinsoga sp* a été significativement plus élevée que celle de *Bidens pilosa* et d'*Ageratum conyzoides*, quels que soient le sexe et l'origine, indiquant une meilleure palatabilité de *Galinsoga sp* chez les cobayes. Elle serait due au fait que *Galinsoga sp* est une herbe tendre, dont pratiquement toutes les parties aériennes sont facilement consommables. Cette palatabilité a été également relevée chez les petits ruminants en Ethiopie (Belete et al., 2011). La faible préférence de *Bidens* ou d'*Ageratum* serait liée à leur caractéristiques physiques et à la présence des facteurs antinutritionnels dans ces plantes (Alonza et Hilderband, 1999 ; Del-Vechio-Vieira et al., 2009). Ces résultats sont en désaccord avec ceux rapportés par Katunga et al. (2012) qui ont observé une préférence élevée pour *Bidens pilosa*, *Ageratum conyzoides* comparée à *Desmodium intortum* et *Canavalia brasiliensis* chez les cobayes et les lapins.

Le poids des reproductrices a augmenté durant la gestation quelles que soient la ration et l'origine. Toutefois aucune différence significative ($P > 0,05$) n'a été observée entre les rations. Ces résultats sont similaires à ceux obtenus par Pamo et al., (2005), Zougou (2013) et Todou (2013). Pendant la période de

lactation, toutes les femelles reproductrices ont perdu du poids quelles que soit la ration et l'origine. Cependant aucune différence significative ($P > 0,05$) n'a été observée entre les traitements. Des résultats similaires ont été obtenus par Pamo et al., (2005), Zougou (2013), Noubissi et al., (2013) Todou (2013) chez les cobayes. Ceci pourrait être dû au fait que pendant la période de lactation, la femelle doit satisfaire non seulement ses propres besoins d'entretien, mais également produire du lait. De ce fait, elle doit mobiliser ses réserves corporelles pour couvrir ces besoins d'où la perte de poids observée.

La supplémentation aux astéracées ou à l'aliment composé enrichi en protéines n'a eu aucun effet significatif sur les taux de fertilité, de prolificité, du sevrage et la taille de la portée. Ces résultats sont similaires à ceux observés par Todou (2013) où la supplémentation à la vitamine E ou au Zinc n'a eu aucun effet sur ces paramètres et avec ceux observés par Kouakou et al., (2012) où le mode d'alimentation et le type de supplément n'a eu aucun effet sur la fertilité et la taille de la portée. Par ailleurs, aucun d'avortement n'a été observé dans le lot témoin tandis qu'il a été significativement ($P < 0,05$) élevé dans les lots supplémentés aux astéracées ou à l'aliment composé enrichi en protéines. Cette différence pourrait être due aux substances anti nutritionnelles présentes dans les deux suppléments. En effet, *Bidens pilosa*, une des astéracées de la ration T1 serait riche en saponine, et autres extraits inhibiteurs de la synthèse des hormones sexuelles, empêchant l'implantation de l'œuf et provoquant des avortements (Alonza et Hilderband, 1999, Francis et al., 2002). Par ailleurs, l'aliment composé enrichi contient 25% du tourteau de coton, le gossypol que contiendrait ce tourteau aurait des effets néfastes sur la reproduction. Ces résultats sont différents de ceux observé par Todou (2013) qui avec une supplémentation au zinc et à la vitamine E a obtenu un taux d'avortement de 12,5% dans le lot témoin pendant que dans les lots supplémentés l'avortement n'a pas observé. Le taux de mortalité pré sevrage a été significativement ($P < 0,05$) plus élevé chez les

petits du lot supplémenté à l'aliment composé enrichi en protéines. Ceci serait lié au taux de tourteau de coton (25%) contenu dans l'aliment. En effet, le gossypol contenu dans ce tourteau, provoquerait des lésions de divers tissus internes mais également une baisse des performances de croissance et l'efficacité alimentaire de la ration. De plus la quantité de cellulose contenue dans le tourteaux de coton qui vient s'ajouter à celle de fourrage de base, pourrait compromettre l'utilisation des nutriments chez les jeunes cobayes incapables de supporter un taux de cellulose élevé (Niba *et al.*, 2004, Diaw *et al.*, 2011). À la naissance et au sevrage, le poids des petits nés des femelles du lot T1 a été significativement ($P < 0,05$) inférieur à ceux des lots T0 et T2. Ceci serait lié à la qualité de l'aliment constitué essentiellement de fourrages moins concentrés en nutriments. Cette observation est en accord avec les résultats de Kouakou *et al.*, (2012) qui ont rapporté des poids significativement faibles ($P < 0,05$) à la naissance et au sevrage dans le lot alimenté uniquement aux fourrages. De même Pamo *et al.*, (2005) ont rapporté des poids faibles avec une supplémentation au Moringa aleifera comparativement au bloc multinutritionnel. Par contre, Zougou (2013) a observé des poids à la naissance et au sevrage élevés chez les lots ayant reçu *T diversifolia* comme supplément. Quel que soient la ration et l'origine, les femelles ont tendance à être plus lourdes à la naissance que les mâles. Ceci est en contradiction avec les observations faites par Manjeli *et al.*, (1998), Niba *et al.*, (2008), Zougou (2013), Noubissi *et al.*, (2013) et Todou (2013) qui ont rapportés un dimorphisme en faveur du mâle à la naissance. Par ailleurs, malgré cette différence de poids à la naissance, la ration n'a pas eu de différence significative ($P > 0,05$) sur le gain de poids de petits de la naissance au sevrage. Ces résultats sont similaires à ceux obtenus par Zougou (2013), Todou (2013) qui n'ont observé aucun effet significatif du type de supplément sur le gain de poids de la naissance au sevrage. Par contre, ils sont différents de ceux de Pamo *et al.*, (2005) qui ont obtenu un gain de poids plus élevé avec le bloc multinutritionnel

comparativement au Moringa. Les valeurs du poids au sevrage obtenues dans la présente étude confirment les travaux de Pamo *et al.*, (2005) et Cicogna, (2000), qui soutiennent que le poids au sevrage chez les cobayes est environ le double du poids à la naissance.

Conclusion

L'augmentation de taux de protéines dans l'aliment et la supplémentation aux astéracées semblent influencer le taux d'avortement chez les femelles reproductrices. Il en est de même pour le taux de survie et le gain de poids pré-sevrage. Il serait nécessaire d'évaluer d'avantage les facteurs anti nutritionnels dans ces aliments qui peuvent entraîner la baisse des performances de reproduction.

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Références

- Alonzo DS, et Hildebrand JW, 1999. *Bidens L.* In: de Padua, LS, Bunyaphatsara, N, Lemmens, RHM (Editors). *Plant Resources of South-East Asia 12 (1). Medicinal and poisonous plants 1.* Backhuys Publishers, Leiden, Netherlands: pp. 150–155.
- A.O.A.C. (Association of Official Analytical Chemist), 1990. *Official method of analysis.* 15th ed. Washington.
- Bacigale B, Ayagirwe B R, Mulemangabo L, Puchu C, Maass BL, 2013. Effects of supplementing waste soybeans or palm kernel cake in usual diet combinations on the utilization of dry-season forages by growing cavies in Kabare territory of Sud-Kivu province, DR Congo. In the proceedings of TSAP Conference Arusha, Tanzania, 22-25 October 2013.

- Belete S, Abubeker H, Abule E, Tadese A, Nura A, 2011. Identification of potential untapped herbaceous flora in the mid rift valley of Ethiopia and their nutritive value ,African Journal of Agricultural Research 6 (17):4153-4158. consulté le 23 juin 2013 sur <http://wwwacademicjournalsorg/AJAR>
- Bindelle J, Ilunga Y, Delacollette M, Muland Kayij M, Umba di M'Balu J, Kindele E , Buldgen A, 2007a. Voluntary intake, chemical composition and in vitro digestibility of refresh forages fed to Guinea pigs in periurban rearing system of Kinshasa (Democratic Republic of Congo). Tropical Animal Health Production 39: 419-426
- Bindelle J, Kinsama A, Dehoux JP, M'Balu JU, Kindele E, Geneviève J et Buldgen A, 2007b. A method combining enzymatic hydrolysis and in vitro fermentation to avoid in vivo trials to determine the nutritional value of forages and diets fed to Guinea pigs raised for meat production. In proceedings of the 34th BCLAS symposium, Katholieke Hogeschool der Kempen, Geel,
- Cigogna M , 2000. Les Cobayes: Guide technique d'élevage n° 4 .Bureau d'Echange et de Distribution de l'Information sur le Mini élevage (BEDIM) . Série Information et Documentation.
- Del-vechion-vieira G, Sousa V, Yamamou To C, Kaplan M, 2009. Chemical composition and antimicrobial activity of *Agerantum* sp . Records of Natural Products 3(1)52-57
- Diaw MT, Dieng A, Mergeai G, Hornick J-L, 2011. Les coproduits de la graine de coton en alimentation du poulet de chair. Annal Médecine Vétérinaire, 155 : 61-82
- Francis G, Kerem Z, Harinder M, Klaus B, 2002. The biological action of saponine in animal system . A review. British Journal Nutrition, 88, 587-605
- Katunga M, Bacigale B, Katunga B, Maass BL, 2012. Feeding Rabbits and Cavies with Improved Forage Legumes in South Kivu, DR Congo. In proceedings Tropentag, September 19-21, 2012, Gottingen -Kassel/Witzenhausen
- Kenfack A, Tchoumboué J, Kamtchouing P et Ngoula F, 2006. Effets de la substitution par l'arachide fourragère (*Arachis glabrata*) de l'herbe à éléphant (*Pennisetum purpurum*) sur le nombre d'ovulations et les mortalités prénatales chez le cobaye (*Cavia porcellus L.*) adulte Tropicultura 24 (3): 143-146
- Kouakou N'GDV, Thys E, Assidjo EN, Danho M, Nogbou EA et Grongnet, JF, 2012. Effets de *Panicum maximum* sur la productivité des femelles primipares durant le cycle de reproduction chez le cobaye (*Cavia porcellus*) Tropicultura, 30 (1) :24-36 consulté le 26 mai 2013 sur <http://wwwtropiculturaorg/text/v30n1/24pdf>
- Kouonmenioc J, Ngou Ngoupayou JD et Fotso JM, 2000. Consommation de quelques graminées tropicales par les cobayes : performance et détermination des surfaces nécessaires à l'entretien d'un cheptel Tropicultura 18 (2): 50-83
- Manjeli Y, Tchoumboue J, Njwe RM, Teguaia A, 1998. Guinea Pig productivity under traditional management. Tropical Animal Health and Production, 30(2), 115-12
- Metre ThK, 2011. Petit, bon pour la santé et très prolifique Rural 21: 51-53. consulté le 24 avril 2012 sur http://wwwrural21.com/uploads/media/rural_fr_51-53_2-2011.pdf
- Metre ThK, 2012. Possibilités d'amélioration de l'élevage de cobaye (*Cavia porcellus L.*) au Sud Kivu, à l'est de la République Démocratique du Congo. Unpublished MSc thesis , Université de Liège, Belgique
- Nguizani B, 2001. Inventaire des fourrages utilisés dans l'alimentation de *Cavia porcellus* à Banzangu (RDC) .Bulletin BEDIM 10 (2),28-29
- Niba AT, Kudi AC, Tchoumboue J, Zoli PA, Fonteh F , Komtangi MC, 2004. Influence of birth weight and litter size on the preweaning growth performance and survival of guinea pigs (*Cavia porcellus L.*), Journal of the Cameroon Academy of Sciences 4: 19-25
- Niba, AT, Kudi, A C, Fonteh, F and Tchoumboue, J, 2008. Influence of birth weight and litter size on the growth performance of guinea pigs under intensive management .Sciences Agronomiques et Développement 4 (1): 13-20
- Niba AT, Meutchieye F, Fon D, Laisin AG, Taboh H, Njakoi H, Bela Tomo A, Maass BL, Djikeng A , Manjeli Y, 2012 Current situation of cavy production in

Cameroon: Challenges and opportunities Livestock Research for Rural Development, 24(11),194-201. consulté le 24 novembre 2012 sur <http://www.lrrd.org/lrrd24/11/niba24194.htm>

Noumbissi M, Tendonkeng F, Zougou T, Miégoué E, Lemoufouet J, Boukila B, Pamo T, 2013. Effet de la complémentation au *Tithonia diversifolia* sur l'évolution du poids post-partum et la croissance pré-sevrage des cobayes (*Cavia porcellus*L), Livestock Research for Rural Development, 25(8). consulté en septembre 2013 sur <http://www.lrrd.org/lrrd25/8/noum25145.htm>

Nuwanyakpa M, Lukefahr S D, Gudahl D , Ngoupayou J D, 1997. The current stage and future prospects of guinea pig production under smallholder conditions in West Africa, Cameroon case. Livestock Research for Rural Development, 5(9) :45-51 consulté , le 23 avril 2013 sur <http://lrrdcipavorgco/lrrd9/5/gp952.htm>

Pamo T E, Niba A T, Fonteh F A, Tedonkeng F, Kana J R, Boukila B , Tsachoung J , 2005: Effet de la supplémentation au *Moringa oleifera* ou aux blocs multinutritionnels sur l'évolution du poids post partum et la croissance pré-sevrage des cobayes (*Cavia porcellus* L) Livestock Research for Rural Development , 17, Art #46 Retrieved October 3, 2005, from <http://www.cipavorgco/lrrd/lrrd17/4/tedo17046.htm>

Todou R, 2013. effets de *pennisetum clandestinum* et de *brachiaria ruziziensis* supplémentés au zinc et a la vitamine E sur les performances des cobayes (*cavia porcellus*), Unpublished Msc thesis, Faculté d'Agronomie et des Sciences Agricoles, Université de Dschang.

Zougou TG, 2013. Effet de différents niveaux de supplémentation aux feuilles de *Tithonia diversifolia* sur les performances de croissance et les caractéristiques de la carcasse chez le cochon d'Inde (*Cavia porcellus*) . Unpublished Msc thesis, Faculté d'Agronomie et des Sciences Agricoles, Université de Dschang.

PRODUCTIVITY AND NUTRITIVE VALUE OF THREE GRASS-LEGUME MIXTURES IN THE SUDAN SAVANNAH ZONE KANO STATE, NIGERIA.

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Abstract

The experiment was conducted at the screen house of Agronomy Department of the Faculty of Agriculture Bayero University Kano Nigeria to evaluate the dry matter yield and nutritive value of three grass-legume mixtures. The mixtures (*Sorghum almum-Lablab purpureus*, *Sorghum almum-Stylosanthes hamata* and *Sorghum almum-Macroptilium bracteatum*) were sown at 50:50 ratio in 12 plastic pots with the dimensions (62cm) width, (31cm) base width and (28cm) depth. The experimental design was a completely randomized design repeated 4 times. Results of the study indicated that *Sorghum almum-Lablab purpureus* mixture recorded numerically higher dry matter yield (7806 kg dm/hectare) compared to other mixtures, similarly leaf area for grass (46.4) and legume (25.03) as well as number of grass tillers (18.25) tended to be higher in *Sorghum almum-Lablab purpureus* mixture. Chemical composition parameters such as crude protein (CP 19.9%), Ash (6.57%), calcium (Ca 3.42 g/kg) and magnesium (Mg 1.63 g/kg) were observed to be higher in *Sorghum almum-Lablab purpureus* while ADF (32%) and NDF (44%) values were the least. In the same vein, other nutritive value indices such as digestible dry matter (DDM 63.9 %) dry matter intake as a percentage of body weight (DMI 2.83 %) and relative feed value (RFV 138.9 %) were also numerically higher in *Sorghum almum-Lablab purpureus* mixture compared to other mixtures. Based on dry matter yield, morphological characteristics and nutritive value parameters, *Sorghum almum-Lablab-purpureus* mixture was recommended.

Key word: Chemical composition, Dry matter, Grass, Legume, Morphological characteristics

PRODUCTIVITÉ ET VALEUR NUTRITIVE DE TROIS MÉLANGES DE LEGUMINEUSES-HERBES DANS LA ZONE DE SAVANE SOUDANAISE DE L'ÉTAT DE KANO AU NIGERIA.

Résumé

L'expérience a été menée dans la serre du Département d'Agronomie de la Faculté d'Agriculture de l'Université Bayero de Kano au Nigeria, en vue d'évaluer le rendement en matière sèche et la valeur nutritive de trois mélanges herbes-légumineuses. Les mélanges (*Sorghum almum-Lablab purpureus*, *Sorghum almum-Stylosanthes hamata* et *Sorghum almum-Macroptilium bracteatum*) ont été ensemencés à raison de 50:50 dans 12 pots en plastique ayant les dimensions suivantes : (62cm) de largeur, 31cm de largeur à la base et 28cm de profondeur. Le dispositif expérimental était complètement randomisé, avec 4 répétitions. Les résultats de l'étude indiquent que le mélange *Sorghum almum-Lablab purpureus* a enregistré un rendement en matière sèche numériquement plus élevé (7806 kg dm / hectare) par rapport aux autres mélanges, de même que la superficie foliaire pour l'herbe (46,4) et les légumineuses (25,03), et le nombre de talles d'herbes (18,25) avait tendance à être plus élevé dans le mélange *Sorghum almum-Lablab purpureus*. On a constaté que les paramètres de composition chimique tels que la protéine brute (CP 19,9%), les cendres (6,57%), le calcium (Ca 3,42 g / kg) et le magnésium (Mg 1,63 g / kg) étaient plus élevés dans le mélange *Sorghum almum-Lablab purpureus* tandis que l'ADF 32% et la NDF (44%) avaient le niveau minimal. Dans le même sens, les autres indices de valeur nutritive tels que la teneur en matière sèche digestible (DDM 63,9%), la consommation de matière sèche en pourcentage du poids corporel (DMI 2,83%) et la valeur relative des aliments (RFV 138,9%) étaient aussi numériquement plus élevés dans le mélange *Sorghum almum-Lablab purpureus* par rapport aux autres mélanges. Sur la base du rendement en matière sèche,

des caractéristiques morphologiques et des paramètres de valeur nutritive, le mélange *Sorghum almum-Lablabpurpureus* a été recommandé.

Mots-clés : composition chimique, matière sèche, herbe, légumineuses, caractéristiques morphologiques

Introduction

Livestock production all over the world is based on pasture (Lascano, 2001). In Nigeria like in most tropical countries, livestock production is constrained by availability and quality of feed during the dry season of the year particularly in the northern part of the country. One of the ways to reduce the effect of seasonality on quantity and quality of feed is through intercropping. Combination of a legume with grass is one of the most common types of intercropping. Majority of successful intercrops grown worldwide also consist of cereal-legume intercrops. During the dry season, the protein content of the predominantly grass pasture could be lower than 7% normally required for efficient rumen function (Van Soest, 1994)

Forage quality and seasonal distribution of bio-mass of grass-legume pastures have proved superior to those of grasses or legumes grown alone (Minson 1990). In addition, grass-legume mixtures have higher advantages over pure stands by reducing the incidence of bloat from pure legumes pasture, reduction in occurrence of diseases and insect pests as well as control of soil erosion (Lulseged, 1985) Increasing the quality of forage available is one of the best methods of improving overall feeding efficiency. Intercropping of grass forage with legume is capable of increasing the protein content of the overall ration. Legumes are good sources of protein and can be used to compensate for grass protein shortage (Gebrehiwots *et al.*, 1996). Thus, growing of grass-legume mixture can boost the forage protein content of diets. The survival of legumes in grass-legume mixtures has always been faced with problem in tropical region. It is therefore believed that the growth habit of legume may influence its survival in mixture. Furthermore, chemical composition of pastures determines their quality in term of intake and digestibility. The experiment aimed at evaluating dry matter

yield and nutritive of Columbus grass (*Sorghum almum*) and three legumes (*Stylosanthes hamata*), (*Lablab purpureus*, *Macroptilium bracteatum* (burgundy bean) as influenced by plant morphological characteristics.

Materials and Methods

Experimental location

The experiment was conducted at the screen house of Agronomy Department Faculty of Agriculture Bayero University, Kano. Kano lies between longitude 9° 30' and 12° 30' North, Latitude 9° 30' and 8° 42' East in the Sudan savannah ecological zone of Nigeria. The annual mean temperature ranges from 21°C to 39°C and mean annual rainfall of 500mm to 1000mm, (KNARDA, 2001) The soil is a sandy loam with the following composition N, P and K being (0.1%, 0.00099 % and 0.027 %) respectively

Treatments and experimental design

The treatments were three grass-legumes mixtures (*Sorghum almum-Lablab purpureus*, *Sorghum almum-Stylosanthes hamata* and *Sorghum almum-Macroptilium bracteatum*) repeated 4 times in a randomized complete block design.

Sowing operation

Legume seeds (burgundy and Stylo) were treated using hot water at 80°C for 3 minute to break seed hardedness. Soil mixture comprising sand/loamy soil was prepared at the ratio of 1:3 respectively, Fifty kilograms of the mixture was put in (12) plastic containers each with the dimensions (62cm) width, (31 cm) base width and (28cm) depth. Water was sprinkled onto the soil mixture contained in the plastic containers, seeds of grass and legumes were sown separately at the rate of 10 seeds per sowing hole dug into the soil and later trimmed to 3 seedlings per hole. In all there were four

holes per pot. The seeds were sown on 22nd April 2015 and lightly covered. Inter and intra row distances between plants were 25cm. All mixtures received P and K fertilizers at the rate of 50kg /ha in the form of triple super phosphate and muriate of potash respectively.

Harvesting

Harvesting was done on 8th July 2015, at 12 week post sowing which coincided with 50% flowering of burgundy bean, and Sorghum alnum at soft dough stage, the following parameters were measured, Dry matter yield determined by harvesting the grass and legume plants in each pot at a stubble height of 5 cm to the ground fresh weights were taken using electronic balance, thereafter, dry weights were determined after oven drying the fresh materials at 65°C for 72 h. Other parameters measured at harvest included plant height, Leaf to stem ratio, leaf area (using leaf area meter model YMJ-A Portable) and number of tillers.

Chemical analysis

Chemical Composition of mixtures was determined by grinding the dried samples to pass through 2 mm sieve, the ground sample was then stored in labeled airtight plastic container. Samples were used for determination of crude protein (CP) and ash according to the procedures described by (AOAC 1999). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according to the procedures described by Van Soest et al. (1991). Mineral Composition of mixtures potassium (K), and calcium (Ca) were determined using Atomic Absorption Spectrophotometer as described by AOAC (1999) while potassium by flame photometer. Other nutritive value parameters (DDM, DMI and RFV) were calculated as thus

$DMI = 120 / \% NDF \text{ dry matter basis,}$

$DDM = 88.9 - (0.779 \times \%ADF, \text{ dry matter basis),}$

$RFV = \%DDM \times \%DMI \times 0.775. (\text{Horrocks and Vallentine, 1999})$

Data Analysis

The data generated were subjected to analysis of variance (ANOVA) using (SAS 1992) version 9.2. Differences among means were separated using least significant difference (LSD)

Result

Dry matter yield and morphological characteristics of mixtures

Dry matter yields of grass-legumes and mixtures are shown in Table 1. The dry matter yield of grass was not significantly different ($p > 0.05$) among the mixtures, however, numerically, dry matter yield of grass in the grass lablab mixture tended to be numerically higher (7377kg dm/ha) compared to the grass in Sorghum alnum-burgundy and Sorghum alnum-stylo. In the case of legumes, lablab had seemingly higher dry matter yield (429 kg/ha) followed by Stylo (351 kg/ha) and burgundy (88 kg/ha). For mixtures, *Sorghum alnum-lablab* mixture produced numerically higher total dry matter yield (7806 kg/ha) compared to Sorghum alnum-burgundy (7300 kg/ha) and Sorghum alnum-stylo (5002 kg/ha). Percentage grass and legume were numerically higher in Sorghum alnum-burgundy and Sorghum alnum-stylo respectively.

Morphological characteristics of mixtures

Leaf area grass (Table 2) was not significantly different among mixtures, however, numerically, leaf area of grass in grass-lablab tended to be higher (46.4) compared to those of Sorghum alnum-burgundy (31.5) and Sorghum alnum-stylo (28.9). In the case of legumes, significant differences were observed. Lablab produced superior ($P < 0.05$) leaf area (25.03) than burgundy (2.95) while no significant difference was observed between Stylo (10.58) and burgundy (2.95). The number of tillers produced by grass was not significantly different among mixtures, however grass in the grass lablab tended to produce highest tiller (18.25) compared to grass in Sorghum alnum-stylo (14.25) and Sorghum alnum burgundy (13.25). Significant differences were found

Table 1 : Dry matter yield of grass, legumes and mixtures

Treatments	Dry matter yield grass (kg/ha)	Percentage Grass (%)	Dry matter yield legume (kg/ha)	Percentage Legumes (%)	Dry matter yield mixtures (kg/ha)
<i>Sorghum almum</i> -Lablab	7377	94.5	429	5.4	7806
<i>Sorghum almum</i> -Burgundy	7212	99	88	1	7300
<i>Sorghum almum</i> -Stylo	4651	93	351	7	5002
P value	0.20		0.14		0.19

Means with same letters within same column are not significantly different ($p < 0.05$)

Table 2 : Morphological characteristics of mixtures

Treatments	Leaf area grass	Leaf area legume	Tiller number	Leaf-to-stem ratio grass	Leaf-to-stem ratio legume
<i>Sorghum almum</i> -Lablab	46.4	25.03a	18.25	0.62ab	1.71
<i>Sorghum almum</i> -Burgundy	31.5	2.95b	13.25	0.55b	1.53
<i>Sorghum almum</i> -Stylo	28.9	10.58ab	14.25	0.75a	1.89
P value	0.43	0.05	0.20	0.046	0.38

Means with same letters within same column are not significantly different ($p < 0.05$)

Table 3 : Crude protein, fibre fractions and mineral composition of mixtures

Treatments	Ash	CP	ADF	NDF	Ca	Mg	P
	(%)			(g/kg)			
<i>Sorghum almum</i> - Lablab	6.57 ^a	19.9	32	44	3.42	1.63	11.4
<i>Sorghum almum</i> - Burgundy	5.23 ^{ab}	19.1	35.9	50.8	2.69	1.59	14.8
<i>Sorghum almum</i> - Stylo	4.57 ^b	17.9	39.4	51	2.71	1.39	14.6
P value	0.05	0.56	0.26	0.46	0.25	0.28	0.15

Table 4 : Digestible dry matter, dry matter intake and relative feed value of mixtures

Treatment	DMD	DMI	RFV
	(%)		
<i>Sorghum almum</i> - Lablab	63.9	2.83	138.9
<i>Sorghum almum</i> - Burgundy	60.9	2.37	112.2
<i>Sorghum almum</i> - Stylo	58.2	2.37	106.8
P value	0.62	0.35	0.13

among mixtures in respect of leaf-to-stem ratio recorded by grass. The grass in *Sorghum alnum-stylo* had significantly higher ($P < 0.05$) leaf-to-stem ratio than grass in *Sorghum alnum-burgundy*. Leaf to stem ratio of legumes in mixtures were not significantly different ($p > 0.05$)

Chemical composition of mixtures

Percentage ash (Table 3) was greater ($P < 0.05$) in *Sorghum alnum-lablab* than *Sorghum alnum-stylo*, no significant difference was found between *Sorghum alnum-burgundy* and *Sorghum alnum-lablab*. Percentage CP was not significantly different among mixtures; however, in absolute terms CP tended to be higher in *Sorghum alnum-lablab* mixture compared to *Sorghum alnum-stylo* and *Sorghum alnum-burgundy*. Fiber fractions (NDF and ADF) were also not significantly different, however, both tended to be lower in *Sorghum alnum-lablab* compared to *Sorghum alnum-stylo* and *Sorghum alnum-burgundy*. Also, mineral composition of mixtures did not differ among mixtures but Ca and Mg had numerically higher values in *Sorghum alnum-lablab* compared to *Sorghum alnum-burgundy* and *Stylo*.

There were no significant different significant differences among mixtures in terms of DMD, DMI and RFV (Table 4), however, the trio were observed to be numerically higher in *Sorghum alnum-lablab* mixture compared to *Sorghum alnum-burgundy* and *Sorghum alnum-stylo* mixtures

Discussion

The numerically higher dry matter yield recorded by *Sorghum alnum-lablab* mixture (Table 1) indicates better compatibility compared to other mixtures evaluated, this is buttressed by the fact that the yields of both grass and legumes were higher in this mixture than other mixtures. Seresinhe et al. (1994) reported that inclusion of legumes in pasture mixture stimulated the growth and increased nitrogen uptake of grass. Nyfeler et al. (2009) reported similarly. The higher dry matter yield recorded by *lablab* among the

legumes in mixture with *Sorghum alnum* may have enriched the soil better through the activities of nitrogen fixing bacteria leading to somewhat higher productivity of both the grass and legume in *Sorghum alnum-lablab* mixture compared to other mixtures. This is further supported by the fact that both grass and legume in *Sorghum alnum-lablab* mixture had higher leaf area (Table 2) suggestive of a higher capacity to capture solar radiation for photosynthesis. Amanullah and Stewart (2013) in an experiment to determine growth dynamics in oats (*Avena sativa L*) at different nitrogen and phosphorus application levels indicated positive relation between leaf area and photosynthesis.

The higher number of tillers (Table 2) in absolute terms recorded by the grass in *Sorghum alnum-lablab* mixture agrees with the report of Brown and Ashley (1974) who observed that increased nitrogen availability increased tillering.

Crude protein value was numerically higher in *Sorghum alnum-lablab* mixture, the higher CP content in this mixture may be attributed to higher proportion of *lablab* compared to other legumes (*Stylo* and *burgundy*). The lower NDF and ADF values recorded for *Sorghum alnum-lablab* mixture compared to other mixtures confers some nutritional benefit to the mixture and is indicative of a feed with higher intake potential and digestibility respectively.

Mineral content of mixtures (Ca and mg) were higher in *Sorghum alnum-lablab* mixture compared to other mixtures, this again could be due to the numerically higher dry matter yield of *lablab* in the mixture compared to other legumes (Table 1) Miles and Manson (2000) reported higher mineral content in forage legumes than grasses.

Other nutritive value indices such as DMD, DMI and RFV were higher in *Sorghum alnum-lablab* mixture compared to other mixtures this is suggestive of higher quality pasture made possible by the higher dry matter yield of the *lablab* in mixtures. Lithourgidis et al. (2006) reported that the RFV index can be used to predict the intake and energy value of

the forages. The RFV of current study ranged from 138.9 to 106.8. Albayrak (2012) gave the categorization of RFV in forages as follows 151 (Prime), 150-125 (Premium), 124-103 (Good), 102-87 (Fair), 86-75 (Poor), Less than 75 (Rejected).

In the light of the above, the quality of the mixtures produced ranged from good to premium.

Conclusion

The results showed no significant differences among most of the parameters measured. However, in absolute value *Sorghum alnum-lablab* tended to have higher dry matter yield compared to other mixtures. Nutritive value parameters also seemed to favour *Sorghum alnum-lablab*, in conclusion therefore, *Sorghum alnum-lablab* 50:50 is recommended for establishment if the goal of the farmer is to achieve higher dry matter yield and nutritive value. The only snag is the fact that none of the mixtures had 30% proportion of legume in mixture as advocated by most researchers in grass-legumes mixtures.

Author's contribution

Baba M. wrote the manuscript Gumel I.A was involved in the field work while Muhammad I.R proof read the manuscript and made further suggestions

References

Albayrak S, 2012. Determination of Forage yield and quality of pea (*Pisum Sativum* L.) mixtures with oat and Barley, Turkish Journal of Field Crops. 17(1):96-99.

Amanullah HA and Stewart BA, 2013. Growth dynamics and leaf characteristics in oats (*Avena sativa* L.) differ at excessive nitrogen and phosphorus application Journal of Botany. 45 (3):853-863.

AOAC 1999, Association of Official Analytical Chemists, Official Methods of Analysis. 18th Edition AOAC Inc, Arlington, Virginia USA. 1094 Pp.

Brown R H and Ashley DA, 1974. Fertilizer effects on photosynthesis, organic reserves and regrowth mechanism of forages in: Mays D.A(ed) forage fertilization American Society of Agronomy, Madison, Wisconsin p 455-479.

Gebrehiwot L, McGrow RL and Assefu G, 1996. Forage yield and quality profile of three annual legumes in the tropical highlands of Ethiopia. Journal of Agriculture. 73:83-98.

Horrocks RD and Vallentine JF, 1999. Harvested Forages. Academic Press, London, UK 439 pp.

KNARDA, 2001. Kano Agricultural and Rural Development Authority. Meteorological station record book and management. 11:1-3.

Lascano CE, 2001. Animal production in grass-legumes pasture in the tropic. in stomayer Rios (ed). Tropical forage plants. Development and uses. CRC Press, Boca Raton, FL, USA, Pp.219-2332.

Lithourgidis A S, Vasilakoglou IB, Dhima KV, Dordas CA and Yiakoulaki MD, 2006. Forage yield and quality of common vetch mixtures with oat and triticale in two seeding ratios. Field Crops Research. 99: 106-113.

Lulseged G, 1985. The status of livestock, pasture and forage research and development in Ethiopia. Proceedings of a workshop held at Addis Ababa, Ethiopia, 8-10 January. (Institute of Agricultural Research: Addis Ababa, Ethiopia).

Miles N and Manson AD, 2000. Nutrition of planted pastures. Proceedings of a conference on pasture Management Tainton N.M (ed) held in South Africa, University of Natal.

Minson DJ, 1990. The chemical composition and nutritive values of tropical grasses in: Skerman, P.J. and Rivers, F (eds) Tropical grasses 2nd edition FAO plant production and protection series no 23 FAO Rome Pp. 163-180.

Nyfelers D O, Huguenin-Elie, Suter M, Frossard E, Connolly J and Luscher A, 2009. Strong mixture effects among four species in fertilized agricultural grassland led to persistent and consistent transgressive overyielding. Journal of Applied Ecology. 46:683-691.

SAS, 2009. Statistical Analysis System Institute, Inc. Cary, North Carolina, USA.

Seresinhe T, Hartwig UA, Kessler W, and Noesberger J, 1994. Symbiotic nitrogen fixation of white clover in a mixed sward is not limited by height of repeated cutting. *Journal of Agronomy and Crop Science*. 172: 279-288.

Van Soest PJ, Robertson JB and Lewis BA, 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*. 74: 3583–359.

Van Soest PJ, 1994. *Nutritional ecology of ruminants* 2nd edition 478: 50-65. Cornell University Press Ithaca, New York USA.

CRYOSURVIVAL OF GOAT SPERMATOZOA IN TRIS-EGG YOLK EXTENDER SUPPLEMENTED WITH MELATONIN

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Abstract

The effect of melatonin supplementation in semen extenders on cryosurvival of *spermatozoa* obtained from West African Dwarf (WAD) goat bucks was studied. Tris-egg yolk extenders supplemented with different levels of melatonin (0, 2, 4, 6 and 8 mM) were diluted with semen samples. The diluted semen samples were cryopreserved for 30 days and thereafter evaluated for sperm quality characteristics. Following cryopreservation, acrosome reaction and capacitation of *spermatozoa* were induced in vitro. The results showed higher ($P < 0.05$) sperm motility, acrosome integrity and membrane integrity in extenders supplemented with melatonin compared to the control and these parameters were optimal at 6 mM and 8 mM of melatonin ($P < 0.05$). Extender supplemented with melatonin at 8 mM consistently improved acrosome reaction and capacitation of *spermatozoa* ($P < 0.05$). The results showed reduced ($P < 0.05$) sperm abnormality and malondialdehyde concentrations in extenders supplemented with melatonin compared to the control and these parameters were lower at 6 mM and 8 mM respectively. The findings revealed that 8 mM of melatonin supplementation in tris-egg yolk extender was consistently effective for improving viability of *spermatozoa* of WAD goat bucks during cryopreservation.

Key words: Antioxidants, Goat, Freezing, Melatonin, Oxidative stress, Sperm viability

CRYOSURVIE DES SPERMATOZOÏDES DE BOUCS DANS UN DILUEUR TRIS/JAUNE D'OEUF SUPPLEMENTE AVEC DE LA MELATONINE

Résumé

L'étude a examiné l'effet de la supplémentation en mélatonine de dilueurs de sperme sur la cryosurvie des spermatozoïdes provenant de boucs nains d'Afrique de l'Ouest (WAD : West-African Dwarf). Des dilueurs Tris/jaune d'œuf additionnés de mélatonine à différents niveaux (0, 2, 4, 6 et 8 mM) ont été dilués avec des échantillons de sperme. Les échantillons de sperme dilués ont été cryoconservés pendant 30 jours et ensuite évalués en vue de déterminer les caractéristiques qualitatives du sperme. Après la cryoconservation, la réaction acrosomique et la capacitation des spermatozoïdes ont été induites in vitro. Les résultats ont montré une motilité des spermatozoïdes ($P < 0,05$), une intégrité de l'acrosome et une intégrité de la membrane plus élevées dans les dilueurs supplémentés avec de la mélatonine par rapport au dilueur témoin, et ces paramètres étaient optimaux à 6 mM et à 8 mM de mélatonine ($P < 0,05$). Le dilueur supplémenté avec de la mélatonine à 8 mM d'acrosome a amélioré de façon constante la réaction de l'acrosome et la capacitation des spermatozoïdes ($P < 0,05$). Les résultats ont montré une diminution ($P < 0,05$) de l'anomalie des spermatozoïdes et des concentrations de malondialdéhyde dans les dilueurs supplémentés avec de la mélatonine par rapport au dilueur témoin, et ces paramètres étaient plus faibles, respectivement à 6 mM et 8 mM. Les résultats ont révélé que la supplémentation en mélatonine à 8 mM dans le dilueur tris/jaune d'œuf a été constamment efficace dans l'amélioration de la viabilité des spermatozoïdes des boucs WAD pendant la cryoconservation.

Mots-clés : antioxydants, chèvre, congélation, mélatonine, stress oxydatif, viabilité du sperme

Introduction

West African Dwarf (WAD) goat (*Capra hircus*) is a common breed in south-western Nigeria. The invaluable contribution to biodiversity of the breed deserves scientific attention for improved production through artificial insemination in order to alleviate the problem of protein shortage common in the sub region. Cryopreservation of gametes from the breed is therefore necessary such that it could be used for artificial insemination (Correa *et al.*, 2006). Nevertheless, cryopreservation induces damage to cells (Pegg, 2007). Besides, goat *spermatozoa* are susceptible to peroxidative damage during cryopreservation (Watson, 2000). Moreover, preservation of *spermatozoa* for longer periods by frozen requires preservative diluents solution to sustain sperm viability (Correa *et al.*, 2006). Sperm quality however still reduces in spite of components of extenders during freezing (Andrabi, 2009). Bucak *et al.* (2009) reported that semen extenders supplemented with antioxidants improved quality of *spermatozoa*. Study has indicated beneficial effects of melatonin arising from its potent antioxidant on preservation of functional parameters of mammalian *spermatozoa* (Ashrafi *et al.*, 2013). Perusal of literatures revealed no information on the effect of melatonin supplementation on sperm viability of semen obtained from WAD goat bucks during cryopreservation. Hence, the objective of this study was to determine the effect of adding different levels of melatonin to semen extenders on cryosurvival of *spermatozoa* obtained from WAD goat bucks during cryopreservation.

Materials and Methods

Location and animal management

The experiment was carried out at the Federal University of Agriculture Abeokuta, Nigeria which falls within 70 10'N and 30 2'E and altitude 76 m above sea level. The area is characterized with a prevailing tropical climate, a mean annual rainfall of 1,037 mm and average temperature of 34.7 °C. Six (6) WAD bucks

that responded well to semen collection by artificial vagina were selected from a group of twenty (20) WAD bucks aged 2.5-3 years. The bucks were kept under intensive management system and fed concentrate and guinea grass (*Panicum maximum*).

Semen collection dilution and cryopreservation

The effect of adding different levels of melatonin to semen extenders on cryosurvival of semen obtained from WAD goat bucks was carried out in a study repeated two times. Semen samples were collected from six WAD goat bucks with the aid of an artificial vagina and pooled. A total of six semen samples (each semen sample originating from six bucks) showing >80 % motility were pooled to minimize individual differences. The pooled semen samples were diluted at room temperature in a two-step process with a tris-based extender composed of 2 fractions. The Fraction 1 solution contained tris-hydroxymethyl-aminomethane (2.42 g), citric acid (1.36 g), glucose (1 g), penicillin (0.028 g), egg yolk (20 mL) and distilled water made up 100 mL as control. Fraction 2 solution had the same composition as the Fraction 1 solution but with the addition of 14.0 % glycerol (v/v) to Fraction 2. The pooled semen was split into 5 parts, diluted with Fraction 1 solution and supplemented each with 0, 2, 4, 6 and 8 mM of melatonin. Fraction 2 solution was subsequently added. Diluted semen samples at a concentration of 225×10^6 sperm/mL and pH of 6.91 were then loaded into 2 mL plastic straws in 2 replicates per treatment, sealed with polyvinyl, cooled to 4 °C at a rate of 0.25 °C/min and equilibrated at 4 °C for 10 min in TYFSF Refrigerated Incubator (Model:SPX-70B III, Hebei China). Subsequently, the straws were then placed in a rack at 4 cm above liquid nitrogen in the vaporous phase for 10 min before plunging them directly and quickly into liquid nitrogen for 30 days and thereafter evaluated for sperm quality characteristics.

Microscopic evaluation of sperm Motility

Sperm motility was determined using microscope. Semen was thawed for 2 min in

Clifton Water bath (Model: 74178 by Nickel Electro Ltd, Weston-S-Mare Somerset, England) at 38°C and accessed for sperm motility using Celestron PentaView microscope (LCD-44348 by RoHS, China) at 400x magnification. Progressively motile *spermatozoa* that moved forward in essentially a straight line was measured in each semen sample (5 µL) by three observers on a warmed microscope slide overlaid with a cover slip (22 x 22 mm). The mean of the ten successive evaluations was recorded as the final motility score.

Acrosome integrity

Percentage of *spermatozoa* with intact acrosome was determined in formalin citrate solution (500 µL) consisting of 96 mL 2.9 % sodium citrate and 4 mL 37 % formaldehyde as described by Ahmad et al. (2003). Two hundred (200) *spermatozoa* were counted in different microscopic fields for each sample using Celestron PentaView LCD microscope (400x magnification) to assessed intact acrosome that showed normal apical ridge.

Sperm membrane integrity

Hypo-osmotic swelling test (HOST) assay was used to determine sperm membrane integrity as (Zubair et al., 2013) by incubating 10 µL semen in 100 µL hypo-osmotic solution (fructose and sodium citrate) at 37 °C for 30 min and 0.1 mL of the mixture was spread over a warmed slide, covered with a cover slip and observed using Celestron PentaView LCD digital microscope (400x magnification). Two hundred *spermatozoa* (200) were observed in different microscopic fields for each sample for their swelling characterized by coiled tail, indicating intact plasma membrane.

Sperm abnormality

Sperm abnormality was evaluated using microscope with the use of eosin-nigrosin smears. A thin smear of mixture of semen and eosin-nigrosin solution was drawn across the slide and dried. The percentage of morphologically abnormal *spermatozoa* with defects in the head, midpiece and tail were observed under Celestron PentaView LCD

microscope (400x magnification).

Malondialdehyde concentration

Malondialdehyde (MDA) concentration in the stored semen was determined in a thiobarbituric acid reactive substances (TBARS) according to Pipan et al. (2014). Sperm sample was (0.1 mL) suspended in 0.1 mL of 150 mM Tris-HCl (pH 7.1) for 20 min at 37 °C prior to incubation of the mixture with 1 mL of 10 % trichloroacetic acid (TCA) and 2 mL of 0.375 % thiobarbituric acid in boiling water for 30 min. Thereafter, it was centrifuged for 15 min at 3000 g and the absorbance was read with UV spectrophotometer (SW7504 model by Surgifriend Medicals, England) at 532 nm. The concentration of MDA (nmol/mL) was calculated as follows: The concentration of MDA (nmol/mL) = $AT - AB / 1.56 \times 10^5$; where AT = the absorbance of the semen sample, AB = the absorbance of the blank, 1.56×10^5 molar absorptivity of MDA.

In vitro acrosome reaction

Cryopreserved semen samples were thawed by plunging straws into a water bath (38 °C) for 1 min and the proportion of acrosome reaction was determined as described by Tardif et al. (1999) with some modifications as described by Daramola et al. (2015).

In vitro capacitation

Chlortetracycline (CTC) fluorescence assay as described by Collin et al. (2000). with some modifications as described by Daramola et al. (2015) was used to evaluate in vitro capacitation of *spermatozoa* using an upright Carl Zeiss Fluorescent Microscope (Primo Star, Germany) equipped with phase contrast and epifluorescence optics..

Statistical analysis

The study was repeated 2 times and estimations were performed for the pooled semen samples for each treatment consisted of two straws. The results analyzed using a two-way analysis of variance in SAS 1999 package were expressed as the means +SE. Duncan Multiple Range Test (Duncan, 1955) was used to

separate significantly different means ($P < 0.05$). The model used is shown below:

$$Y_{ijkl} = \mu + J_i + R_j + T_k + \sum_{ijkl}$$

Where Y_{ijkl} = Dependent variable; μ = population mean; J_i = i th effect due to level of melatonin inclusion, $i = 0, 2, 4, 6, 8$; R_j = j th effect due to number of experiment, $j = 1, 2$; T_k = k th effect due to number of straw, $k = 1, 2$; \sum_{ijkl} = Experimental error.

Results

The viability parameters of *spermatozoa* cryopreserved with tris-egg yolk extenders supplemented with melatonin are presented in Table 1. The results showed higher ($P < 0.05$) *spermatozoa* motility, acrosome integrity and membrane integrity in extenders supplemented with melatonin compared to the control. Motility, acrosome integrity and membrane integrity were higher and better sustained in extenders supplemented with 6 mM and 8 mM of melatonin compared to other treatments ($P < 0.05$). Sperm abnormality was lower in extenders supplemented melatonin compared to the control and lowest value was observed at 6 mM melatonin supplementation.

The percentages of acrosome reaction and capacitation of *spermatozoa* cryopreserved with tris-egg yolk extenders supplemented with melatonin are presented in Table 2. The results showed that more *spermatozoa* cryopreserved with melatonin underwent acrosome reaction and capacitation compared to the control ($P < 0.05$). The highest percentage of acrosome reacted *spermatozoa* and *spermatozoa* that underwent capacitation were observed at 4 mM and 8 mM melatonin supplementation ($P < 0.05$).

The MDA concentrations of semen cryopreserved with tris-egg yolk extenders supplemented with melatonin are presented in Figure 1. The results showed reduced ($P < 0.05$) MDA concentrations in extenders supplemented with melatonin compared to the control and lowest values were observed at 8 mM melatonin supplementation.

Discussion

The addition of melatonin in the present study improved the viability of *spermatozoa* obtained from WAD goat bucks. The improved sperm motility was similar to observation of Succu et al. (2011). The improvement in motility indicated the impact of melatonin on sperm viability and this might be due to increased ATPase levels by melatonin (Chen et al., 1994). Increased ATPase is known to correlate with an increase in adenosine triphosphate (ATP) which is the main energy source used by sperm flagellum to initiate and activate forward motility (Burger et al. (1991). It is known that mitochondria in sperm cells encase axoneme, connect with dense fibers in mid-piece and produce ATP (Perumal et al., 2013). High level of ROS was reported to cause axoneme and mitochondria damage (Aitken et al., 1988). Melatonin could stabilise and protect mitochondria via several mechanisms including direct reaction with ROS (Ashrafi et al., 2013). The present study agreed with Li et al. (2012) who reported significantly higher mitochondrial activity in sperm incubated with melatonin, suggesting that melatonin could help to protect sperm from ROS induced by cryopreservation processes.

The improved sperm viability consequent upon addition of melatonin observed in this study supported previous studies on the protective role of melatonin on motility and intact acrosomal membrane in boar sperm (Martín-hidalgo et al., 2011) and bull sperm (Ashrafi et al., 2013). Moreover, the higher acrosome and membrane integrities coupled with concurrent improvement in acrosome reaction and capacitation in extenders supplemented with melatonin in consonant with previous reports further supported the beneficial effect of melatonin on sperm viability during cryopreservation (Martín-hidalgo et al., 2011; Ashrafi et al., 2013).

Evaluation of acrosome reaction can be used to provide fair estimate of success of fertilization in artificial insemination programme. *Mammalian spermatozoa* undergo capacitation, a series of intracellular and

Table 1: Means (+SE) viability parameters of spermatozoa cryopreserved with tris egg yolk extenders supplemented with melatonin

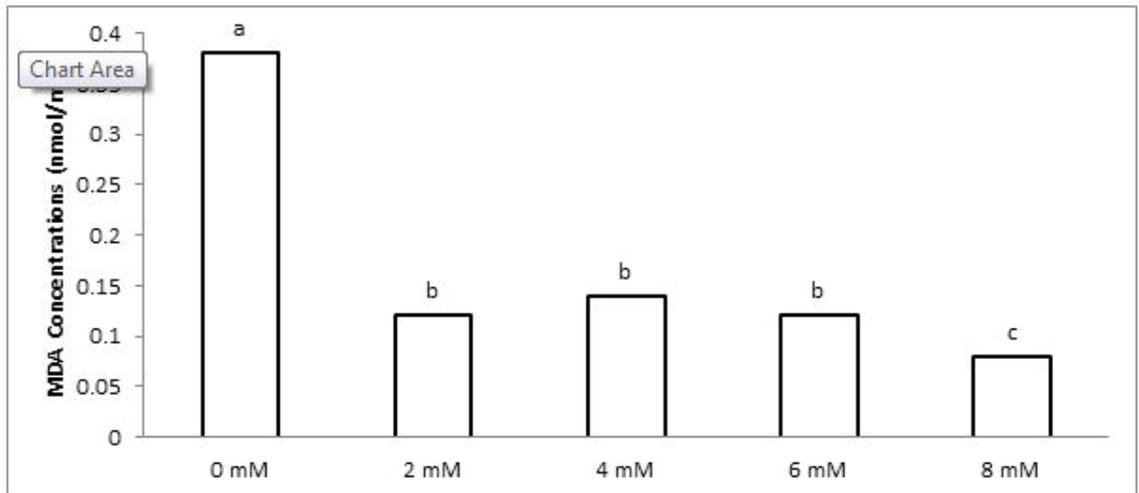
Parameters	0 mM	2 mM	4 mM	6 mM	8 mM
Motility (%)	35.36+2.67 ^c	51.24+2.47 ^b	51.16+3.21 ^b	55.00+2.91 ^a	58.64+2.60 ^a
Acrosome Integrity (%)	54.33+3.44 ^c	62.50+4.01 ^b	67.18+4.41 ^a	68.42+4.56 ^a	70.67+5.32 ^a
Membrane Integrity (%)	51.83+4.07 ^c	64.00+4.42 ^b	69.83+4.44 ^a	73.67+2.72 ^a	70.33+6.11 ^a
Abnormality (%)	2.50+0.31 ^a	2.12+0.28 ^b	1.43+0.34 ^c	1.25+0.17 ^d	1.54+0.32 ^c

^{a,b,c,d} Values within the same row with different superscripts differ ($p < 0.05$), SE = Standard of Error

Table 2: Means (+SE) in vitro acrosome reaction (%) and capacitation (%) of buck spermatozoa cryopreserved with melatonin

Parameters	0 mM	2 mM	4 mM	6 mM	8 mM
Acrosome reaction (%)	49.33+3.49 ^d	56.00+6.64 ^c	72.66+3.37 ^a	62.33+7.17 ^b	73.00+6.03 ^a
Capacitation (%)	42.00+4.58 ^c	67.00+7.45 ^b	76.66+4.37 ^a	70.33+7.31 ^b	78.67+5.31 ^a

^{a,b,c,d} Values within the same row with different superscripts differ ($p < 0.05$), SE = Standard of Error

**Figure 1:** Malondialdehyde concentrations of semen cryopreserved with tris egg yolk extenders supplemented with melatonin (n=32); a,b,c, Values within the same row with different superscripts differ ($p < 0.05$)

membrane physicochemical changes that give spermatozoa ability to fertilize ova (Patrat et al., 2000). The present in vitro study indicated that melatonin was able to maintain fertilizing capacity as evidenced by improved percentage of capacitation and acrosome reaction of cryopreserved spermatozoa. In ram spermatozoa, melatonin administration was observed to increase plasminogen activator activity, known to be involved in sperm capacitation and acrosome reaction (Tsantarliotou et al., 2008). The present results agreed with Di francesco et al., (2009) who demonstrated that melatonin

determined capacitation of buffalo spermatozoa in vitro.

The improvement in sperm parameters observed in the present study could be linked to antioxidant derived from melatonin, suggesting antioxidant potential of these extenders to suppress seminal oxidative stress due to lipid peroxidation or ROS production. MDA concentration is a useful index of seminal oxidative stress and has been used to determine adverse effects of seminal oxidative stress on viability of spermatozoa (Arabi and Seidaie, 2008). In addition, Pasqualotto et al.,

2000) observed an association between high seminal ROS levels and reduced percentage motile *spermatozoa* in semen. Higher MDA concentrations reflect greater extent of oxidative damage to *spermatozoa* (Piyali *et al.*, 2009). The reduced concentrations of MDA observed in extenders supplemented with melatonin further supported the protective role of melatonin in this study. This was in consonant with previous study that melatonin inhibited lipid peroxidation (Armagan *et al.*, 2006), indicating possible effect of melatonin in activating activities of antioxidant enzyme in semen and thereby providing indirect protection against detrimental effect of free radical on *spermatozoa*. Melatonin is an efficient antioxidant that protects cells and initiates a host of receptor-mediated effects (Li *et al.*, 2012). Addition of melatonin to cryopreservation media has been observed to reduce lipid peroxidation and oxidative stress in stallion (Balao da Silva *et al.*, 2011) and ram (Succu *et al.*, 2011) respectively. In contrast to most potent radical scavengers, melatonin is multi-functional and universal; soluble both in water and in lipids and hence acts as a hydrophilic and hydrophobic antioxidant (Hardeland, 2005). The observation that melatonin is effective in antioxidative defence is linked to its ability to directly scavenge hydroxyl radicals to form cyclic 3-hydroxymelatonin, a stable metabolite of melatonin (Pähkla *et al.*, 1998). The present results contributed to its protective effects against oxidative damage to *spermatozoa* and indicated its ability involving reduced concentrations of MDA in cryopreserved WAD goat buck *spermatozoa*, and supported the direct scavenging action on highly toxic hydroxyl radicals (Pähkla *et al.*, 1998).

Conclusion

The findings revealed that melatonin at 8 mM in tris-egg yolk extender consistently improved viability and fertilizing ability parameters, and resulted in optimal seminal oxidative stress parameters of WAD goat bucks during cryopreservation. Supplementation of tris-egg yolk extender with 8 mM of melatonin

would be satisfactory for cryopreservation of semen obtained from WAD goat bucks for successful artificial insemination programme.

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References

- Ahmad Z, Anzar M, Shahab N, Ahmad S, Andrabi MH, 2003. Sephadex and sephadex ion exchange filtration improves the quality and freezability of low-grade buffalo semen ejaculates. *Theriogenology*, 59: 1189-1202.
- Aitken RJ, Clarkson JS, 1988. Significance of reactive oxygen species and antioxidants in defining the efficacy of *spermatozoa* preparation techniques. *Journal of Andrology*, 9: 367-376.
- Andrabi SMH, 2009. Factors affecting the quality of cryopreserved buffalo (*Bubalus bubalis*) bull *spermatozoa*. *Reproduction in Domestic Animals*, 44 (3): 552-569.
- Arabi M, Seidaie SR, 2008. Assessment of motility and membrane peroxidation of Bull *spermatozoa* in the presence of different concentration of vitamin C. *Veterinary Medicine, Shahrekord*, 2, 39-46.
- Armagan A, Ramazan E, Soyupek YS, Oksay T, Ozcelik N, 2006. Effects of melatonin on lipid peroxidation and antioxidant enzymes in streptozotocin-induced diabetic rat testis. *Asian Journal of Andrology*, 8 (5): 595-600.
- Ashrafi I, Kohram H, Ardabili F, 2013. Antioxidative effects of melatonin on kinetics, microscopic and oxidative parameters of cryopreserved bull *spermatozoa*. *Animal Reproduction Science*, 03: 016.
- Balao CM, Silva DA, Macias-garcia B, Miro-moran

- A, Gonzalez-Fernandez L, Morillo-Rodriguez A, Ortega-Ferrusola C, Gallardo-Bolaños JM, Stilwell G, Tapia JA, PEÑA FJ, 2011. Melatonin reduces lipid peroxidation and apoptotic-like changes in stallion spermatozoa. *Journal of Pineal Research*, 51: 172-179.
- Bucak MN, Sariözkan S, Tuncer PB, Ulutas PA, Akcadag HI, 2009. Effect of antioxidants on microscopic semen parameters, lipid peroxidation and antioxidant activities in Angora goat semen following cryopreservation. *Small Ruminant Research*, 81: 90-95.
- Burger B, Vanderhorst G, Menkveld R, Maritz DE, Villierse A, Conradie E, Kruger TF, 1991. Relationship between biochemical markers and fertilization in vitro. The Annual Reproductive Biology Work Seminar, Pretoria, South Africa.
- Chen LD, Kumar P, Reiter RJ, Tan DX, Manchester LD, Chambers JP, Poeggeler B, Saarela S, 1994. Melatonin prevents the suppression of cardiac Ca^{2+} -stimulated ATPase activity induced by alloxan. *American Journal of Physiology*, 267: E57-62.
- Collin S, Sirard MA, Dufour M, Bailey JL, 2000. Sperm calcium levels and chlortetracycline fluorescence patterns are related to the in vivo fertility of cryopreserved bovine semen. *Journal of Andrology*, 21: 938-943.
- Correa MN, Lucia T, Bianchi I, Schmitt E, Bordignon J, Rech DC, Peruzzo AI, Deschamps JC, 2006. Swine semen cooled at 5 °C with PIGPEL-5 extender: effects on semen quality in vitro and fertility estimators in vivo *Animal Reproduction*, 3: 41-48.
- Daramola JO, Adekunle EO, Oke OE, Onagbesan OM, Iyasere OS, Williams TJ, James IJ, Oyewusi IK, Oyewusi JA, 2015. Effects of pyridoxine supplementation or in combination with other antioxidants on motility, in vitro capacitation and acrosome reaction of goat buck spermatozoa during cryopreservation. *Small Ruminant Research*, 131: 113-117.
- Duncan BD, 1955. Multiple Range Test and Multiple F-test. *Biometrics*, 11, 1-42.
- Hardeland R, 2005. Antioxidative protection by melatonin: multiplicity of mechanisms from radical detoxification to radical avoidance. *Endocrine*, 27 (2): 119-130.
- Li XX, Yang XG, Lu YQ, Zhang M, Yao HI, Meng LJ, Lu KH, 2012. Protective effects of melatonin against oxidative stress in flow cytometry-sorted buffalo sperm. *Reproduction in Domestic Animal*, 47 (2): 299-307.
- Lowry OH, Rosebroug NJ, Farr A, Randall LJ, 1951. Protein measurement with the folin phenol reagent. *Journal of Biological Chemistry*, 193: 265-275.
- Martin-Hidalgo D, Baron FJ, Bragado MJ, Carmona P, Robina A, Garcia-Marin LJ, Gil M, 2011. The effect of melatonin on the quality of extended boar semen after long-term storage at 17 °C. *Theriogenology*, 75(8): 1550-60.
- Pähkla R, Zilmer M, Kullisaar T, Rago L, 1998. Comparison of the antioxidant activity of melatonin and pinoline in vitro. *Journal of Pineal Research*, 24: 96-101.
- Pasqualotto FF, Sharma RK, Potts JM, Nelson DR, Thomas AJ, Agarwal A, 2000. Seminal oxidative stress in patients with chronic prostatitis. *Urology*, 55: 881-885.
- Patrat C, Serres C, Jouannet P, 2000. The acrosome reaction in human spermatozoa. *Biology of the Cell*, 92: 255-266.
- Pegg DE, 2007. Principles of cryopreservation. *Methods of Molecular Biology*, 368: 39-57.
- Perumal P, Kezhavituo Vupru, Khate K, 2013. Effect of Addition of Melatonin on the Liquid Storage (5 °C) of Mithun (*Bos frontalis*) Semen. *International Journal of Zoology*, Volume 2013. Article ID 642632, 10 pages <http://dx.doi.org/10.1155/2013/642632>
- Pipan MZ, Mrkun J, Kosec M, Svete AN, Zrimšek P, 2014. \rightarrow Superoxide dismutase: A predicting factor for boar semen characteristics for short-term preservation. *Biomedical Research International*, 2014: 105280.
- Piyali AR, Das Choudhari, Singh AK, Ramji Singhc, 2009. Correlation among routine semen parameters, sperm viability and malondialdehyde levels in human subjects with different fertility potential. *Indian Journal of Physiology and Pharmacology*, 53 (3): 253-258.

Succu S, Berlinguer F, Pasciu V, Satta V, Leoni GG, Naitana S, 2011. Melatonin protects ram *spermatozoa* from cryopreservation injuries in a dose-dependent manner. *Journal of Pineal Research*, 50 (3): 310-318.

Tardif S, Sirard MA, Sullivan R, Bailey J, 1999. Identification of capacitation-associated phosphoproteins in porcine sperm electroporated with ATP- γ -32 P. *Mol. Q. Molecular Reproduction and Development*, 54: 292-302.

Tsantarliotou MP, Kokolis NA, Smokovitis A, 2008. Melatonin administration increased plasminogen activator activity in ram *spermatozoa*. *Theriogenology*, 69: 458-465.

Watson PF, 2000. The causes of reduced fertility with cryopreserved semen. *Animal Reproduction Science*, 61:481-92.

Zubair M, Akbarlodhi L, Ahmad E, Muhammad G, 2013. Osmotic swelling test as screening for evaluation of semen of bull. *Journal of Entomology and Zoological Studies*, 1 (6): 124-128.

CONTAGIOUS CAPRINE PLEURO-PNEUMONIA, KNOWLEDGE, ATTITUDES AND CONTROL PRACTICES AMONG PASTORALISTS IN THE RIFT VALLEY REGION, KENYA.

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Abstract

This study assessed the knowledge, attitudes and use of the current F38 vaccine in pastoral production areas in the Rift Valley region in a cross-sectional survey conducted between the months of March, 2014 and March, 2015. A semi-structured questionnaire was used to collect information from the pastoralists. Responses were obtained from 54 pastoralists whose flocks were also sampled for confirmation of CCPP sero-prevalence. The pastoralists were knowledgeable of CCPP based on the ability to recognize the disease from the clinical signs and post-mortem lesions observed. The characteristic lung lesions commonly associated with the disease was mentioned by majority (88.9%) of the Pokot and Maasai pastoralists and more than half (50.7%) of the Turkana pastoralists. Serology results estimated the sero-prevalence for Turkana West at 63.9% (CI = 56.0 -71.8), Kajiado Central at 48.6% (CI = 40.7- 56.5) and Pokot East at 29.2% (CI= 21.3-37.0). The differences in sero-prevalence were statistically significant in the study areas ($\chi^2 = 34.997$; $P = 0.000$). Only 11.2% of the pastoralists had used the vaccine for controlling CCPP the in their flocks with a majority of them relying on antibiotics to treat CCPP cases. The results confirmed that CCPP is wide spread in the region and that there was generally low uptake of the available vaccine. Thus, there is need for awareness creation among the pastoralists on the use of vaccines for effective control of CCPP in Kenya.

Key words: *Contagious caprine pleuropneumonia*, vaccine, pastoralist, goats, indigenous knowledge, Rift Valley.

PLEURO-PNEUMONIE CONTAGIEUSE CAPRINE, CONNAISSANCES, ATTITUDES ET PRATIQUES DE CONTROLE CHEZ LES PASTORALISTES DE LA REGION DE LA VALLEE DU RIFT AU KENYA.

Résumé

Cette étude a évalué les connaissances, les attitudes et l'utilisation du vaccin F38 actuel dans les zones de production pastorale de la région de la vallée du Rift, dans une enquête transversale menée entre mars 2014 et mars 2015. Un questionnaire semi-structuré a été utilisé pour recueillir des informations auprès des pasteurs. Les réponses ont été recueillies auprès de 54 pasteurs dont les troupeaux ont également été échantillonnés pour confirmer la séroprévalence de la PPCC. Les éleveurs connaissaient bien la PPCC, car ils étaient à même de reconnaître la maladie à partir des signes cliniques et des lésions post-mortem observées. Les lésions pulmonaires caractéristiques communément associées à la maladie ont été mentionnées par la majorité (88,9%) des pasteurs Pokot et Maasai, et par plus de la moitié (50,7%) des pasteurs Turkana. Les résultats de la sérologie ont estimé la prévalence sérologique de Turkana West à

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63,9% (CI = 56,0 -71,8), Kajiado Central à 48,6% (IC = 40,7- 56,5) et Pokot East à 29,2% (IC = 21,3-37,0). Les différences au niveau de la séroprévalence étaient statistiquement significatives dans les zones d'étude ($\chi^2 = 34,997$, $P = 0,000$). Seul 11,2% des éleveurs avaient utilisé le vaccin pour contrôler la PPCC dans leurs troupeaux, la majorité d'entre eux ayant eu recours à des antibiotiques pour traiter les cas de PPCC. Les résultats ont confirmé que la PPCC est très répandue dans la région et que le taux d'utilisation du vaccin disponible était généralement faible. Il est donc nécessaire de sensibiliser les pasteurs à l'utilisation de vaccins pour un contrôle efficace de la PPCC au Kenya.

Mots-clés : pleuropneumonie contagieuse caprine, vaccin, pasteur, chèvres, connaissances autochtones, Vallée du Rift.

Introduction

Contagious caprine pleuropneumonia (CCPP) is a highly infectious and devastating disease of goats caused by *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp) (MacOwan and Minette 1976) originally known as *Mycoplasma* F38. The disease, listed as notifiable by the World Organization for Animal Health (OIE) has been associated with major economic losses to goat production in at least 30 countries in Africa and Asia and poses a serious threat to disease-free areas (OIE, 2015). The disease is introduced into a new region by healthy carriers. In Africa where extensive and traditional husbandry is practiced, pathogens have been reported to spread when animals meet at watering points and grazing areas as well as gathering during housing animals (Atim et al, 2016). Infection of susceptible goats is mainly through inhalation of contaminated aerosols from infected goats.

Contagious caprine pleuropneumonia is a disease of major economic importance posing a major constraint to goat production. In fully susceptible flocks that encounter outbreak, direct losses are usually associated with high rates of morbidity (90–100%) and mortality (60–80%) (Nicholas and Churchward, 2012) resulting in reduced milk and meat yield. Indirect losses occur as a result of emaciation, delayed market weight and infertility, due to the sub-acute or chronic pneumonia in goats. In addition to this, other losses are associated with the extra cost of treatment, increased risk associated with antibiotic residues, reproductive wastage and trade restrictions with great economic impact on livestock

production in fragile rural economies (FAO, 2005).

At field level, CCPP can be controlled by application of treatment, controlling animal movement, slaughtering infected animals and vaccination (Mare, 2004). Currently, vaccination associated with antibiotic treatment is the most effective strategy. Like most mycoplasma infections, CCPP is generally refractory to many commonly used antibiotics (Heldtander et al., 2001). Complete elimination of the mycoplasma is rarely achieved, and treated animals should always be considered as potential carriers and are responsible for the perpetuation of the disease in a flock (Wesonga et al., 1998). In this regard, efforts have been directed towards controlling the disease by vaccination.

An F38 vaccine is available from the Kenya Veterinary Vaccines Production Institute (KEVEVAPI) and the National Veterinary Institute (NVI) in Ethiopia and is produced and distributed for control of CCPP in goats throughout the country. The Mccp antigen is in-activated with saponin as an adjuvant (Rurangirwa et al, 1987). The vaccine is available commercially and provides protection for over 1 year. However, little is known about attitudes towards this vaccine and uptake among the pastoralists which was being assessed in this study. The results obtained are useful to the veterinary extension officers in improving uptake of vaccination services and can be incorporated when planning routine vaccination activities for effective control of CCPP in the country.

Materials and Methods

Description of the study areas

The study was conducted in Pokot East, Turkana West and Kajiado Sub-counties in the Rift Valley, Kenya in the months of March, 2014 to March, 2015. The study areas were mainly rangelands in lowland zones of the sub-counties where majority of the pastoralists are found. In this zone, rainfall is highly variable but generally below 600 mm per year and is usually erratic in season, duration and distribution. The mean annual temperatures is 30°C (NDMA, 2016). The soils are characteristically low in fertility, shallow and highly erodible and cannot support sustainable crop farming. The vegetation mainly consists of scattered Acacia bush and herbaceous plant species and livestock production was the sole means of livelihood for households.

Study design and data collection

A cross sectional study was conducted between the months of March, 2014 and March, 2015 and involved administration of a semi-structured questionnaire to participating pastoralists whose animals were then sampled for serological analysis. The questionnaire was designed to record the respondents' location, personal information and livestock management practices. A number of open-ended questions were included in the questionnaire to allow the pastoralists an opportunity to provide their perspectives and experiences on treatments and control methods available for use. Probing of responses was done to obtain more information on pastoralists' knowledge, attitudes and control practices of CCPP.

Sampling by proportion was used to select goats for bleeding. Twenty percent of the animals in each herd were selected by systematic random sampling method as described by Thrusfield (1995). The number of goats bled were determined using the formula for sample size estimation;

$$n = Z^2\alpha pq / L^2, \text{ (Martin et al. 1987).}$$

Where, n = sample size, $Z\alpha$ = normal deviate (1.96) at 5% level of significance, p = estimated prevalence, q = 1-p and L = precision of estimate usually at 5%. A priori prevalence of 30% was used based on the findings by Wafula, (2006) in a study done in Turkana. A total of 432 goats were bled as calculated from the above formula which was adjusted by increasing the sample size by 30% to adjust for potential non-compliance and design effect.

Blood samples were collected from animals by jugular veni-puncture in 10 ml plain vacutainer tubes and sera were obtained by the method described by Eshetu et al. (2007). The samples were labelled (date, age, sex) and stored temporarily at -20°C until processing. Monoclonal antibody based competitive Enzyme-linked immuno-sorbent assay (c-ELISA) was used to assess presence of specific antibodies against *Mycoplasma capricolum* sub. spp. *capripneumonia* (Mccp) using the procedure described by Peyraud et al., 2014. The test kit was supplied by CIRAD-EMVT, France. An ELISA reader was used to obtain optical density (OD) readings at 405nm and values of over 50% were considered positive. Laboratory analysis was carried out at the Kenya Agricultural and Livestock Research Organization (KALRO), National Veterinary Research Institute, Muguga, Kenya.

Data analysis

The data derived from the study were transferred from field notebooks and laboratory computer prints to a database and stored in Microsoft excel spreadsheet for analysis. Statistical analyses were carried out using the IBM SPSS statistics 20 software. Data was analyzed using both descriptive and inferential statistics descriptive and parameters were summarized in tables and graphs. Cross-tabulations were carried out to estimate the prevalence of CCPP and Chi square (χ^2) test was used to compare the prevalence of the disease in the different study areas. A p-value <0.05 was considered statistically significant.

Results

Socio-demographic characteristics of the respondent pastoralists

A total of 54 pastoralists participated in the study. A summary of the socio-demographic characteristics of the pastoralists who participated in the study is shown in table 1. Nearly all (98.0%) the respondents were male in different age categories (18-65 years). All the Turkana pastoralists were living a nomadic lifestyle while the Pokot and Maasai were had both transhumant (for 50.0% and 88.9% of the respondents respectively) and nomadic lifestyles (for 50.0% and 11.1% of the respondents respectively). There was virtually no frequent contacts between the pastoralists and livestock service extension agents except for only 1.8% who reported having had contact once a year. Majority (81.5%) of the respondents had no formal education with less than 2% having attained tertiary level of education.

Pastoralists' knowledge of CCPP in the study areas

Contagious caprine pleuropneumonia was frequently mentioned among other goat diseases in all the study areas reflecting the knowledge of the pastoralists on this economically important disease of goats. An overwhelming majority (96.3%) of the respondents in the study areas reported to have had a case of CCPP in their flocks in the last one year. The pastoralists were keen in explaining the clinical/postmortem findings in goats that were suspected to have suffered from the infection with emphasis that the disease was often recognized based on clinical signs and post-mortem findings. In particular, coughing (correctly mentioned by 73.9%) and characteristic lung lesions (correctly mentioned by 75.9%) of the respondents were some of the clinical clinical/postmortem findings often associated with the disease. The other clinical signs/ post-mortem findings reported to be commonly observed were; nasal discharge, difficult breathing (dyspnea), loss of appetite, seeking of shed (which may indicative of fever), excess pleural fluid in the

pleural cavity among other signs. The findings indicated that the respondents were aware of CCPP and to clarify further, they gave the name of the disease in their local language as 'loukoi' among the pokot and turkana communities and 'orkipei' among the maasai community. A comparative presentation of knowledge of CCPP regarding recognition these and other clinical/postmortem findings in the different communities is shown in Table 2.

Assessment of prevalence of CCPP in the study areas

Out of the 432 samples collected nearly half (47.2% CI = 39.3 –55.1) were sero-positive to the disease based on monoclonal antibody based competitive Enzyme-linked immuno-sorbent assay (c-ELISA). A higher sero-prevalence was recorded in Turkana West and Kajiado Central Sub-counties (63.9%; CI = 56.0 -71.8) and 48.6%; CI = 40.7- 56.5) respectively) with almost two times as high as the sero-prevalence observed in East Pokot Sub-county (29.2%; CI= 21.3-37.0) (Table 3). The sero-prevalence was shown to be statistically significant ($\chi^2 = 34.997$; $P = 0.000$) in the different Sub-counties.

Pastoralists' perception of seasonal occurrence of CCPP

According to the respondents, occurrence of CCPP followed a seasonal pattern (Figure 1). All the respondents in Turkana West reported to have experienced outbreak of the disease during the wet season while majority (71.5%) of the respondents in Kajiado Central reported to have had more cases of the disease during wet season compared to the number

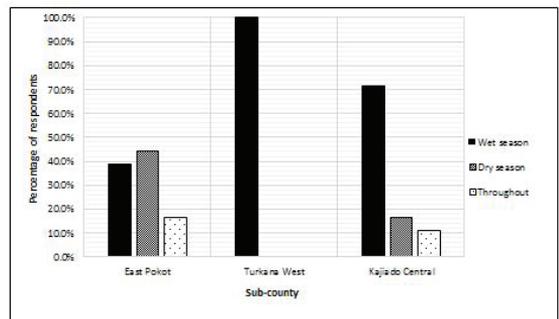


Figure 1: Seasonal occurrence of CCPP in the study areas as observed by the respondent pastoralists.

Table 1: Socio-demographic characteristics of the respondent pastoralists in the study areas

Characteristic	Category	Frequency per sub-county (%)		
		Pokot East	Kajiado Central	Turkana West
Gender	Male	94.4	100.0	100.0
	Female	5.6	0.0	0.0
Age (in years)	18-35	16.7	38.9	94.4
	36-45	38.9	22.2	5.6
	46-55	27.8	11.1	0.0
	56-65	5.6	16.7	0.0
	66-75	0.0	11.1	0.0
Education level	None	77.8	72.2	94.4
	Primary	22.2	16.7	5.6
	Secondary	0.0	5.6	0.0
	Tertiary	0.0	5.6	0.0
Way of living	Nomadic	50.0	11.1	100.0
	Transhumance	50.0	88.9	0.0
Access to extension services	Never	94.4	94.4	100.0
	Once a month	0.0	0.0	0.0
	Once in 3 months	0.0	0.0	0.0
	Once a year	5.6	5.6	0.0

Table 2: Knowledge of CCPP among the Turkana and Pokot and Maasai pastoralists based on clinical signs/post-mortem findings.

Common clinical sign/post-mortem findings	Number of times mentioned by the respondents		
	Pokot	Turkana	Maasai
Coughing	94.0	71.5	56.2
Nasal discharge	77.8	0.0	11.8
Lung lesions/attachment to rib cage	88.9	50.7	88.9
Pleural fluid	22.2	5.6	11.1
Dyspnea	22.2	77.1	43.8
Other signs (e.g. anorexia, seeking of shed)	27.1	67.4	77.8

Table 3: Sero-prevalence of CCPP by c-ELISA in goats in the study area

Sub-county	No. of samples (N)	Positive (+ve)	Sero-prevalence (%)	95% CI
East Pokot	114	42	29.2	21.3-37.0
Kajiado Central	114	70	48.6	40.7- 56.5
Turkana West	144	92	63.9	56.0 -71.8
Total	432	204	47.2	39.3 - 55.1

$\chi^2 = 34.997$; P -value < 0.0001

Table 4: Treatment and control options for CCPP in the sub-counties involved in the study.

Activity	Percentage respondents		
	Pokot East	Turkana West	Kajiado Central
Pastoralists who vaccinated goats during the previous year	0.0	5.6	27.9
Pastoralists who treated goats with antibiotics	100.0	100.0	100.0
Pastoralists who used herbal concoctions	5.6	0.0	0.0
Person administering vaccine to goats			
<i>Self</i>	0.0	0.0	5.6
<i>Veterinary staff</i>	0.0	0.0	94.4
Person administering antibiotics to sick goats			
<i>Self</i>	100.0	100.0	100.0
<i>Veterinary staff</i>	0.0	0.0	0.0
Pastoralists perceiving vaccination to be effective against CCPP outbreaks	0.0	0.0	22.2
Pastoralists perceiving vaccination to be ineffective against CCPP outbreaks	0.0	5.6	5.6
Pastoralists without an idea of benefits of vaccination against CCPP outbreaks	100.0	94.4	72.2

of cases during the dry season. However, the report was different for the pastoralists in Pokot East as they reportedly experienced disease outbreaks in dry and wet seasons especially during the interphase.

Treatment and control options for CCPP

Aspects of management of CCPP by respondent pastoralists are shown in Table 4. All the respondents were aware of availability of drugs for treatment of CCPP and had used them for treatment of sick animals. Only a small number (11.2%) of the pastoralists, mainly from Kajiado Central sub-County, vaccinated their goats as a way of preventing outbreaks with most of them perceiving vaccination to be effective against CCPP. However, a large number (88.8%) of the respondents had no idea of the benefits of vaccinating their stock against CCPP outbreaks. Surprisingly, none of the respondents sought professional advice while administering antibiotics to sick goats and thus they treated them on their own. Of the respondent pastoralists who used vaccines for control of the CCPP, majority of them (94.4%) sought the services of the veterinary extension

officers to carry out vaccination of their flocks. Herbal concoctions were not commonly used in treatment of CCPP cases as only a small percentage (5.6%) of the respondents in Pokot East reported to have used it as a form of treatment.

Discussion

The socio-demographic findings in this study are typical of pastoral communities who rely on livestock as a source of livelihood. This is supported by the fact that transhumance and nomadism were the only ways of life reported by the respondents. These two forms of pastoralism involved movement of livestock only in transhumance way of life and together with their families in the case of nomadism. Nomadic pastoralism, which was widely reported in the region, has been reported as an indigenous strategy for adaptation to climate disturbances, especially frequent droughts (Ericksen et al 2008) and that the indigenous practices and technologies can often be quite effective at decreasing risk (Grace et al 2008). In both cases, the pastoralists relied heavily on

strategic mobility to ensure access to grazing land and water in areas where seasonal weather patterns mean such resources are not available all year round.

The study yielded interesting findings regarding knowledge, attitudes, and control practices of contagious caprine pleuro-pneumonia among the pastoralists in the Rift Valley region. In general, the results indicated that the pastoralists were knowledgeable in recognition of CCPP. The detection of antibodies from serum samples submitted for serology confirmed the prevalence of the disease in the region. The clinical signs and postmortem lesions identified by the pastoralists were closely related to the findings documented in earlier studies by Thiaucourt et al. (1992) and Wesonga et al. (2004) and could be useful in disease surveillance exercises. This clearly reveals the cumulative body of knowledge that is unique to the pastoralists and is handed down through generations (Berkes et al., 1995). This knowledge is strongly reflected in herding practices, adaption strategies and has become part of their cultural practices in everyday life. It is an output of repeated experiences, accumulated through time. It is dynamic and it can be updated, modified, and amended as a result of acquiring new experiences and observations (Fernandez-Gimenez, 2000 and Abdalla et al. 2012).

The pastoralists in the study area associated cases of CCPP with climate change. Most outbreaks were reported to occur during the wet season. The observation of seasonal pattern of the disease agreed with previous report by Nicholas (2002) which found that adverse weather conditions and stress caused by transhumance, which coincidentally is a common practice in the region, are among the conditions that may exacerbate CCPP. A study by Aklilu et al (2015) in Western Ethiopia, reported that the wet season was by far a major risk factor for disease outbreak. During this time, animals encounter highly stressing conditions and are more likely exposed to other concurrent infections like pasteurellosis and endoparasites (Thiaucourt and Bolske, 1996). The pastoralists' knowledge of climatic

characteristics and disease pattern could be integrated during planning and execution of CCPP of control programs and activities.

As regards their attitude towards treatment and control of CCPP, majority of the pastoralists were conversant with the antibiotics recommended for treatment of cases of CCPP. The fact that herbal concoctions were not commonly used in the region suggest that the drugs are readily available though from distant markets as reported in Turkana West and Pokot East Sub-counties (Kipronoh et al. 2016). The drugs were mainly obtained from open-air markets and agro-vet stores while vaccines were provided by the veterinary personnel. Some of the drugs commonly used included; oxytetracyclines, Tylosin, and penicillin/streptomycin. All these are among the recommended drugs (Hassan et al., 1984; Onovarian, 1974) that are active against *Mycoplasma capricolum* subsp. *Capripneumoniae* (Mcpp) but their success depends on early intervention and treatment. However, complete elimination of the mycoplasma is rarely achieved and treated animals should always be considered as potential carriers (Nicholas, 2002).

Despite adequate knowledge on occurrence and recognition of CCPP, it was evident that there was patchy awareness and poor attitude of vaccines for controlling the disease. Most of the pastoralists had no idea of the benefits of vaccination of goats against the disease which is worrying. Failure to vaccinate goats may have exposed flocks to an increased risk of losses during outbreaks. Besides, majority of the pastoralists administered antibiotics to sick animals on their own and therefore adherence to dosage and drug regimens was questionable. Overreliance on treatment of cases with antibiotics may not be effective since complete recovery following administration of antibiotics is not guaranteed and often lead to development of disease carrier state. The phenomenon has been found to be responsible for the perpetuation of the disease in a flock (Wesonga et al., 1998).

Conclusion

This study adds to the limited literature exploring knowledge, attitudes, and control practices of contagious caprine pleuropneumonia among the communities in pastoral production systems. Through the study, we appreciate indigenous knowledge of the disease accumulated by the pastoralists while generally noting the low uptake of the available vaccine. There is need for awareness creation on use of vaccines and incorporation of this knowledge in implementing CCPP control programs and for effective control of the disease in Kenyan pastoral production systems.

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References

Abdalla Y, Hadary E and Samat N, 2012. Managing Scarcity in the Dryland of the Eastern Sudan: the Role of Pastoralists' Local Knowledge in Rangeland Management. *Resources and Environment* 2012, 2(1): 55-66. DOI: 10.5923/j.re.20120201.08.

Aklilu F, Asfaw Y, Baumann M and Abie G, 2015. Epidemiological study of *contagious caprine pleuropneumonia* (CCPP) in selected districts of Gambella Region, Western Ethiopia. *Afri. Journal of Agricultural Research*. Vol. 10 number 24.

Atim SA, Ayebazibwe C, Mwiine FN, Erume J and Tweyongyere R, 2016. A Survey for *contagious caprine pleuropneumonia* in Agago and Otuke Districts in Northern Uganda. *Open Journal of Veterinary Medicine*, 6, 9-14. <http://dx.doi.org/10.4236/ojvm.2016.61002>

Eshetu L, Yigezu L and Asfaw Y, 2007. A study on Contagious Pleuropneumonia (CCPP) in goats at export oriented abattoir, Debrezeit, Ethiopia. *Tropical Animal Health and Production*. 39, 427-432. Doi: 10.1007/s11250-007-9041-1.

Ericksen S, 2008. Climate change in Eastern and Southern Africa. Impacts, vulnerability and adaptation. Gechs International Project Office, eport 2008:2, University of Oslo, 22 pp.

Fernandez-Gimenez ME, 2000. The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management. *Ecological Applicationis*, 10(5)

FAO, 2005. *Contagious caprine pleuropneumonia* in Animal Health Disease Cards. Agriculture Department, Animal Production and Health Division. <http://www.fao.org/ag/againfo/subjects/en/health/diseases-cards/ccpp.html>.

Grace D, Randolph T, Olawoye J, Dipelou M and Kang'ethe E, 2008. Participatory risk assessment: a new approach for safer food in vulnerable African communities. *Development in Practice*, 18(4) .611 – 618.

Hassan SM, Harbi M, Bakr M, 1984. Treatment of *contagious caprine pleuropneumonia*. *Veterinary Research Communications*, 8(1):65-67; 7 ref.

Heldtander M, Wesonga H, Bölske G, Pettersson B and Johansson KE, 2001. Genetic diversity and evolution of *Mycoplasma capricolum* subsp. *capripneumoniae* strains from eastern Africa assessed by 16S rDNA sequence analysis. *Vet Microbiol*. 2001 Jan 5; 78(1):13-28.

Kipronoh KA., Kiara HK., Binepal YS, Thurairana E and Ombui JN, 2016. Pastoralists' perception of constraints affecting goat production in the Rift Valley region of Kenya. *Livestock Research for Rural Development*. Volume 28, Article #33. <http://www.lrrd.org/lrrd28/3/kipr28033.html>.

MacOwan KJ, and Minette JE, 1976. A mycoplasma from acute Contagious Caprine pleuro-pneumonia in Kenya. *Trop. Anim. Health Prod.* 8: 91–95.

Martin SW, Meek AH, and Willeberg P, 1987. *Veterinary Epidemiology. Principles and Methods.* Iowa State University Press, Ames Iowa, 343 pp.

NDMA, 2016. The 2015 Short Rains Food Security Assessment Report.

Nicholas R, Churchward C, 2012. *Contagious caprine pleuropneumonia: a new aspects of an old disease.* *Transboundary and Emerging Diseases* 59, 189–196.

Nicholas RAJ, 2002. *Contagious Caprine Pleuropneumonia*, In: Tempesta M. (Ed.), *Recent Advances in Goat Diseases.* International Veterinary Information Service (IVIS), Ithaca Ny (www.ivis.org); Document No. A0907.0802: available at file: //A:/ ccpp. HTML.

OIE, 2015, Manual of Diagnostic Tests and Vaccines for Terrestrial animals *Contagious Caprine pleuropneumonia.* <http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2015/>

Onovarian O, 1974. The comparative efficacy of some antibiotics used to treat experimentally induced mycoplasma infection in goats. *Veterinary Record*, 94:418-420.

Rurangirwa FR, McGuire TC, Kibor A, and Chema S, 1987. An inactivated vaccine for *contagious caprine pleuropneumonia.* *Vet. Rec.*, 121, 397–400.

Thiaucourt F, and Bolske G, 1996. *Contagious caprine pleuropneumonia* and other pulmonary mycoplasmoses of sheep and goats. *Rev. Sci. Tech. Off. Int. Epiz.* 15:1397–1414.

Thiaucourt F, Bolske G, Leneguersh G, Smith D, Wesonga H, 1996. Diagnosis and control of *contagious caprine pleuropneumonia.* *Revue Scientifique et Technique Of-fice of International Epizootics* 15, 1415–1429

Thrusfield M, 1995. *Veterinary Epidemiology.* Second Edition, Blackwell Science Ltd, Oxford.

Wesonga HO, Bölske G, Thiaucourt F, Wanjohi C and Lindberg R, 2004. Experimental *Contagious Caprine Pleuropneumonia: A Long Term Study on the*

Course of Infection and Pathology in a Flock of Goats Infected with *Mycoplasma capricolum* subsp. *capripneumoniae.* *Acta Veterinaria Scandinavica*, 45, 167-179. <http://dx.doi.org/10.1186/1751-0147-45-167>.

Wesonga HO, Lindberg R, Litamoi JK, and Bålske G, 1998. Late lesions of experimental *contagious caprine pleuropneumonia* caused by *Mycoplasma capricolum* ssp. *capripneumoniae.* *Journal of Veterinary Medicine. Series B*, 45 (2):105-114; 22.

COMPARISON OF INFRARED, ELECTRONIC DIGITAL AND MERCURY-IN-GLASS THERMOMETERS: 2. RED SOKOTO GOATS

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Abstract

Forty eight (male=8; female=40) adult Red Sokoto goats were used in an experiment to compare accuracy of different thermometers. Body temperature (BT) was concurrently measured with electronic digital (ED), mercury-in-glass (MG) and infrared (IR) thermometers. ED and MG thermometry was taken via the rectum (TEMPd and TEMPa respectively) while the IR thermometer was used on the opening of the rectum (TEMPiR) and forehead (TEMPiH). The data were subjected to analysis of variance and Pearson correlation analysis. Scatter diagrams were plotted to generate R squared for the relationships between the readings of the thermometers. Thermometer type had significant ($P < 0.001$) effect on BT in RS goats. TEMPd was similar ($P > 0.05$) to TEMPa, but the duo were significantly higher than TEMPiR and TEMPiH. BT from IR thermometer on the forehead was significantly lower than at the opening of the rectum. There was strong positive significant ($P < 0.001$) correlation between TEMPd and TEMPa ($r = 0.958$). TEMPd and TEMPa had significant ($P < 0.001$) correlations with TEMPiR ($r = 0.519$ and $r = 0.562$ respectively), but not ($P > 0.05$) with TEMPiH. Linear regression of TEMPd with TEMPa, TEMPiR and TEMPiH yielded R^2 of 0.918, 0.269 and 0.040 respectively. Deviations from TEMPd obtained were 0.23, 0.91 and 1.69°C for TEMPa, TEMPiR and TEMPiH respectively. The use IR thermometer on the forehead of RS did not yield similar reading compared to other thermometers. Temperature measurement with IR thermometer on the opening of the rectum of RS goats seems to be more accurate than on the forehead.

Keywords: rectal temperature, heat stress, health, welfare, diagnosis

COMPARAISON DES THERMOMÈTRES INFRAROUGE, ÉLECTRONIQUE NUMÉRIQUE, ET THERMOMÈTRES DE VERRE CONTENANT DU MERCURE: 2. CHEVRES ROUSSES DE SOKOTO

Résumé

Quarante-huit (mâles = 8, femelles = 40) chèvres rousses de Sokoto adultes ont été utilisées dans une expérience visant à comparer la précision des différents thermomètres. La température corporelle (BT) a été mesurée simultanément avec les thermomètres suivants : électronique numérique (ED), verre contenant du mercure (MG) et infrarouge (IR). La thermométrie ED et MG a été prise via le rectum (respectivement TEMPd et TEMPa) tandis que le thermomètre IR a été utilisé à l'ouverture du rectum (TEMPiR) et sur le front (TEMPiH). Les données ont été soumises à une analyse de variance et à une analyse de corrélation de Pearson. Des diagrammes de dispersion ont été tracés pour générer un R carré pour les relations entre les températures enregistrées par les thermomètres. Le type de thermomètre a eu un effet significatif ($P < 0,001$) sur la BT des chèvres rousses de Sokoto (RS). TEMPd était similaire ($P > 0,05$) à TEMPa, mais le duo était significativement plus élevé que TEMPiR et TEMPiH. La température corporelle (BT) sur le front enregistrée par le thermomètre IR était significativement plus faible qu'à celle notée à l'ouverture du rectum. On a noté une forte corrélation positive significative ($P < 0,001$) entre TEMPd et TEMPa ($r = 0,958$). TEMPi et TEMPa ont montré des corrélations significatives ($P < 0,001$) avec TEMPiR (respectivement $r = 0,519$ et $r = 0,562$), mais pas ($P > 0,05$) avec TEMPiH. La régression linéaire de TEMPd avec TEMPa, TEMPiR et TEMPiH a donné respectivement R^2 de 0,918, 0,269 et 0,040. Les écarts par rapport à TEMPd obtenus étaient de 0,23, 0,91 et 1,69 ° C, respectivement pour TEMPa, TEMPiR et TEMPiH. L'utilisation du thermomètre infrarouge sur le front des RS n'a pas donné de résultat similaire à

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celui des autres thermomètres. La mesure de la température avec un thermomètre infrarouge à l'ouverture du rectum des chèvres RS semble être plus précise que sur le front.

Mots-clés : température rectale, stress de chaleur, santé, bien-être, diagnostic

Introduction

Goats are good sources of animal proteins and income for rural dwellers in Nigeria. Any managerial steps that ensure adequate productivity and welfare are taken to be important. Measurement of body temperature in farm animals is important to ascertain the health status (Stephens Devalle, 2005; Brunnel, 2012) and to ensure they are free from stress. Traditionally, body temperature in goats had been with the use of clinical thermometers, either mercury-in-glass (MG) or electronic digital (ED), inserted into the rectum (Adedeji, 2012; Okoruwa, 2014; Daramola *et al.*, 2015; Kubkomawa *et al.*, 2015). Even in humans, the duo had been in use in most hospitals and clinics. Infrared (IR; non-contact) thermometers became popular during the scourge of Ebola in the coastal West Africa (Musa *et al.*, 2015; Ohimain, 2015; Patrick and Major, 2015). Necessity to avoid contact with suspected Ebola informed its importation to Nigeria. Its use in humans has really gained ground and has come to stay (Haastrup, 2016). The temperature readings are read off the visual display unit as the laser is beamed on the patient's fore head. However in livestock, non-contact IR thermometer is being adopted gradually by some farmers and researchers. This has raised the concern for its accuracy and the point at which it should be used. Canadian Agency for Drugs and Technologies in Health (CADTH, 2014) had stated in a review on clinical effectiveness of non-contact thermometers that evidence for the accuracy of IR skin thermometers is equivocal and requires more research.

Red Sokoto (RS) goats are unique goats of meat and milk type if they can be improved. Their skin is known to be of superior quality and high premium (Otoikhian, 2012). They are adapted to the drier conditions of semi-desert regions. In the face of adverse effects climate

change, these goats are immense usefulness because of the adaptability to hot climate (Abioja *et al.*, 2007). Presently, they are found in the humid tropics (Abioja *et al.*, 2010) where they are crossed with the West African Dwarf goats.

The foregoing justifies the need for accurate monitoring of the welfare of RS goats. Body temperature is one of the indicators of heat stress (Abioja *et al.*, 2012) and ill-health in goats. It becomes imperative to ascertain the accuracy of newly introduced IR thermometer in measuring body temperature in RS goats. Therefore, this study aimed at comparing the data of thermometry taken with clinical (MG and ED) thermometers with the noncontact IR thermometer on the forehead and at the opening of the rectum.

Materials and methods

Location

The research was carried out at the Small Ruminant Unit of the University Teaching and Research Farm, Federal University of Agriculture, Alabata Road, Abeokuta, Nigeria (latitude 7° 13' 49.46"N; longitude 3° 26' 11.98"E (Google Earth, 2013) and altitude 76 m above sea level).

Meteorological observations

Ambient temperature and relative humidity in the pens were monitored immediately at the point of body temperature measurements with digital thermal hygrometer.

Experimental animals and management

Forty adult (2-3years; male=8 and female=40) RS goats kept in open-sided, slatted-floor pens were used for this experiment. The animals were fed with fresh elephant grass and concentrate 5% body weight basis. Fresh water was made available ad libitum daily. Vaccination programme and recommended medications

were adequately adhered to.

Data collection

Body temperature measurement on all the goats was carried out using three different (ED, MG and IR) thermometers. The first two thermometers (TEMPd and TEMPa respectively) were used via rectum of the animals. However, body temperature measurement with the latter was done on the forehead (TEMPiH) and at the opening of the rectum (TEMPiR). The four readings were taken at the same time on individual animals.

Mercury-in-glass thermometer

Rectal temperature of goats was measured with a mercury-in-glass (MG) thermometer (0.1°C accuracy) inserted into the rectum and held for 1 minute.

Electronic digital thermometer

Electronic digital (ED) thermometer (0.1°C accuracy) was inserted into the rectum of goats and held in contact with the epithelial lining until it beeped as earlier described by Abioja *et al.* (2012).

Infra-red non-contact thermometer

Body temperatures of goats were taken

by beaming the laser from the IR thermometer (0.1°C accuracy) on the forehead and at the opening of the rectum. It was ensured that the distance between the animal and the thermometer did not exceed the value recommended by the manufacturer.

Data analyses

Data collected were subjected to analysis of variance using SYSTAT analytical statistical package version 5.0 (SYSTAT, 1992). Means that are statistically different were separated using Duncan Multiple Range Test. The data on TEMPd, TEMPa, TEMPiR and TEMPiH were further subjected to Pearson correlation analysis. Taken TEMPd as the dependent variable, scatter diagrams were plotted to generate R squared for the relationships between the readings of the thermometers

Results

Effect of thermometer type on body temperature of RS goats is presented in Figure 1. Thermometer type had significant ($P < 0.001$) effect on BT in RS goats. TEMPd was similar ($P > 0.05$) to TEMPa, but the duo were significantly higher than TEMPiR and TEMPiH. BT from TEMPiH was significantly lower

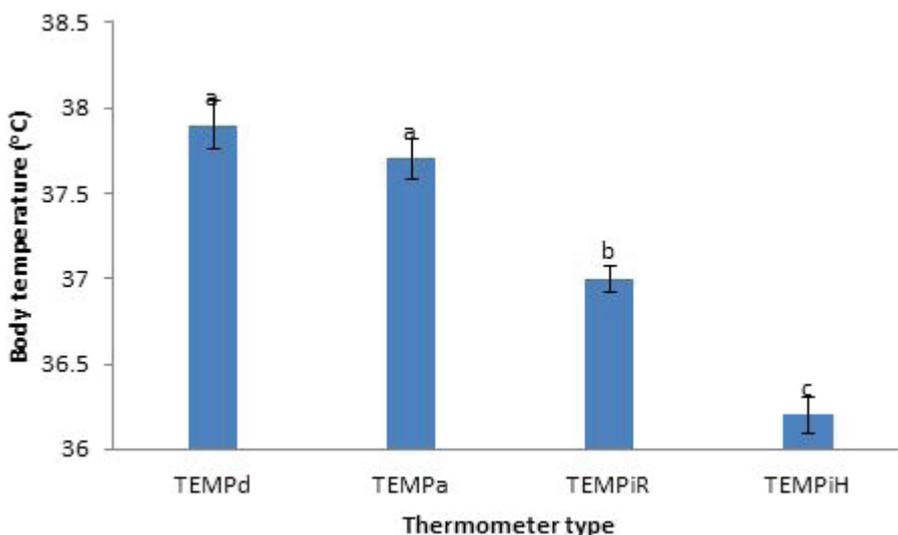


Figure 1: Body temperature (°C) of WAD goats as affected by thermometer type
^{a,b,c,d} Means with different letters in different section of the chart differ significantly ($P < 0.05$)

Table 1: Correlation matrix of the body temperature of WAD goats measured with electronic digital (ED), mercury-in-glass (MG) and infrared (rectum opening and forehead) thermometers

	TEMPd	TEMPa	TEMPiR	TEMPiH
TEMPd	1.000			
TEMPa	0.896***	1.000		
TEMPiR	0.237*	0.222*	1.000	
TEMPiH	-0.007	-0.017	0.503***	1.000

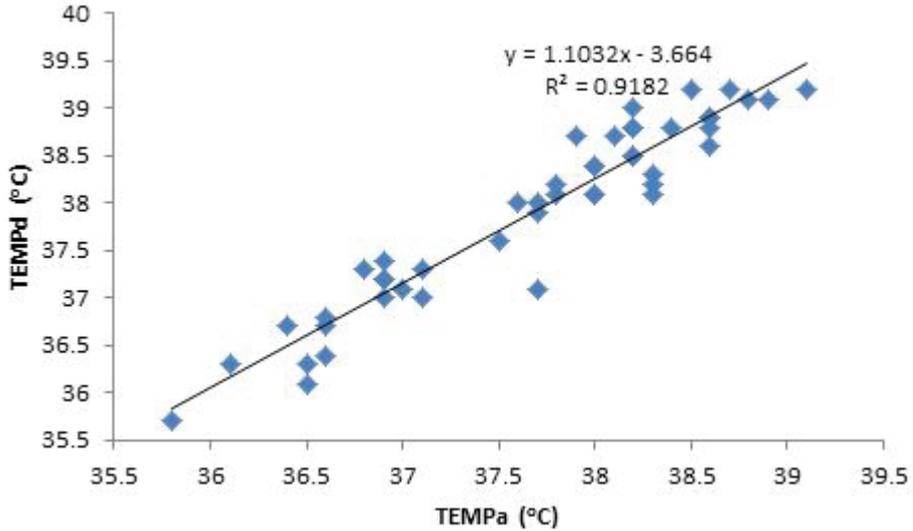


Figure 2: Scatter diagram of temperature readings of ED against MG

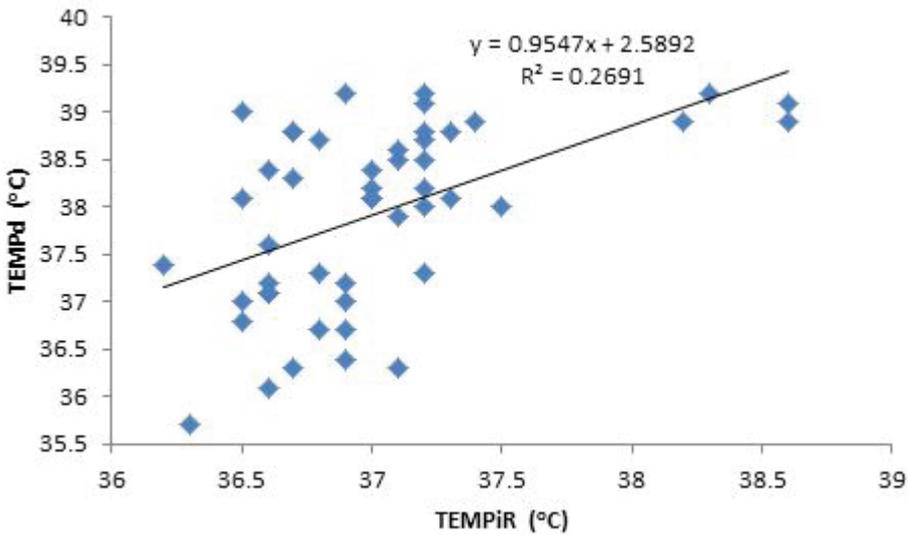


Figure 3. Scatter diagram of temperature readings of ED against IR at the opening of the rectum

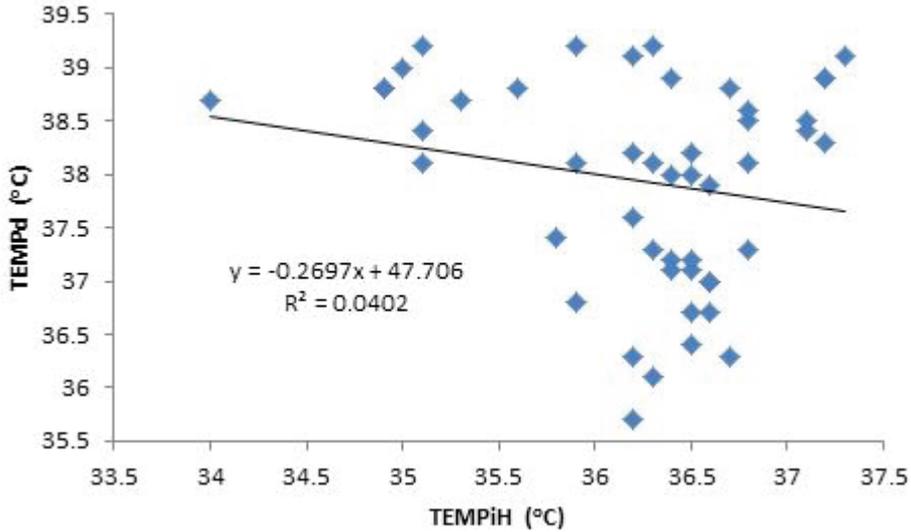


Figure 4. Scatter diagram of temperature readings of ED against IR on the forehead

Table 2: Deviations from readings of thermometer types from electronic digital thermometer

Temperature readings	Bias (°C)	Standard deviation (°C)	Maximum (°C)	Minimum (°C)
ED-MG	0.34	0.66	1.3	-0.5
ED-IR rectum	0.92	0.94	3.9	-1.0
ED-IR forehead	2.54	1.44	4.8	0.2
MG- IR rectum	0.59	0.90	3.8	-1.5
MG- IR forehead	2.20	1.32	5.0	-0.2
IR rectum - IR forehead	1.62	1.20	3.5	-2.2

than TEMPiR. Table I shows the correlation matrix between the values obtained with different thermometers in RS goats. There was strong positive significant ($P < 0.001$) correlation between TEMPd and TEMPa ($r = 0.896$). The correlations between TEMPiR and TEMPd ($r = 0.237$) and TEMPiR and TEMPa ($r = 0.222$), though significant ($P < 0.05$), were weak. TEMPiH and TEMPiR had positive and significant ($P < 0.001$) correlation ($r = 0.503$). Scatter diagrams showing the relationships between readings of TEMPd against TEMPa, TEMPiR and TEMPiH are presented in Figures 2-4 respectively. TEMPd had regression coefficients R^2 of 0.918, 0.269 and 0.040 with TEMPa, TEMPiR and TEMPiH respectively. Table 2 shows the deviations of the readings of other

thermometer types from the electronic digital thermometer. Deviations from TEMPd obtained were 0.23, 0.91 and 1.69°C for TEMPa, TEMPiR and TEMPiH respectively.

Discussion

The average temperatures obtained with electronic digital and mercury-in-glass thermometers in this study are within the values reported in Red Sokoto goats by various authors in previous studies (Ayo *et al.*, 1999; Bello *et al.*, 2015; Habibu *et al.*, 2016). However, the mean value obtained with infrared thermometer was below values in literatures.. Monitoring body temperature with infrared thermometer actually measures skin

temperature (°C). Normally, skin temperature is lower than core body temperature. This is the case except when considering insulated skin temperature which was found to have close relationship with core (rectal) temperature in humans (Richmond *et al.*, 2013). Ng *et al.* (2005) had stated that to obtain estimated core temperature approximately 2 degrees must be added to the measured skin temperature. Skin temperature taking on the forehead is not a good representative of core body temperature (Dräger, 2015) because of its sensitivity to a number of external and internal factors (Casa *et al.*, 2007). In this study, temperature measurements with infrared thermometer recorded lower values. The use of infrared thermometer though easier and faster than the traditional mercury-in-glass and electronic digital thermometers (Rextroat *et al.*, 1999), will however give skin temperature instead of core body temperature measured by the other two. Body temperature measurement depends on the type of thermometer used and portion of the body at which the temperature is taken (Rubia-Rubia *et al.*, 2011). Moreover, lower temperature might have resulted from barrier of the skull. The skull is a thick bone case housing the brain, especially the frontal lobe. In contrast, Rextroat *et al.* (1999) closer relationship was obtained from infrared Vet-Temp™ VT100 instant tympanic thermometers with mercury-in-glass and electronic digital thermometers in cats and dogs. This might be due to the fact that tympanic muscle belongs to the core and not the shell. Tympanic temperature is a representation of the core temperature (Brinnel and Cabanac, 1989).

Brinnel (2012) stated that a time lag between changes in core and subcutaneous temperatures could account for some of the disparity obtained in temperature readings. A cursory look at the differences in the readings of infrared thermometer at forehead and opening of rectum signals that the accuracy of measurement will depend on the location. It suggests that taking reading at other parts of the body may yield closer readings to rectal temperatures. Gasim *et al.* (2013) had reported that thermometry infrared tympanic membrane

thermometer is reliable and as accurate as axillary mercury-in-glass thermometer in humans, yet Yaron *et al.* (1995) reported that infrared tympanic thermometry did not agree with rectal temperature measurements. Both Chue *et al.* (2012) and Rabbani *et al.* (2010) recorded agreement in readings with infrared tympanic thermometer and oral mercury-in-glass thermometers.

Conclusion

IR thermometer measures the skin temperature rather than the core body temperature, unlike the ED and MG thermometers that take the core body temperature. Taking body temperature of RS goats with IR thermometer on the forehead may not give correct measurement as with the traditional MG and ED thermometers. Temperature measurement with IR thermometer on the opening of the rectum of RS goats seems to be more accurate and nearer the core body temperature than on the forehead.

Impact

Red Sokoto goat is a promising animal because of its adaptability as effects of climate change are becoming more evident. Its welfare must be taken seriously. Traditionally, body temperature is taken with either mercury-in-glass (MG) or digital (ED) thermometers via the rectum. Infrared (IR) thermometers are newly introduced. Its accuracy was determined in this study. Readings of MG and ED are related but IR thermometer recorded lower temperature with little relationship with the traditional thermometers especially when used on the forehead of RS goats. IR readings at the opening of the rectum showed a closer relationship.

References

Abioja MO, Ogundimu KB, Akibo TE, Odutola KE, Ajiboye OO, Abiona JA, Williams TJ, Oke OE, Osinowo OA, 2012. Growth, mineral deposition

and physiological responses of broiler chickens offered honey in drinking water during hot-dry season. *International Journal of Zoology* 2012:1-6.

Abioja MO, Osinowo OA, Adebambo OA, Bello NJ, Abiona JA, 2007. Physiological response of Red Sokoto and Red Sokoto goats to water restriction in the humid tropics of south-western Nigeria. *Tropical Journal of Animal Science* 10(1-2): 451-455.

Abioja MO, Osinowo OA, Adebambo OA, Bello, NJ, Abiona JA, 2010. Effect of water restriction in goats during hot-dry season in the humid tropics: feed intake and weight gain. *Archivos de Zootecnia* 59: 195-203.

Adedeji TA, 2012. Effect of some qualitative traits and non-genetic factors on heat tolerance attributes of extensively reared Red Sokoto (RS) goats. *International Journal of Applied Agricultural and Apicultural Research* 8(1): 68-81.

Ayo JO, Oladele SB, Ngam S, Fayomi A, Afolayan SB, 1999. Diurnal fluctuations in rectal temperature of the Red Sokoto goat during the harmattan season. *Research in Veterinary Science* 66(1): 7-9.

Bello TK, Ayo JO, Chiezey NP, Oyelowo BB, Samuel FU, Egbodo BE, Ibrahim M, Maikaji FS, Hassan R, Haruna MH, 2015. Effects of ascorbic acid on rectal temperature in Red Sokoto goats exposed to heat stress during the early rainy season. *Journal of Animal Production Research* 27: 66-70.

Brinnel H, Cabanac M, 1989. Tympanic temperature is a core temperature in humans. *Journal of Thermal Biology* 14: 47-53.

Brunnel MK, 2012. Comparison of noncontact infrared thermometry and 3 commercial subcutaneous temperature transponding microchips with rectal thermometry in rhesus macaques (*Macaca mulatta*). *Journal of American Association for Laboratory Animal Science* 51(4): 479-484.

CADTH, 2014. Canadian Agency for Drugs and Technologies in Health. Non-contact thermometers for detecting fever: A review of clinical effectiveness. https://www.ncbi.nlm.nih.gov/books/NBK263237/pdf/Bookshelf_NBK263237.pdf access date: September 28, 2016.

Casa DJ, Becker SM, Ganio MS, Brown CM, Yeargin SW, Roti MW, Siegel J, Blowers JA, Gaviano NR, Huggins RA, Armstrong LE, Maresh CM, 2007. Validity of devices that assess body temperature during outdoor exercise in the heat. *Journal of Athletic Training* 42(3): 333-342.

Chue AL, Moore RL, Cavey A, Ashley EA, Stepniowska K, Nosten F, McGready R, 2012. Comparability of tympanic and oral mercury thermometers at high ambient temperatures. *BMC Research Notes* 16(5):356.

Daramola JO, Adeloye AA, Yousuf MB, Olatunde AO, Oke OE, Abioja MO, Adenaike O, 2015. Changes in blood and physio-clinical indices of Red Sokoto goats during road transport. *Nigerian Journal of Animal Production* 42(2): 14-20

Dräger, 2015. The significance of core temperature-pathophysiology and measurement methods. Dräger Medical GmbH, Germany. 1-58.

Gasim IG, Imad RM, Mohaned TA, Ishaq M, 2013. *BMC Research Notes* 6:1-5.

Haastrup A, 2016. Preventive health practices in an Ebola virus disease free period. *International Journal of Social Sciences and Education* 6(1): 71-80.

Habibu B, Kawu MU, Aluwong T, Makun Hj, 2016. Influence of seasonal changes on physiological variables, haematology and serum thyroid hormone profile in male Red Sokoto and Sahel goats. *Journal of Applied Animal Research* 45(1): 507-516.

Kubkomawa IH, Emenalom OO, Okoli IC, 2015. Body condition score, rectal temperature, respiratory, pulse and heart rates of tropical indigenous zebu cattle: a review. *International Journal of Agriculture Innovations and Research* 4(3): 448-454.

Musa EO, Adeire E, Adeoye O, Adewuyi P, Waziri N, Nguku P, Nanjuya M, Adebayo B, Fatiregun A, Enya B, Ohuabunwo C, Sabitu K, Shuaib F, Okoh A, Oguntimehin O, Onyekwere N, Nasidi A, Olayinka A, 2014. Epidemiological profile of the Ebola virus disease outbreak in Nigeria, July-September, 2014 *Pan African Medical Journal* 21:331-336.

Ng C, Chan KC, Lau H, 2005. A brief report on the normal range of forehead temperature as determined by noncontact, handheld, infrared

thermometer. *American Journal of Infection Control* 33:227-229.

Ohimain EI, 2015. How the spread of Ebola virus was curtailed in Nigeria. *International Journal of Medical and Pharmaceutical Case Reports* 4(1): 11-20.

Okoruwa MI, 2014. Effect of heat stress on thermoregulatory, live bodyweight and physiological responses of dwarf goats in southern Nigeria. *European Scientific Journal* 10(27): 255-264.

Otoikhian CSO, 2012. Qualitative traits and blood biochemical characterization of White Bornu and Red Sokoto goat breeds in Nigeria. *African Scientists* 13(1): 41-48.

Patrick O, Major NB, 2015. Impact of Ebola Virus Disease on school administration in Nigeria. *American Journal of Contemporary Research* 5(3): 63-67.

Rabbani MZ, Amir M, Malik M, Mufti M, Bin Pervez M, Iftekhhar S, 2010. Tympanic temperature comparison with oral mercury thermometer readings in an OPD setting. *Journal College Physicians and Surgeons Pakistan* 20:33-36.

Rextroat J, Benish K, Fraden J, 1999. Clinical accuracy of Vet-Temp™ instant ear thermometer (Comparative study with dogs and cats). *Advanced Monitor Corporation*. 1-4. www.admon.com accessed 25th August, 2016.

Richmond VL, Wilkinson DM, Blacker SD, Horner FE, Carter J, Havenith G, Rayson MP, 2013. Insulated skin temperature as a measure of core body temperature for individuals wearing CBRN protective clothing. *Physiological Measurement* 34(11):1531-1544.

Rubia-Rubia J, Arias A, Sierra A, Aguirre-Jaime A, 2011. Measurement of body temperature in adult patients: comparative study of accuracy, reliability and validity of different devices. *International Journal of Nursing Studies* 48:872-880.

Stephens Devalle JM, 2005. Comparison of tympanic, transponder, and noncontact infrared laser thermometry with rectal thermometry in strain 13 guinea pigs (*Cavia porcellus*). *Contemporary Top Laboratory Animal Science* 44:35-38.

Yaron M, Lowenstein SR, Koziol-McLain J, 1995. Measuring the accuracy of the infrared tympanic thermometer: correlation does not signify agreement. *Journal of Emerging Medicine* 13:617-621.

GENETIC PARAMETER ESTIMATES FOR GROWTH TRAITS AT DIFFERENT AGES IN NIGERIAN INDIGENOUS TURKEYS

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Abstract

Precise and accurate genetic parameter estimates are crucial for making sound decisions in many stages of animal improvement programme. Genetic parameter estimates for eight growth traits were determined in 308 turkeys generated from mating pure indigenous parents. PROC MIXED of SAS was used to estimate variance and covariance components of the growth traits. The highest heritability estimates for body weight, breast girth, thigh length, shank length, keel length and wing length were observed at week 1, week 8, week 4, week 16, week 4, and a day old-old, respectively. The repeatability estimates ranged from 0.01 to 0.93 with body weight and body length having the least values at week 20 and week 1, respectively. Negative genetic correlations were observed among the growth traits at a day-old. Also, negative correlations were observed among all the growth traits at week 20 except between body weight and shank length, shank length and wing length, shank length and wing span as well as wing length and wing span. Positive phenotypic correlations existed among all the growth traits measured except among some traits at weeks 1 and 16. Phenotypic correlations observed at week 20 were relatively higher than those observed in other weeks. These results suggested that breeders can select for body weight, breast girth, thigh length, shank length, keel length and wing length of Nigerian indigenous turkeys at week 1, week 8, week 4, week 16, week 4, and a day old-old, respectively. Fewer records are required to estimate response to selection of Nigerian indigenous turkeys when selecting for breast girth at a day-old and body length at week 16. The negative genetic correlation observed among most growth traits at week 20 was an indication of unpredictability among these traits at week 20, so tandem method of selection cannot be used in selecting these traits.

Keywords: correlations, heritability, repeatability, selection, turkey.

ESTIMATIONS DES PARAMÈTRES GÉNÉTIQUES POUR LES CARACTÈRES DE CROISSANCE À DIFFÉRENTS ÂGES CHEZ LES DINDES INDIGÈNES NIGÉRIENS

Résumé

Les estimations précises et sûres des paramètres génétiques sont cruciales pour une prise de décisions judicieuses à plusieurs étapes du programme d'amélioration des animaux. Les estimations des paramètres génétiques pour huit caractères de croissance ont été déterminées chez 308 dindes issues de parents autochtones purs. PROC MIXED de SAS a été utilisé pour l'estimation des composantes de variance et de covariance des caractères de croissance. Les estimations les plus élevées d'héritabilité pour le poids corporel, le tour de poitrine, la longueur de la cuisse, la longueur du pilon, la longueur de la crête sternale et la longueur de l'aile ont été observées respectivement à la semaine 1, à la semaine 8, à la semaine 4, à la semaine 16, à la semaine 4 et à un jour d'âge. Les estimations de répétabilité variaient de 0,01 à 0,93, le poids corporel et la longueur corporelle ayant les plus faibles valeurs respectivement à la semaine 20 et à la semaine 1. Des corrélations génétiques négatives ont été observées entre les caractères de croissance à un jour d'âge. De plus, des corrélations négatives ont été observées entre tous les caractères de croissance à la semaine 20, sauf entre le poids corporel et la longueur du pilon, la longueur du pilon et

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la portée de l'aile, la longueur de la tige et la portée de l'aile. Des corrélations phénotypiques positives ont été notées entre tous les caractères de croissance mesurés, sauf entre certains traits aux semaines 1 et 16. Des corrélations phénotypiques observées à la semaine 20 étaient relativement plus élevées que celles observées aux autres semaines. Ces résultats portent à croire que les éleveurs peuvent choisir le poids corporel, le tour de poitrine, la longueur de la cuisse, la longueur du pilon, la longueur de la quille et la longueur de l'aile des dindes indigènes nigérianes respectivement à la semaine 1, à la semaine 8, à la semaine 4, à la semaine 16, à un jour. Peu de données sont nécessaires pour estimer la réponse à la sélection de dindes indigènes nigérianes lors de la sélection du tour de poitrine à un jour et de la longueur du corps à la semaine 16. La corrélation génétique négative observée dans la plupart des caractères de croissance à la semaine 20 était une indication de l'imprévisibilité de ces traits à la semaine 20, donc une méthode tandem de sélection ne peut pas être utilisée dans la sélection de ces caractères.

Mots-clés : corrélations, héritabilité, répétabilité, sélection, dinde.

Introduction

Turkey is an important agricultural bird that is largely used as a meat type bird. It is not common among poultry growers in Nigeria but a number of farms are beginning to breed the bird at commercial level owing to increase in the interest as a provider of meat to complement chicken. Nigerian indigenous turkeys are mostly located in urban areas and are gradually spreading even to village farms. The fast growth in the industry requires an extensive research approach to boost its production especially considering the potentials associated with it (Ibe, 1989).

Growth can be regarded as a direct fitness trait. It can also be defined as the increase in the number of cells of the body (Oluyemi, 1990). Growth is also a fundamental property of biological systems and it is an increase in body size per unit time (Norris *et al.*, 2007).

Precise and accurate genetic parameter estimates are crucial for making sound decisions in many stages of animal improvement programme (Hodge and White, 1992). Estimate of genetic parameters of quantitative traits are important because they give an indication of the ability of a species to respond to selection (Lande 1982; Mousseau and Roff 1987; Falconer and Mackay 1996; Lande and Shannon, 1996). Genetic evaluation and subsequent animal selection depends on several factors, including the availability of co(variance) components and genetic parameter estimates for the trait of interest (Sarmiento *et al.*, 2006). Variances and

covariances change over time and considerable changes might have occurred in a population due to environment and breeding programmes. The knowledge of the genetic parameters will allow more accurate assessment of breeding values and increase the rate of response to selection (Weiner, 1994).

To calculate selection index, it is necessary to know the heritability and the correlation between the traits in addition to the economic weight of the trait (Komlosi, 2008). Uses of heritability cannot be over emphasized and some are to estimate progress and setbacks in different traits expected from different mating. Also, the knowledge of the heritability estimate is used to decide which animal evaluation method should be used. Genetic correlations among growth traits during different time intervals may be of use to researchers attempting to identify physiological mechanisms associated with superior performance in the field (Hodge and White, 1992).

The aim of the study was to estimate genetic parameters for growth traits at different ages in Nigeria indigenous turkeys in order to know the age when selection can be done, predict correlated response, develop selection indices for selection of multiple traits simultaneously, determine extent of genotype-by-environment interaction and understand evolutionary process of growth traits.

Materials and Methods

Experimental site

The experiment was carried out at the Turkey Breeding Unit of the Teaching and Research Farm of the Department of Animal Breeding and Genetics, Federal University of Agriculture, Abeokuta, Alabata, Ogun State Nigeria. Alabata (latitude 7°10'N and longitude 3°2'E) is in Odeda Local Government Area of Ogun State, Nigeria. The area which lies in the South Western part of Nigeria has a prevailing tropical climate with a mean annual rainfall of about 1037 mm. The mean ambient temperature ranges from 28°C in December to 36°C in February with a yearly average humidity of about 82%. The vegetation represents an interphase between the tropical rainforest and the derived savannah.

Source, sample size and management of experimental birds

The experimental birds were generated from mating of pure indigenous parent stocks (24 sires and 52 dams) available on the farm through artificial insemination. Three hundred and eight (308) progenies were used for the experiment which lasted for 20 weeks. The experimental birds were raised under intensive management system. The poults were brooded in deep litter pens at the brooding stage. All progenies were wing-tagged along the sire-dam marks for proper identification and subjected to the same management practices throughout the experimental period. Commercial feeds were provided for the birds ad libitum. Starter mash containing 28% crude protein and grower mash containing 24% crude protein were fed to the birds from 0-8 and 9-20 weeks of age, respectively. Clean water was also provided for the birds ad libitum. Vaccination schedule for turkey was strictly adhered to and adequate sanitation was practised to prevent occurrence of diseases.

Data collection

The growth traits of Nigerian indigenous turkeys were measured as described below:

- **Body weight:** This was recorded individually on a weekly basis from day old till 20 weeks of age using Avery Berkel scale.
- **Body length:** This was measured as the distance between the base of the snood and the base of the cloaca.
- **Shank length:** This was measured as the distance between the tarsometatarsus and the hock joint.
- **Keel length:** This was measured as the length of the cartilaginous keel bone or metasternum.
- **Wing length:** This was measured as the length from the shoulder joint to the extreme of the terminal balance.
- **Thigh length:** This was measured as the distance between the hock joint and pelvic joint.
- **Breast girth:** This was measured as the circumference of the breast around the deepest region.
- **Wing span:** This was measured as the distance between the left wing tip to the right wing tip across the back of the turkey.

Statistical analyses

The growth data obtained were analysed using PROC MIXED of SAS (2002) using restricted maximum likelihood method to estimate variance and covariance components. The fitted random model is as follows:

$$Y_{ijk} = \mu + S_i + D_{j(i)} + W_{k(ij)}$$

Where:

Y_{ijk} = the record of each growth trait of individual progeny of each sire

μ = overall mean

S_i = effect of the sire

$D_{j(i)}$ = the random effect of j^{th} dam within the i^{th} sire

$W_{k(ij)}$ = the random effect of the k^{th} individual within the ij^{th} family.

The computed variances and covariances were used to estimate the heritability, repeatability, genetic and phenotypic correlations using the formulae below:

Heritability: This was calculated from sib analysis using the formula below:

$$h^2 = \frac{2\delta_s^2 + 2\delta_D^2}{\delta_s^2 + \delta_D^2 + \delta_w^2}$$

Repeatability: This was calculated using the formula below:

$$R = \frac{\delta_s^2}{\delta_s^2 + \delta_w^2}$$

Genetic correlation: This was calculated using the formula below:

$$r_g = \frac{\text{cov}_{xy}}{\sqrt{(\delta_x^2 \cdot \delta_y^2)}}$$

Phenotypic correlation: This was calculated using the formula below:

$$r_p = \frac{\text{cov}_w(x, y) + \text{cov}_s(x, y)}{\sqrt{(\delta_w^2(x) + \delta_s^2(x))(\delta_w^2(y) + \delta_s^2(y))}}$$

Where δ_s^2 = Variance component of sire
 δ_D^2 = variance component of dam
 δ_w^2 = Variance component within progeny.
 cov_{xy} = Covariance of any two growth traits X and Y.

Results

Descriptive statistics of growth traits of Nigerian indigenous turkeys at different ages

Means, standard errors and coefficients of variation of growth traits of Nigerian indigenous turkey were shown in Table 1. The growth traits increased with age. The coefficient of variation for all the growth traits at all ages ranged from 5.73% in body length at week 8 to 95.60% in breast girth at week 20. Most of the coefficients of variation were less than 30% except for keel length at week 1, thigh length at week 16 and breast girth at week 20.

Heritability estimates of growth traits of Nigerian indigenous turkeys at different ages

Heritability estimates of growth traits of Nigerian indigenous turkeys at different ages were presented in Table 2. The heritability estimates ranged from very low to high. The least heritability estimate (0.003) was observed in breast girth and shank length at week 20 while the highest heritability estimate was observed in wing length at a day-old. Higher heritability estimates were observed in body length at a day-old, week 1 and week 4. The highest heritability estimates for body weight, breast girth, thigh length, shank length, keel length and wing length were observed at week 1, week 8, week 4, week 16, week 4, and a day old-old, respectively.

Repeatability estimates of growth traits of Nigerian indigenous turkeys at different ages

Repeatability estimates of growth traits of Nigerian indigenous turkeys at different ages were shown in Table 3. The repeatability estimates ranged from 0.01 to 0.93 with body weight and body length having the least values at week 20 and week 1 respectively. The highest repeatability estimates for breast girth and wing span were observed at a day-old.

Genetic correlation of growth traits of Nigerian indigenous turkeys at different ages

Genetic correlations among the growth traits of Nigerian indigenous turkeys were shown in Tables 4-10. Negative genetic correlations were observed among the growth traits at a day-old. Positive genotypic correlation existed among all the traits at week 8 except body length and keel length, thigh length and wing span as well as shank length and wing span. The genetic correlations observed at week 12 among the growth traits ranged from -0.555 to 0.930. High genetic correlation values were observed among the growth traits of Nigerian indigenous turkeys at week 16 except between thigh length and other growth traits. Also, negative correlations were observed among all the growth traits at week 20 except between body weight and shank length, shank length and wing length, shank length and wing span as well as wing length and wing span.

Table 1: Descriptive statistics of growth traits of Nigerian indigenous turkeys at different ages

Trait	Day old			Week 1			Week 4			Week 8			Week 12			Week 16			Week 20		
	Mean	SE	CV	Mean	SE	CV	Mean	SE	CV	Mean	SE	CV	Mean	SE	CV	Mean	SE	CV	Mean	SE	CV
BW (g)	53.69	0.89	14.59	87.34	2.54	25.38	407.23	7.13	15.05	1105.66	15.12	16.95	1575.35	31.68	16.95	2134.56	53.13	20.53	2753.79	70.69	20.85
BL (cm)	7.72	0.08	9.13	8.87	0.10	9.52	14.30	0.16	9.30	21.90	0.15	5.73	28.22	0.23	6.89	34.02	0.34	8.13	37.14	0.39	8.45
BG (cm)	10.30	0.08	7.13	11.54	0.10	7.34	16.21	0.17	8.90	29.89	0.27	7.77	41.07	0.36	7.33	47.40	0.45	7.89	59.60	7.01	95.60
TL (cm)	3.86	0.06	14.18	4.40	0.06	11.87	6.03	0.07	9.70	10.37	0.11	8.77	13.97	0.11	6.81	18.49	2.07	92.47	18.30	0.17	7.65
SL (cm)	2.28	0.04	13.54	2.69	0.03	10.56	3.93	0.04	9.42	7.12	0.09	11.14	10.21	0.09	7.53	11.58	0.11	7.79	12.23	0.14	8.98
KL (cm)	1.76	0.05	22.55	2.46	0.25	89.46	3.88	0.10	22.27	6.92	0.07	9.05	9.39	0.08	7.37	11.06	0.10	7.21	12.74	0.14	9.19
WL (cm)	5.80	0.10	15.67	6.95	0.12	15.09	10.98	0.10	8.16	19.20	0.18	7.93	25.94	0.21	6.80	29.45	0.27	7.60	31.65	0.35	8.88
WS (cm)	13.80	0.13	8.29	17.05	0.17	8.91	26.57	0.25	8.20	42.46	0.34	6.82	55.22	0.41	6.30	62.57	0.60	7.50	67.16	0.73	8.78

Table 2: Heritability estimates of growth traits of Nigerian indigenous turkeys at different ages

Trait	A day-old	Week 1	Week 4	Week 8	Week 12	Week 16	Week 20
Body weight	0.05	0.72	0.31	0.26	0.42	0.36	0.01
Body length	0.68	0.84	0.77	0.01	0.42	0.14	0.02
Breast girth	0.01	0.83	0.22	0.84	0.09	0.22	0.003
Thigh length	0.11	0.43	0.53	0.05	0.49	0.01	0.48
Shank length	0.18	0.18	0.01	0.18	0.01	0.25	0.003
Keel length	0.27	0.11	0.87	0.34	0.20	0.29	0.51
Wing length	0.91	0.20	0.46	0.30	0.05	0.29	0.73
Wing span	0.86	0.30	0.35	0.05	0.30	0.25	0.69

Table 3: Repeatability estimates of growth traits of Nigerian indigenous turkeys at different ages

Trait	A day-old	Week 1	Week 4	Week 8	Week 12	Week 16	Week 20
Body weight	0.10	0.19	0.25	0.06	0.07	0.09	0.01
Body length	0.34	0.01	0.19	0.61	0.69	0.85	0.72
Breast girth	0.93	0.43	0.24	0.58	0.17	0.45	0.05
Thigh length	0.33	0.22	0.29	0.45	0.49	0.09	0.76
Shank length	0.10	0.12	0.07	0.35	0.17	0.40	0.21
Keel length	0.13	0.17	0.44	0.23	0.29	0.49	0.13
Wing length	0.45	0.47	0.27	0.63	0.24	0.16	0.36
Wing span	0.43	0.30	0.18	0.11	0.08	0.11	0.35

Table 4: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at a day-old

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		-0.022	-0.033	-0.013	-0.010	-0.009	-0.013	-0.030
BL	0.118		-0.172	-0.335	-0.220	-0.184	-0.561	-0.507
BG	0.137	0.483		-0.125	-0.512	-0.666	-0.223	-0.206
TL	0.102	0.527	0.474		-0.183	-0.477	-0.577	-0.129
SL	0.048	0.494	0.538	0.485		-0.499	-0.220	-0.370
KL	0.071	0.584	0.580	0.744	0.662		-0.175	-0.158
WL	0.151	0.768	0.510	0.651	0.489	0.706		-0.199
WS	0.186	0.499	0.483	0.659	0.482	0.623	0.582	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 5: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 1

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		0.607	0.011	0.628	-0.096	-0.052	0.838	0.480
BL	0.647		-0.424	0.783	-0.577	0.522	0.697	0.824
BG	0.590	0.714		-0.091	-0.295	0.773	-0.457	-0.544
TL	0.441	0.556	0.595		-0.566	0.415	-0.509	-0.375
SL	0.381	0.516	0.481	0.591		-0.115	-0.332	-0.242
KL	0.049	0.074	0.239	0.207	0.088		-0.946	-0.743
WL	0.544	0.632	0.548	0.557	0.505	-0.030		0.152
WS	0.486	0.389	0.521	0.731	0.501	-0.055	0.516	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 6: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 4

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		0.314	0.957	0.064	0.630	0.105	0.799	0.376
BL	0.688		0.997	-0.073	0.643	0.114	0.847	0.290
BG	0.795	0.760		-0.284	0.522	-0.190	0.820	-0.812
TL	0.481	0.377	0.557		-0.200	-0.652	-0.118	-0.313
SL	0.532	0.523	0.645	0.561		-0.183	0.636	0.128
KL	0.605	0.573	0.563	0.440	0.364		-0.453	-0.535
WL	0.721	0.724	0.842	0.472	0.550	0.399		0.321
WS	0.646	0.560	0.780	0.560	0.572	0.385	0.637	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 7: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 8

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		0.629	0.892	0.148	0.563	0.083	0.753	0.226
BL	0.709		0.956	0.924	0.735	-0.407	0.799	-0.939
BG	0.702	0.678		0.928	0.967	0.535	0.784	0.799
TL	0.662	0.742	0.688		0.934	0.975	0.314	-0.939
SL	0.709	0.701	0.735	0.755		0.622	0.523	-0.438
KL	0.579	0.488	0.556	0.421	0.514		0.879	0.854
WL	0.751	0.637	0.552	0.683	0.589	0.622		0.633
WS	0.805	0.667	0.603	0.727	0.704	0.505	0.768	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 8: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 12

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		0.391	0.671	0.020	0.257	0.134	0.876	0.193
BL	0.721		0.805	-0.122	0.568	0.909	0.930	0.227
BG	0.619	0.597		-0.467	-0.304	0.758	0.585	0.065
TL	0.627	0.462	0.673		-0.193	-0.147	-0.326	-0.228
SL	0.550	0.422	0.759	0.568		-0.060	-0.555	-0.116
KL	0.568	0.595	0.720	0.481	0.645		0.914	0.019
WL	0.723	0.538	0.625	0.669	0.689	0.695		-0.065
WS	0.718	0.517	0.649	0.551	0.461	0.399	0.751	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 9: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 16

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		0.619	0.931	-0.459	0.994	0.913	0.856	0.972
BL	0.823		0.857	-0.259	0.677	0.722	0.057	0.279
BG	0.931	0.860		-0.327	0.781	0.991	0.763	0.890
TL	-0.027	-0.027	0.014		-0.057	-0.052	-0.154	-0.277
SL	0.847	0.668	0.800	-0.009		0.855	0.998	0.985
KL	0.888	0.789	0.901	-0.008	0.803		0.791	0.967
WL	0.897	0.665	0.850	0.0002	0.859	0.824		0.966
WS	0.904	0.678	0.867	-0.015	0.908	0.841	0.916	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Table 10: Genetic (upper diagonal) and phenotypic (lower diagonal) correlations of growth traits of Nigerian indigenous turkey at week 20

Trait	BW	BL	BG	TL	SL	KL	WL	WS
BW		-0.934	-0.395	-0.107	0.623	-0.397	-0.687	-0.655
BL	0.835		-0.530	-0.229	-0.211	-0.170	-0.733	-0.319
BG	0.942	0.801		-0.297	-0.221	-0.140	-0.234	-0.562
TL	0.918	0.661	0.874		0.194	-0.217	-0.552	-0.563
SL	0.858	0.530	0.789	0.829		-0.843	0.986	0.951
KL	0.855	0.606	0.672	0.788	0.801		-0.279	-0.813
WL	0.871	0.657	0.789	0.865	0.917	0.746		0.620
WS	0.909	0.636	0.880	0.902	0.935	0.801	0.921	

BW: body weight, BL: body length, BG: breast girth, TL: thigh length, SL: shank length, KL: keel length, WL: wing length, WS: wing span

Phenotypic correlation of growth traits of Nigerian indigenous turkeys at different ages

Positive phenotypic correlations existed among all the growth traits measured (Tables 4-10) except among some traits at weeks 1 and 16. Phenotypic correlations observed at week 20 were relatively higher than those observed in other weeks.

Discussion

The mean values of all the growth traits measured in this study were within the range reported by Ilori et al. (2016) for Nigerian indigenous turkeys. The high coefficient of variation observed in breast girth at week 20 was an indication that selection has not been applied for this trait or breast girth responds more to environment than other traits (Pundir et al., 2011).

Heritability estimates of the growth traits studied in this experiment ranged from very low to high, heritability estimates of this nature suggests that appreciable genetic variance exists for these traits in the turkey population studied and therefore fast response to selection is expected. The amount of additive genetic variance in any population is largely a function of the level of selection that has taken place in that population, selection depletes additive genetic variance (Peters, 2000). The highest heritability values obtained in this result falls within the range obtained by Aslam et al. (2011) in their study on turkey birds while the least heritability value 0.003 obtained in this research is lower than the result obtained by Aslam et al. (2011) and this could be due to environmental differences, nutrition, dam effects and non-additive genetic effects such as dominance and epistasis (Adeleke et al., 2011). The highest heritability estimates for body weight, breast girth, thigh length, shank length, keel length and wing length observed at week 1, week 8, week 4, week 16, week 4, and a day old-old, respectively is an indication that breeders can select for these traits at these ages. High heritability in some ages and low heritability in other ages for a particular trait observed in this study could indicate various expressions of

different genes at different ages of the turkey's growth. Heritability is the single most important consideration in determining appropriate animal evaluation methods, selection methods and mating systems. It measures the relative importance of hereditary and environmental influences on the development of a specific quantitative trait. It is said to measure that part of the total variability of the trait caused by genetic differences among the animals from which the measurements were taken. The numerical value of a heritability estimate can be increased or decreased by changes in either of its component parts. An increase results from a reduction in the environmental variance or from an increase in genetic variance and vice versa (Falconer and Mackay, 1996).

The repeatability estimates obtained in this study were lower than the ones reported by Ilori et al. (2016) for Nigerian indigenous turkeys and could be due to larger sample size used in this study. This can also be caused by management system as management of animal can bring a big variation in expression of genetic potential (Bedhane et al., 2013). High repeatability estimates obtained for breast girth at a day-old and body length at week 16 showed that fewer records are required to estimate the potential of these birds for these traits at these ages and to realize a high expected response from selection (Sola-Ojo and Ayorinde, 2011). However, larger records are required for those with lower repeatability, especially body length at week 1 and body weight at week 20. Falconer (1989) stated that fewer records are required to realize a high expected response from selection in traits with high repeatability estimates while those with low repeatability estimates will require larger number of records. Repeatability is the correlation between the repeated measurements of the same individual and represents the proportion of the variance of single measurement which is due to permanent or non-localized differences between individuals, both genetics as well as environmental. It also reduces the variance due to temporary environmental differences and therefore the total variance decreases which leads to an increase in the heritability (Komlosi,

2008).

The genetic correlation is the correlation between the additive and breeding values for two traits or between the sums of additive effects of the genes influencing the two traits (Adeleke *et al.*, 2011). Some of the genetic correlations among the growth traits were positive and this implied that as one growth trait was increasing, a corresponding increase was also expressed in other growth trait, however some were negative especially at week 20, which also implied that as one growth trait was increasing, a decrease was expressed in other body measurements. Correlation coefficients obtained in this study ranged from low to high. Positive genetic correlation coefficient among some growth traits was an implication that selection for one growth trait will bring about selection for the other growth trait while the negative genetic correlation coefficient among some growth traits implied that selection for one growth trait will not bring about selection for the other growth trait. According to Lynch (1999), genetic correlations between traits are of substantial interest because, depending on their sign, they can either facilitate or impede the joint evolution of the characters involved. Increase in growth traits in poultry is one of the essential goals of improvement programmes, which requires adequate knowledge of correlated traits that can be considered when selection is to be applied, though some limitations can be anticipated due to multi-collinearity that may exist when using linear traits which could render prediction unreliable (Ibe, 1989; Malau-Aduli *et al.*, 2004). The genetic cause of correlation is chiefly pleiotropy, though linkage is a cause of transient correlation, particularly in population derived from crosses between divergent strains. Pleiotropy is simply the property of a gene whereby it affects two or more characters, so that if the gene is segregating it causes simultaneous variation in the characters it affects. The degree of correlation arising from pleiotropy expresses the extent to which two characters are influenced by the same genes. The correlation resulting from pleiotropy is the overall or net effect of all the segregating

genes that affect both characters (Falconer and Mackay, 1996). The association between two characters that can be directly observed is the correlation of phenotypic values, or the phenotypic correlation. Positive phenotypic correlation coefficients varying from low to high obtained among most traits in this study are consistent with the reports of Adebambo *et al.* (2006) and Adedeji *et al.* (2008).

Conclusions

- The highest heritability estimates for body weight, breast girth, thigh length, shank length, keel length and wing length observed at week 1, week 8, week 4, week 16, week 4, and a day old-old, respectively is an indication that breeders can select for these traits at these ages in Nigerian indigenous turkeys.
- Changes in heritability estimate at different ages is an indication of different expression of different growth-correlated genes at different ages in Nigerian indigenous turkeys
- Fewer records are required to estimate response to selection of Nigerian Indigenous Turkeys when selecting for breast girth at a day-old and body length at week 16.
- The negative genetic correlation observed among most growth traits at week 20 is an indication of unpredictability among these traits at week 20, so tandem method of selection cannot be used in selecting these traits.

Impact

Precise and accurate genetic parameter estimates are crucial for making sound decisions in breeding of Nigerian indigenous turkeys. The information obtained in this study is useful in the improvement of growth traits in the bird. Also, this study has revealed that tandem method of selection cannot be used in selecting growth traits in the bird at 20 weeks of age.

References

- Adebambo AO, Ozoje MO, Adebambo Funmi, Abiola SS, 2006. Genetic variations in growth performance of Giriraja, Indian White Leghorn and Improved Indigenous chicken breeds in South West Nigeria. *Nigerian Journal of Genetics*, 20: 7-16.
- Adedeji TA, Ojedapo LO, Ige AO, Ameen SA, Akinwumi AO, Amao SR, 2008. Genetic evaluation of growth performance of pure and crossbred chicken progenies in a derived savanna environment. In the Proceedings of the 13th annual conference of Animal Science Association of Nigeria, pp 8-12.
- Adeleke MA, Peters SO, Ozoje MO, Ikeobi CON, Bamgbose AM, Adebambo OA, 2011. Genetic parameter estimates for body weight and linear body measurement in pure and crossbred progenies of Nigerian Indigenous chickens. *Livestock Research for Rural Development*, 23 (1).
- Aslam LM, Bastiaansen WM, Crooijmans PMA, Ducro BJ, Vereijken A, Groenen AM, 2011. Genetic variances, heritability and maternal effects on body weight, breast meat yield, meat quality traits and the shape of the growth curve in turkey birds. *BMC Genetics*, 12:14.
- Bedhame M, Haile A, Dadi H, Alemu T, 2013. Estimates of genetic and phenotypic parameters for growth traits in Arsi-Bale goat in Ethiopia. *Journal of Animal Science Advances*, 3(9): 439-448
- Falconer DS, 1989. *Introduction to Quantitative Genetics*, 3rd Edition. Longman Scientific and Technical, London.
- Falconer DS, Mackay TFC, 1996. *Introduction to Quantitative Genetics*, 4th Edition. Longman, Harlow, Essex, United Kingdom.
- Hodge GR, White TL, 1992. Genetic parameter estimates for growth traits at different ages in Slash pine and some implications for breeding. *Silvae Genetica*, 41: 252-262.
- Ibe SN, 1989. Measurement of size and confirmation in commercial broilers. *Journal of Animal Breeding and Genetics*, 106: 461-469.
- Ilori BM, Akano K, Durosaro SO, Adebambo AO, Ozoje MO, 2016. Estimates of repeatability for growth traits of pure and crossbred turkeys in the tropics. *Nigerian Journal of Animal Production*, 43(1): 27-36.
- Komlosi I, 2008. Genetic parameters for growth traits of the Hungarian merino and meat sheep breeds in Hungary. PhD. Thesis, Institute of Animal Science, Debrecen University.
- Lande R, 1982. A quantitative genetic theory of life history evolution. *Ecology*, 63: 607-615.
- Lande R, Shannon S, 1996. The role of genetic variation in adaptation and population persistence in a changing environment. *Evolution*, 50: 434-437.
- Lynch M, 1999. *Understanding Genetics Correlation in Natural Population*. Dept. of Biology, University of Oregon, Eugene.
- Lynch M, Walsh B, 1998. *Genetics and Analysis of Quantitative Traits*. Sinauer Associates, Sunderland, MA.
- Malau-Aduli AEO, Aziz MA, Kojina T, Niibayashi T, Oshima K, Komatsu M, 2004. Fixing collinearity instability using principal component and ridge regression analyses in the relationship between body measurement and body weight in Japanese Black cattle. *Journal of Animal and Veterinary Advances*, 4: 856-863.
- Mousseau TA, Roff DA, 1987. Natural selection and the heritability of fitness components. *Heredity*, 59: 181-197.
- Oluyemi JA, 1990. Germ plasm component of rural poultry development in Africa. Workshop on rural Poultry Development in Africa at OAU, Ile-Ife.
- Peters SO, 2000. Genetic variations in the reproductive performance of chicken and growth rate of its pure and half bred progeny. M. Agric. thesis in the Department of Animal Breeding and Genetics, University of Agriculture, Abeokuta.
- Pundir RK, Singh PK, Singh KP, Dangi PS, 2011. Factor analysis of biometric traits of Kankej cows to explain body conformation. *Asian-Australasian Journal of Animal Science*, 24(4): 449-456.
- SAS, 2002. *Statistical analysis system. Users guide*. Cary. North Caroline, USA.

Sarmento JLR, Torres RA, Pereira CS, 2006. Avaliação genética de características de crescimento de ovinos Santa Inês utilizando modelos de regressão aleatória. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, 58(1): 68-77.

Sola-Ojo FE, Ayorinde KL, 2011. Repeatability estimates of some growth traits in four broiler strains at different ages. *Nigerian Journal of Genetics*, 25:35-43.

Weiner G, 1994. *Animal Breeding: The Tropical Agriculturalist Series*. Macmilan Education LTD, London and Basingstoke.

Norris D, Ngambi JW, Benyi K, Makgahlela ML, Shimelis HA, Nesamvuni EA, 2007. Analysis of growth curves of indigenous male Venda and Naked Neck chickens, *South African Journal of Animal Science*, 37: 21-26.

ISOLATION AND MOLECULAR CHARACTERIZATION OF *CAMPYLOBACTER COLI* AMONG TRADE PIGS IN KAFANCHAN, KADUNA STATE, NIGERIA

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Abstract

Campylobacter coli is a zoonotic bacterium associated with gastroenteritis in both man and animals, causing considerable morbidity and mortality among the young, the aged and the immuno-compromised in most developing countries including Nigeria. This study isolated and characterized *Campylobacter coli* from trade pigs in Kafanchan, Nigeria, using charcoal-cefoperazone-deoxycholate agar (CCDA) and a multiplex polymerase chain reaction that targeted a 439 bp of 16 rRNA of thermophilic campylobacters. Faecal samples from 114 (57.0%) females and 86 (43.0%) males totaling 200 samples were analyzed for the presence of *Campylobacter* species of which 16 were positive for *Campylobacter coli* yielding an overall prevalence rate of 8.0%. Sex-based prevalence rates varied significantly ($p < 0.05$) between the 2.3% and 12.3% recorded by males and females respectively while breed-based prevalence rates were 4.9% and 10.1% for exotic and indigenous pigs respectively. The prevalence rates of 0%, 2.6%, 7.8%, 21.7% and 11.7% revealed by pigs that originated from Abuja, Kaduna, Nasarawa, Niger and Plateau States respectively showed significant variation ($p < 0.05$). *Campylobacter coli* is prevalent among trade pigs in Kafanchan, Nigeria and is distributed across four of the five states from which trade pigs were sourced. Adequate hand hygiene is recommended for farmers, traders and Veterinary professionals handling pigs to prevent the transmission of this zoonosis to humans.

Keywords: Isolation, molecular characterization, *Campylobacter coli*, trade pigs, Kafanchan-Nigeria.

ISOLEMENT ET CARACTERISATION MOLECULAIRE DE *CAMPYLOBACTER COLI* CHEZ LES PORCS COMMERCIAUX A KAFANCHAN, DANS L'ETAT DE KADUNA AU NIGERIA

Résumé

Campylobacter coli est une bactérie zoonotique associée à la gastroentérite à la fois chez l'homme et l'animal, et elle est à l'origine d'une morbidité et d'une mortalité considérables chez les individus jeunes, les individus âgés et les individus immunodéprimés dans la plupart des pays en développement, notamment au Nigéria. La présente étude a procédé à l'isolement et à la caractérisation de la bactérie *Campylobacter coli* chez les porcs commerciaux à Kafanchan au Nigeria, en utilisant la gélose au charbon à la céfopérazone et au déoxycholate (CCDA) et une réaction en chaîne de la polymérase multiplex qui a visé un 439 bp of 16 rRNA des campylobacters thermophiles. Des échantillons fécaux prélevés sur 114 (57.0%) femelles et 86 (43.0%) mâles (totalisant 200 échantillons) ont été analysés pour détecter la présence de l'espèce *Campylobacter*, et 16 échantillons se sont révélés positifs pour *Campylobacter coli*, soit un taux de prévalence global de 8,0%. Les taux de prévalence par sexe ont varié de manière significative ($p < 0.05$) entre les 2,3% et les 12,3% enregistrés respectivement pour les mâles et les femelles, tandis que les taux de prévalence déterminés sur base de la race étaient de 4,9% et 10,1% respectivement pour les porcs exotiques et locaux. Les taux de prévalence de 0%, 2,6%, 7,8%, 21,7% et 11,7% notés respectivement pour

les porcs originaires des États d'Abuja, de Kaduna, de Nasarawa, du Niger et du Plateau, ont montré une variation significative ($p < 0.05$). La bactérie *Campylobacter coli* est présente chez les porcs commerciaux de Kafanchan au Nigeria et dans les quatre des cinq États dont les porcs étaient issus. Une hygiène adéquate des mains est recommandée pour les éleveurs, les commerçants et les professionnels vétérinaires s'occupant des porcs afin de prévenir la transmission de cette zoonose à l'homme.

Mots-clés : isolement, caractérisation moléculaire, *Campylobacter coli*, porcs commerciaux, Kafanchan-Nigeria.

Introduction

Campylobacter is a genus of a food-borne pathogen belonging to the bacterial family campylobacteriaceae, which are fastidious, gram negative, non-sporulating, motile, microaerobic and spiral shaped organisms (Vandamme and De-Ley, 1991). They are among the most commonly identified bacterial causes of zoonotic gastroenteritis causing serious morbidity among the young, the aged and the immunocompromised especially in developing countries (Allos, 2001). Infection is acquired via the consumption of meat and meat products especially poultry (Workman *et al.*, 2005), unpasteurized milk and milk products, untreated water and unhygienic handling of animals and their faeces (Danborg *et al.*, 2004; Minihan *et al.*, 2004).

Despite the self-limiting nature of campylobacteriosis (Samuel *et al.*, 2004), mild to severe disease manifesting in watery and bloody diarrhea and abdominal cramps are well documented in man (Skirrow and Blaser, 2000; Janssen *et al.*, 2008) and animals (Bell and Manning, 1990; Young *et al.*, 2000). *Campylobacter* infections can be initiated with as few as 500 organisms with an incubation period of 2-4 days.

Epidemiological evidence has suggested the zoonotic transmission of these pathogens from animals to man especially via the consumption of foods of animal origin (Morgan *et al.*, 1994; Manning *et al.*, 2003; Chu *et al.*, 2004). Recent reports have also indicated an increase in the incidence of *Campylobacter* infections worldwide (Tam *et al.*, 2012; EFSA, 2013).

Campylobacter species are now recognized as major public health issues worldwide due to their association with

diarrhea in people living with HIV/AIDS (Martinez *et al.*, 1994; Molina *et al.*, 1995), antimicrobial resistance (Ternhag *et al.*, 2007; Fabrega *et al.*, 2008) and their ability to trigger Guillain-Barre-Syndrome and reactive arthritis (Hughes and Cornblath 2005). Despite the importance of *C. coli* as a human pathogen due to its increasing trend to greater number of antimicrobial agents (Saenz *et al.*, 2000; Tam *et al.*, 2012) and the reservoir role of pigs to *C. coli* (Harvey *et al.*, 1999; Heuer *et al.*, 2001), there is dearth of information on *Campylobacter* infections in trade pigs in Kafanchan, Nigeria. This study was therefore designed to isolate and characterize *Campylobacter* species from trade pigs which is believed to provide baseline data which will be useful in understanding the epidemiology of campylobacteriosis in pigs in the study area.

Materials and Methods

Study area

This study was carried out in Kafanchan; the head-quarter of Jama'a Local Government Area of Kaduna State. It is located 750 meters above sea level between latitudes 9° and 10°N and longitudes 8° and 9°E. Kafanchan is located within the Tropical Savannah region of Nigeria and is characterized with two distinct seasons namely; dry which runs from November to March and rainy which extends from April to October. The mean annual rainfall, temperatures and humidity are 1524 mm, 25°C and 62% respectively. Kafanchan has a population of 83,093 people, with agriculture as the predominant occupation in the area.

Study design

This was a randomized cross sectional study. Pigs were systematically sampled based

on the arrangement of poles to which they were tied. Every fifth pig was selected based on these arrangements. Sampling was also stratified based on breed, sex, production systems and sources of pigs. Production systems and sources of trade pigs were determined through verbal interviews.

Sample collection

Faecal samples were aseptically collected directly from the rectum of each pig using gloved-fingers. These samples were immediately transferred into universal sample bottles and transported in cooled ice box to the Applied Biotechnology Laboratory of the National Veterinary Research Institute, Vom, Nigeria for analysis.

Isolation of *Campylobacter* on charcoal cefoperazone desoxycholate agar

Faecal samples were streaked onto charcoal cefoperazone desoxycholate agar (CCDA) plates using a loop stick and then incubated at 42°C for two days under microaerophilic condition as described by

Hendriksen et al. (2003). Culture plates with suspected *Campylobacter* were then sub-cultured onto fresh CCDA plates to get pure culture free of contaminants.

Genomic DNA extraction

DNA extraction was done with Chelex 100 resin (CAT No.142-1253; Bio-Rad Laboratories, CA, USA) using the protocol earlier described by Gomley et al. (2008) and the DNA obtained was stored at -80°C until needed for PCR.

PCR amplification of *Campylobacter* DNA

PCR targeting a 439 bp of 16S rRNA fragment from thermotolerant *campylobacters* was carried out in a 25.0 µl reaction volume, with primer sets Cam 220F- 5' GGTGTAGGATGAGACTATATA 3' and Cam 659R- 5' TTCCATCTGCCTCTCCCY 3' using the protocol described by Moreno et al. (2001). The reaction volume contained 0.75 µl of 25 mM MgCl₂ (Fermentas, Canada), 2.5 µl of 5x Green GoTaq reaction buffer (Promega, USA), 0.25 µl of 10 mM dNTP mix (Applied

Table 1: Sex and breed based prevalence of *Campylobacter coli* infections in trade pigs in Kafanchan.

SEX	Number examined	Number positive	Prevalence (%)	p-value (χ^2)	Odds ratio (95% CI)
Females	114	14	12.3	0.0102	5.880
Males	86	2	2.3	(6.601)	(1.299-26.62)
Total	200	16	8.0	-	-
BREED					
Exotic	122	6	4.9	0.045	0.3517
Indigenous	78	10	12.8	(4.037)	(0.1224-1.011)
Total	200	16	8.0	-	-

Table 2: Prevalence of *Campylobacter coli* infections in trade pigs in relation to production systems.

Management practice	Number examined	Number positive	Prevalence (%)	P-value (χ^2)
Extensive	58	8	13.8	-
Intensive	64	3	4.7	0.1447
Semi-intensive	78	5	6.4	(3.867)
Total	200	16	8.0	-

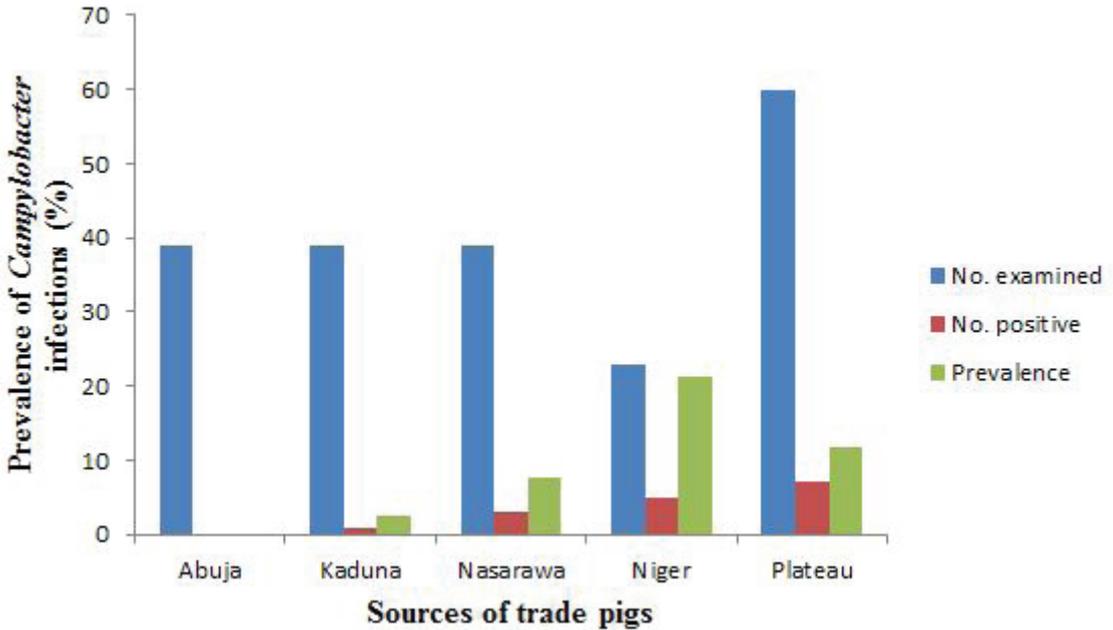


Figure 1: Distribution of *Campylobacter coli* infections based on sources of trade pigs.



Plate 1: Ethidium bromide stained agarose gel showing PCR amplified products of *Campylobacter coli* isolated from trade pigs.

[Lane 1 (100 bp molecular ladder), lanes 2-8, 10, 11 and 13 shows *Campylobacter coli* amplicons at 126 bp, lane 15 (Negative control) and lane 16 (positive control)].

Biosystems, UK), 0.25 µl of GoTaq DNA polymerase (Promega, USA), 0.5 µl of both forward and reverse primers, and 3.0 µl of the extracted *Campylobacter* DNA.

Amplification was done using a Gene Amp PCR system 9700 (Applied Biosystems, UK). The amplification conditions were as follows; pre-denaturation at 95°C for 5 minutes, 30 cycles of denaturation at 95°C for 1 minute,

annealing at 58°C for 1 minute, extension at 72°C for 2 minutes and a final extension at 72°C for 2 minutes. Amplified products were analyzed by electrophoresis in a 1.5% agarose gel at 140 volts for 50 minutes and UV illumination after ethidium bromide staining.

Data analysis

Data generated were analyzed using Graph Pad Prism Version 4.0. Prevalence rates were calculated by multiplying the ratio of infected pigs to total number of pigs examined by 100. This was done for different variables such as age, sex, breeds and origin of pigs. The Chi square test, Fisher's exact test and Odds ratio were employed at 95% confidence interval to test for statistical association between different variables and values of $p < 0.05$ were considered significant.

Results

A total of 200 faecal samples from trade pigs in Kafanchan were analyzed for the presence of *Campylobacter* infections. Of this, 16 were positive for *Campylobacter coli* yielding an overall prevalence of 8.0%. Prevalence in relation to sex varied significantly ($p = 0.0102$, $\chi^2 = 6.601$, OR = 5.880, 95% CI = 1.299-26.62) between the 12.3% and 2.3% recorded by females and males respectively.

There was also significant variation ($p = 0.045$, $\chi^2 = 4.037$, OR = 0.3517, 95% CI = 0.1124-1.011) between the prevalence of 4.9% and 12.8% recorded by exotic and indigenous breeds of pigs. Prevalence rates in relation to management practices were 13.8% for extensively, 4.7% for intensively and 6.4% for semi-intensively managed pigs. The distribution of *C. coli* based on source of trade pigs were 0%, 2.6%, 7.8%, 21.7% and 11.7% for Abuja, Kaduna, Nasarawa, Niger and Plateau States respectively.

Discussion

Campylobacteriosis has become a cosmopolitan food-borne problem and so detecting *Campylobacter coli* among trade pigs in Kafanchan, Nigeria, was not surprising. The prevalence of 8.0% observed in this study is lower than the prevalence of 14.0% (Uaboi-Egbenni *et al.*, 2008) and 92.7% (Gwimi *et al.*, 2015) reported in Nigeria as well as the 32.5% (Kashoma *et al.*, 2015) and 53.7% (Carrique-Mas *et al.*, 2014) reported in Tanzania and Vietnam

respectively. These variations may be as a result of factors including improved hygiene, types of production systems and differences in sensitivity of the techniques of diagnosis as well as levels of environmental contamination. Other factors such as the omnivorous nature of pigs, the consumption of unclean water, undercooked poultry (Workman *et al.*, 2005) and human stool as well as proximity to other livestock (Humphrey, O'Brien and Madson, 2007; Sahin *et al.*, 2015) might have also contributed to the occurrence of these infections.

Pigs have been shown to serve as reservoirs of *Campylobacter coli* (Harvey *et al.* 1999; Heuer *et al.*, 2001). It was therefore not surprising to have detected this specie of *Campylobacter* in this study. The significantly higher prevalence recorded by females over males is in line with the report of Gwimi *et al.* (2015) in Zuru, Kebbi State, Nigeria. This higher prevalence in females may not be unconnected with the stress associated with pregnancy and lactation which usually increases susceptibility of females to infections. Their higher representation in the sample size may be another possible explanation. Indigenous breed also recorded a significantly higher prevalence than the exotic breed probably due poor sanitation and the extensive production system usually employed for the management of this breed.

Scavenging is a common practice among extensively managed animals. This practice usually exposes pigs to the consumption of human excreta and dead animals exposing them to several infections. This may be a possible reason for the higher prevalence observed among the extensively managed pigs. The lowest prevalence observed among intensively managed pigs may be as a result of reduced contact with this pathogen probably due to the confinement associated with this production system. The implication of this finding is that, improved management systems will help in the prevention of this bacterial zoonosis.

The finding of *Campylobacter coli* among pigs from four of the five states where trade pigs were sourced is a possible indication that the risk of acquiring *campylobacteriosis* is wide

spread across Nigeria. This finding also suggests the significance of the study among trade pigs as it provides information on the distribution of *Campylobacter coli* in different locations in Nigeria.

The epidemiological significance this finding is the risk of transmission of this pathogen from pigs to humans as previously reported (Manning *et al.*, 2003; Chu *et al.*, 2004). Though this study did not consider the antimicrobial sensitivity profile of these isolates, but the recent risk of antimicrobial resistance (Ternhag *et al.*, 2007; Fabrega *et al.*, 2008), the ability of these organisms to trigger Gullain-Barre-Syndrome and reactive arthritis (Hughes and Cornblath, 2005) are of great public health concern.

Conclusion

In conclusion, *Campylobacter coli* is prevalent among trade pigs in Kafanchan, Nigeria and is distributed across breeds, sex, production systems and sources of trade pigs. Adequate hand hygiene is recommended for farmers, traders and veterinary professionals handling pigs to curtail the transmission of this bacterial zoonosis to humans.

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Competing interests

The authors declare that there is no any conflicting interest regarding the publication of this article.

References

Allos BM, 2001. *Campylobacter jejuni* Infections: Update on emerging issues and trends. *Clinical Infectious Diseases*, 32: 1201-1206.

Bell JA, and Manning DD, 1990. A domestic ferret model of immunity to *Campylobacter jejuni*-induced enteric disease. *Infection and Immunity*, 58: 1848-1852.

Carrique-Mas JJ, Bryant JE, Cuong NV, Hoang NVM, Campbell J, Dung TTN, Duy DT, Hoa NT, Thompson C, Hien VV, Phat VV, Farrar J, Chu YW, Chu MY, Luey KY, Ngan YW, Tsang KL, and Kam KM, 2004. Genetic relatedness and quinolone resistance of *Campylobacter jejuni* strains isolated in 2002 in Hong Kong. *Journal of Clinical Microbiology*, 42: 3321-3323.

Danborg P, Olsen KEP, Nielsen EM, and Guardabassi, L, 2004. Occurrence of *Campylobacter jejuni* in pets living with human patients infected with *C. jejuni*. *Journal of Clinical Microbiology*, 42(3): 1363-1364.

European Food Safety Agency, 2013. The European Union summary report on trends and sources of zoonoses, zoonotic agents and foodborne outbreaks in 2011. *European Food Safety Agency Journal*, 11(4): 3129.

Fàbrega A, Sánchez-Céspedes J, Soto S, and Vila J, 2008. Quinolone resistance in the food chain. *International Journal of Antimicrobial Agents*, 31(4): 307-315. doi:10.1016/j.ijantimicag.2007.12.010. PMID 18308515.

Gomley FJ, 2008. Has retail chicken played a role in the decline of human *campylobacteriosis*? *Applied Environmental Microbiology*, 74: 383-390.

Gwimi PB, Faleke OO, Salihu MD, Magaji AA, Abubakar MB, Nwankwo IO, Ibitoye EB, 2015. Prevalence of *Campylobacter* species in faecal samples of pigs and humans from Zuru Kebbi State, Nigeria. *International Journal of One Health*, 1: 1-5.

Harvey RB, Young CR, Ziprin RI, Hume ME, Eenovese KJ, Anderson RC, Droleskey RE, Stanker IH, Nisbet DJ, 1999. Prevalence of *Campylobacter* species isolated from the intestinal tract of pigs raised in an integrated swine production system. *Journal of American Veterinary Medical Association*, 215: 1601-1604.

Hendriksen RS, Wagenaar J, and Van-Bergen M, 2003. Isolation of thermo-tolerant *Campylobacter* from faeces. *Laboratory Protocols*, 3: 57-66.

- Heuer OE, Pedersen K, Anderso JS, Madsen M, 2001. Prevalence and antimicrobial susceptibility of thermophilic *Campylobacter* in organic and conventional broiler flocks. *Applied Microbiology*, 33: 269-274.
- Hughes RA, Cornblath DR, 2005. Guillain-Barre syndrome. *Lancet*, 366: 1653-1666.
- Humphrey T, O'Brien S, Madsen M, 2007. *Campylobacters* as zoonotic pathogens: a food production perspective. *International Journal of Food Microbiology*, 117: 237-257. doi:10.1016/j.ijfoodmicro.2007.01.006.
- Janssen R, Krogfelt AK, Cawthraw SA, Van-Pelt W, Wagenaar JA, Owen RJ, 2008. Host-pathogen interactions in *Campylobacter* infections: the host perspective. *Clinical and Microbiological Review*, 21(3): 505-518. doi: 10.1128/CMR.00055-07.
- Kashoma IP, Kassem II, Kumar A, Kessy BM, Gebreyes W, Kazwala RR, Rajashekara G, 2015. Antimicrobial resistance and genotypic diversity of *Campylobacter* isolated from pigs, dairy, and beef cattle in Tanzania. *Frontiers in Microbiology*, 6: 1240. doi: 10.3389/fmicb.2015.01240.
- Manning, G, Dowson CG, Bagnall MC, Ahmad IH, West M, Newell DG, 2003. Multilocus sequence typing for comparison of veterinary and human isolates of *Campylobacter jejuni*. *Applied and Environmental Microbiology*, 69: 6370-6379.
- Martínez RM, Figueras MP, Ramos C, Sanjuán F, Aguirre JM, 1994. *Campylobacter jejuni* and HIV infection. *Enfermedades Infecciosas y Microbiología Clínica*, 12(2): 90-94.
- Minihan D, Whyte P, O'Mahony M, Fanning S, McGill K, Collins JD, 2004. *Campylobacter* spp. in Irish feedlot cattle: A longitudinal study involving pre-harvest and harvest phases of the food chain. *Journal of Veterinary Medicine*, 51: 28-33.
- Molina J, Casin I, Hausfater P, Giretti E, Welker Y, Decazes J, Garrait V, Lagrange P, Modai J, 1995. *Campylobacter* infections in HIV-infected patients: clinical and bacteriological features, *AIDS*, 9(8): 881-885.
- Moreno Y, Hernández M, Ferrús MA, Alonso JL, Botella S, Montes R, Hernández J, 2001. Direct detection of thermotolerant *campylobacters* in chicken products by PCR and in situ hybridization. *Research in Microbiology*, 152: 577-582.
- Morgan D, Gunneberg C, Gunnell D, Healing TD, Lamerton S, Soltanpoor N, Lewis DA, White DG, 1994. An outbreak of *Campylobacter* infection associated with the consumption of unpasteurized milk at a large festival in England. *European Journal of Epidemiology*, 10: 581-585.
- Saenz Y, Zarazaga M, Lentero M, Gastanares MJ, Baquero F, Torres C, 2000. Antibiotics resistance in *Campylobacter* strains isolated from animals, foods and humans in Spain in 1997-1998. *Antimicrobial Agents and Chemotherapy*, 44: 267-271.
- Sahin O, Kassem II, Shen Z, Lin J, Rajashekara G, Zhang Q, 2015. *Campylobacter* in poultry :ecology and potential interventions. *Avian Diseases*, 59: 185-200. doi: 10.1637/11072-032315.
- Samuel MC, Vugia DJ, Shallow S, Marcus R, Segler S, McGivern T, Kassenborg H, Reilly K, Kennedy M, Angulo F, Tauxe RV, 2004. Epidemiology of sporadic *Campylobacter* infection in the United States and declining trend in incidence, *FoodNet 1996-1999*. *Clinical Infectious Diseases*, 38(3): S165-S174.
- Skirrow MB, Blaser MJ, 2000. Clinical aspects of *Campylobacter* infection, In: I. Nachamkin and M. J. Blaser (ed.), *Campylobacter*, 2nd ed. ASM Press, Washington, DC, pp. 69-88.
- Tam CC, Rodrigues LC, Viviani L, Dodds JP, Evans MR, Hunter PR, Gray JJ, Letley LH, Rait G, Tompkins DS, O'Brien SJ, 2012. Longitudinal study of infectious intestinal disease in the UK (IID2 study): incidence in the community and presenting to general practice. *Gut*, 61(1): 69-77.
- Ternhag A, Asikainen T, Giesecke J, Ekdam K, 2007. A meta-analysis on the effects of antibiotic treatment on duration of symptoms caused by infection with *Campylobacter* species. *Clinical Infectious Diseases*, 44(5): 696-700. doi:10.1086/509924. PMID 17278062.
- Uaboi-Egbenni PO, Okolie PN, Adesanya OD, Omonigbehin E, Sobande AO, 2008. Epidemiological studies of the incidence of pathogenic *Campylobacter* spp. amongst animals in Lagos metropolis, *African Journal of Biotechnology*, 7(16): 2852-2956.

Vandamme P, De-Ley J, 1991. Proposal for a new family *Campylobacteraceae*. International Journal of Systematic Bacteriology, 41: 451-455.

Workman, SN, Mathison GE, Lavoie MC, 2005. Pet dogs and chicken meat as reservoirs of *Campylobacter* species in Barbados. Journal of Clinical Microbiology, 43: 2642-2650.

Young VB, Schauer DB, Fox JG, 2000. Animal models of *Campylobacter* infection, In: I. Nachamkin and M. J. Blaser (ed.), *Campylobacter*, 2nd ed. ASM Press, Washington, DC, pp. 287-302.

GROWTH PERFORMANCES AND CARCASS CHARACTERISTICS OF CAVIES SUPPLEMENTED WITH ASTERACEAE OR AN ENRICHED PROTEIN RATION

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Abstract

An 8 week trial to evaluate the effect of supplementation with Asteraceae or a protein enriched ration on the growth performances and carcass characteristics of cavies was conducted at the Teaching and Research Farm (FAR) of the University of Dschang. Prior to the experimental phase a two weeks acceptability trial was conducted to select two best asteraceae from *Galinsoga*, sp, *Bidens pilosa* and *Ageratum conyzoides*. The two best legumes were used in the feeding trial. 96 young cavies (48 males and 48 females) from two Regions of Cameroon (West and North-West), were randomly distributed in a 3x2x2 factorial design according to diet, sex and origin. The experimental diets constituted of *Penisetum clandestinum* + basic diet (T0), *Penisetum clandestinum* + *Galinsoga* sp + *Bidens pilosa* (T1), and *Penisetum clandestinum* + proteins enriched ration (T2). Results from the acceptability trial indicated that *Galinsoga* sp was significantly ($P<0.05$) more palatable followed by *Bidens pilosa*. This results formed the basis for inclusion of treatment T1 in the feeding trial. Results from the feeding trial showed that supplementation with Asteraceae (T1) significantly ($P<0.05$) increased feed consumption (181.07 ± 10 and 194.48 ± 6.02 g for animals collected from North West and West Regions respectively). Feeding with Asteriaceae (T1) was also associated with a higher feed conversion ratio (7.59 ± 0.24 and 8.24 ± 0.31 for North West and West respectively) as compared with T0 and T2. The same trend was observed for T1 in live body weight (327.70 ± 42.62 and 303.75 ± 22.52 g), weight gain (2.08 ± 0.40 , 1.92 ± 0.68 g) and carcass yield (42.35 ± 4.12 and $44.38\pm 2.07\%$) for animals coming from the North West and West Regions respectively. However, no significant differences were observed between the treatments for these parameters although feeding with Asteraceae had higher values. It can be concluded from this study, that Asteraceae can be valorized in feeding for growing cavies.

Keywords: Asteraceae, Cameroon, cavies, proteins, supplementation, weight gain

PERFORMANCES DE CROISSANCE ET CARACTERISTIQUES DES CARCASSES DES COBAYES RECEVANT UN SUPPLEMENTES AUX ASTERACEES OU UNE RATION ENRICHIE DE PROTEINES

Résumé

Un essai de 8 semaines visant à évaluer l'effet de la supplémentation aux astéracées ou une ration enrichie en protéines sur les performances de croissance et les caractéristiques des carcasses des cobayes a été réalisé à la Ferme d'Application et de recherche (FAR : Teaching and Research Farm) de l'Université de Dschang. Avant la phase expérimentale, un essai d'acceptabilité de deux semaines a été réalisé pour sélectionner deux meilleures astéracées entre *Galinsoga*, sp, *Bidens pilosa* et *Ageratum conyzoides*. Les deux meilleures légumineuses ont été utilisées dans l'essai alimentaire. 96 jeunes cobayes (48 mâles et 48 femelles) issus de deux régions du Cameroun (Ouest et Nord-Ouest) ont été répartis de manière aléatoire dans un schéma factoriel 3x2x2 sur base du régime, du sexe et de l'origine. Les régimes expérimentaux étaient constitués de *Penisetum clandestinum* + régime de base (T0) ; *Penisetum clandestinum* + *Galinsoga* sp + *Bidens pilosa* (T1) ; et *Penisetum clandestinum* + ration enrichie de protéines (T2). Les résultats de l'essai d'acceptabilité ont indiqué que *Galinsoga* sp était significativement ($P<0.05$) plus appétée, suivi de *Bidens pilosa*. Ces résultats ont été utilisés comme base pour l'inclusion du Traitement T1 dans l'essai

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alimentaire. Les résultats de l'essai alimentaire ont montré que la supplémentation aux astéracées (T1) a significativement ($P < 0,05$) augmenté la consommation des aliments ($181,07 \pm 10$ et $194,48 \pm 6,02$ g pour les animaux issus respectivement des régions Nord-Ouest et Ouest). L'alimentation aux astéracées (T1) a été également associée à un indice de consommation alimentaire élevé ($7,59 \pm 0,24$ et $8,24 \pm 0,31$ respectivement pour le Nord-Ouest et l'Ouest) par rapport aux T0 et T2. La même tendance a été observée pour le traitement T1 au niveau du poids vif ($327,70 \pm 42,62$ et $303,75 \pm 22,52$ g), du gain pondéral ($2,08 \pm 0,40$; $1,92 \pm 0,68$ g) et du rendement en carcasse ($42,35 \pm 4,12$ et $44,38 \pm 2,07\%$) respectivement pour les animaux originaires du Nord-Ouest et de l'Ouest. Cependant, aucune différence significative n'a été observée entre les traitements pour ces paramètres même si l'alimentation aux astéracées a produit des valeurs plus élevées. L'on peut conclure sur la base de cette étude que les astéracées peuvent être valorisées dans l'alimentation des cobayes en croissance.

Mots-clés: astéracées, Cameroun, cobayes, protéines, supplémentation, gain pondéral

Introduction

Feed availability and feed quality remain the most important constraints in cavy breeding (Nuwanyakpa *et al.*, 1997; Pamo *et al.*, 2005; Bindelle *et al.*, 2007a; Metre, 2011; Niba *et al.*, 2012). This situation can be due to scarcity of essential protein sources for a good growth, and to a long dry season resulting in poor quality forages. Cavies usually feed on grasses (Gramineae), kitchen wastes and crop residues which are sometimes poor in essential nutrients such as proteins and minerals (Kouommenioc *et al.*, 2000; Bindelle *et al.*, 2007b; Kouakou *et al.*, 2012). With this low nutrient intake the nutritional needs of the cavy will not be covered and thus the productivity that ensues is somehow mediocre (Niba *et al.*, 2004). To increase the protein content of the ration and to optimize feed utilization, grasses can be associated with legumes or compound diet (Kouommenioc *et al.*, 2000; Pamo *et al.*, 2005; Kenfack *et al.*, 2006) which is not usually practiced by cavy farmers in the rural landscape. It has been demonstrated that some vegetables such as Galinsoga sp, Bidens pilosa, Ageratum conyzoides, Crassocephalum sp, belonging to the family of Asteraceae could be important sources of protein especially in the dry season (Nguizani, 2001; Metre, 2012; Katunga *et al.*, 2012; Bacigale *et al.*, 2013) for cavies and rabbits. However, these legumes have not been used for cavies in Cameroon. Although the use of concentrate diets has been researched as an alternative to poor nutrition of cavies (Niba *et al.*, 2004; Zougou, 2013) in Cameroon, these

feeds have low levels of protein which may not permit the cavies to meet their nutritional needs for growth. The objective of this study is to investigate the growth performance of Cavies fed Asteraceae as a protein supplement compared with a proteins enriched ration as reflected by the origin of the cavies.

Materials and methods

Experimental site

The study was carried out from May to July 2013 at the Teaching and Research Farm of the University of Dschang ($5^{\circ} 26'$ North Latitude, $10^{\circ} 26'$ East Longitude, and 1420 m altitude). The climatic characteristics of the study site have been described by Kenfack *et al.*, (2006). The climate is the Sudano-Guinean type and mean annual temperatures range between 10°C from July to August with highs of 25°C in February. The annual sunshine is 1800 hours and relative humidity ranging from 40-97 %. Rainfall varies between 1500 and 2000 mm per year. The dry season is from mid -November to mid-March and the rain season from mid -March to mid -November.

Trial management

Feeding trial

32 young cavies (16 from the North West and 16 from the West of Cameroon) were randomly distributed according to a factorial design including two populations (NW and W), two sexes and three replicates. These animals were provided 150 g each of three

asteraceae species (*Galinsoga* sp., *Bidens pilosa* and *Ageratum conyzoides*) for a period of two weeks to adapt the cavies to the new forages and determine their feeding preferences. Prior to feeding the forages were wilted for 24 h. The daily feed intake (on DM basis g/day) was evaluated. Based on the results two forages which were more palatable were incorporated in the feeding trial to evaluate their effect on cavy growth.

Evaluation of growth performances and carcass characteristics

96 young cavies aged 30 days with mean weight of 200.21 ± 14.56 g were randomly distributed in a factorial design (two populations, two sexes and three experimental diets) with three replicates per factor. The experimental diets fed during the 8 weeks trial were as follows: T0: Pennisetum clandestinum + a basal diet (18% Crude Protein), T1: Pennisetum clandestinum + *Galinsoga* sp + *Bidens pilosa*, T2: Pennisetum clandestinum + a ration enriched in protein (24.18% Crude Protein). The quantity of concentrate diets were pegged at 5% of the body weight. The proximate chemical composition of the basal and test diets determined according to the methods described by A.O.A.C (1990) is shown on table 1.

Animals were housed in identical plywood cages of 0.6 by 0.4m corresponding to a space allocation of 0.06 m² per animal. Animals were fed ad libitum and cages were cleaned daily. Live weight measurements were made weekly for males and females while feed consumed was measured indirectly by weighing

the feed given and the leftovers. At the end of the 8 week trial, 48 cavies (4 for each sex, origin and treatment) were fasted for a period of 12 hours and slaughtered by cervical dislocation for carcass evaluation and relative organ weights.

Data analysis

Data were subjected to analysis of variance (ANOVA) according to the factorial design earlier described. Significant means were separated using the Turkey's HDS test at 5 % level of probability. The statistics software used was RGue 3.0.2

Results

Acceptability and feeding trial

Results showed that independent of cavy origin or sex, the mean daily consumption of *Galinsoga* sp was significantly ($P < 0.05$) higher than *Bidens pilosa* and *Ageratum conyzoides*. The consumption of *Bidens pilosa* was also significantly higher ($P < 0.05$) than the value for *Ageratum conyzoides*. When the origin of the cavies was considered, the consumption of *Galinsoga* sp by cavies originating from the North West was significantly higher than values of Cavies from the West. However, cavies from these two regions consumed *Bidens pilosa* and *Ageratum conyzoides* in a similar non-significant manner ($P > 0.05$).

Apart from the origin and sex, the daily feed consumption of animals supplemented with Asteraceae (T1) during the feeding trial was significantly ($P < 0.05$) higher than the consumption of the other two groups (T0 and

Table 1: Chemical composition of diets used

Samples	Dry Matter DM(%)	Crude Protein (%DM)	Lipids (%DM)	Crude fiber (%DM)	Ash (%DM)	EM (Kcal/Kg DM)
<i>P. clandestinum</i>	93.77	12.76	3.66	26.03	16.09	1184.56
<i>Galinsoga</i> sp.	87.78	18.92	4.23	24.24	20.65	1187.72
<i>Bidens pilosa</i>	90.24	18.48	4.85	24.06	15.47	1448.91
Basal diet	9637	18.97	7.40	15.47	7.76	2664.55
Protein enriched ration	95.41	24.18	8.01	14.31	6.80	2839.55

Table 2: Mean Daily feed consumption (gDM) of *Galinsoga sp.*, *Bidens pilosa* and *Agerantum conysoidens*

Origin	Sex	<i>Galinsoga sp</i>	<i>Bidens pilosa</i>	<i>Agerantum conysoidens</i>
NW	□	37.50±0.86 ^a	23.97±4.27 ^b	13.04±4.6 ^c
	□	38.69±0.50 ^a	18.27±1.08 ^b	11.75±1.72 ^c
	□□	38.10±0.68 ^{aA}	16.04±2.67 ^{bA}	12.40±3.16 ^{cA}
W	□	29.20±0.33 ^a	13.81±0.19 ^b	9.22±2.26 ^c
	□	34.23±3.06 ^a	15.67±5.46 ^b	10.91±0.89 ^c
	□□	31.71±2.70 ^{aB}	14.74±2.83 ^{bA}	10.06±1.58 ^{cA}

^{a,b,c}: Means bearing the different letter in the same row are significantly different ($P<0.05$). A,B : Means(□□) bearing the different letter in the same column are significantly different ($P<0.05$). NW : North West, W : West

Table 3: Growth performance of cavies supplemented with asteraceae or a protein enriched ration

Parameters	Origin	Sex	Rations		
			T0	T1	T2
Mean daily intake (g DM)	NW	□	57.85±9.42 ^a	186.75±5.67 ^b	66.29±7.24 ^a
		□	62.45±15.50 ^a	175.39±16.19 ^b	73.82±5.32 ^a
		□□	60.15±12.46 ^a	181.07±10.94 ^b	70.05±6.27 ^a
	W	□	61.97±7.86 ^a	219.52±6.44 ^b	52.04±6.29 ^a
		□	50.34±1.76 ^a	169.44±5.61 ^b	50.32±5.95 ^a
		□□	56.15±4.81 ^a	194.48±6.02 ^b	50.32±5.32 ^a
Live weight(g)	NW	□	278.87±29.90	335.12±54.13	322.00±51.77
		□	279.50±41.90	330.37±31.10	302.87±28.69
		□□	279.18±35.90	327.70±42.62	312.43±40.23
	W	□	283.25±36.55	307.25±17.83	299.37±26.25
		□	286.62±19.44	300.25±27.22	298.87±16.82
		□□	284.93±28.00	303.75±22.52	299.12±21.53
Mean weight gain (g)	NW	□	1.33±0.36	1.94±0.53	1.55±0.65
		□	1.64±0.57	2.23±0.27	1.87±0.41
		□□	1.48±0.47	2.08±0.40	1.71±0.53
	W	□	1.78±0.81	1.98±0.73	1.82±0.68
		□	1.58±0.61	1.85±0.62	1.80±0.37
		□□	1.68±0.71	1.92±0.68	1.81±0.53
Feed conversion ratio	NW	□	1.85±0.14 ^a	7.13±0.34 ^b	2.80±0.21 ^c
		□	2.29±0.10 ^a	8.06±0.13 ^b	3.94±0.35 ^c
		□□	2.07±0.12 ^{aA}	7.59±0.24 ^{bA}	3.41±0.28 ^{cA}
	W	□	2.38±0.22 ^a	9.86±0.30 ^b	2.05±0.28 ^a
		□	1.81±0.89 ^a	6.64±0.32 ^b	1.94±0.32 ^a
		□□	2.09±0.56 ^{aA}	8.25±0.31 ^{bA}	2.00±0.30 ^{aB}

^{a,b,c}: Means bearing the different letter in the same row are significantly different ($P<0.05$). A,B : Means(□□) bearing the different letter in the same column are significantly different ($P<0.05$). NW : North West, W : West. T0=P.clandestinum+ basal diet, T1 = P.clandestinum +Galinsoga sp and Bidens Pilosa, T2= P.clandestinum + protein enriched ration

Table 4: Carcass characteristics of cavies supplemented with asteraceae or a proteins enriched ration

Parameters	Origin	Sex	Rations		
			T0	T1	T2
Slaughtering weight (g)	NW	□	324.5±47.93	332.5±57.33	326.25±52.63
		□	270.25±47.54	325.75±19.63	306.00±14.02
		□□	297.37±47.73	329.12±43.49	316.12±38.32
	W	□	271.75±18.74	271.00±12.10	311.00±8.08
		□	260.75±31.35	268.00±18.11	242.75±36.53
		□□	266.25±25.04	269.50±15.10	276.87±22.30
Carcass weight (g)	NW	□	131.25±28.44	143.25±44.58	133.25±27.65
		□	91.00±34.46	138.75±14.97	118.25±14.5
		□□	111.12±31.45	141.00±29.78	125.75±21.07
	W	□	110.00±16.00	123.25±11.29	134.00±1.15
		□	102.00±19.73	106.25±11.92	89.00±20.29
		□□	106.00±17.86	114.75±11.60	111.50±10.71
Head weight (g)	NW	□	41.50±6.45	43.5±7.93	39.5±4.35
		□	34.00±6.68	42.00±5.29	39.00±2.44
		□□	37.75±6.56	42.75±5.29	39.25±3.40
	W	□	35.50±2.69	37.75±1.86	43.00±0.00
		□	34.25±1.70	38.00±4.69	33.5±3.78
		□□	34.87±2.20	37.87±3.27	38.25±1.89
Dressing pourcentage (%)	NW	□	40.08±3.24 ^a	42.19±6.04 ^a	40.77±1.89 ^a
		□	34.33±13.99 ^a	42.50±2.21 ^a	38.55±3.24 ^a
		□□	37.21±8.62 ^a	42.35±4.12 ^a	39.66±2.56 ^a
	W	□	39.94±2.66 ^a	49.18±1.99 ^b	43.11±1.49 ^a
		□	38.86±3.14 ^a	39.57±2.15 ^a	36.33±2.91 ^a
		□□	39.40±3.04 ^{ab}	44.38±2.07 ^b	39.74±2.20 ^a

a,b,c :Means bearing the different letter in the same row are significantly different ($P<0.05$) A,B : Means(□□)bearing the different letter in the same column are significantly different ($P<0.05$). NW : North West, W : West. T0=P.clandestinum+ basal diet, T1 = P.clandestinum +Galinsoga sp and Bidens Pilosa, T2= P.clandestinum + protein enriched ration

T2). Indeed, consumption of animals in the T1 was about triple that recorded in T0 and T2 treatments (Table 3).

Body weight and daily weight gain

There were no significant differences ($P< 0.05$) observed between the treatments for final live weights and mean daily weight gain for cavies irrespective of their origin and sex (Table 3). However, supplementation with Asteraceae or proteins enriched ration tended to increase body weight and daily weight gain. Meanwhile feeding with Asteraceae induced

the highest numerical body weight and daily weight gain. In terms of origin, the body weight and daily weight gain observed with animals from the North West Cameroon was higher.

Feed conversion ratio

Results showed that the supplementation increased the feed conversion ratio (table 3). Feed conversion ratio of T1 and T2 were significantly ($P < 0.05$) higher than T0 (2.07 ± 0.12). However, the feed conversion ratio of T1 ration recorded the highest values which were 8.25 ± 0.31 for the West and 7.59

Table 5: Gut characteristics of cavies supplemented with asteraceae or a proteins enriched ration

Parameters	Origin	Sex	Rations		
			T0	T1	T2
Viscera weight (g)	NW	□	114.00±17.6	103.25±9.70	106.00±14.0
		□	96.75±10.14	103.50±10.21	107.00±11.69
		□□	105.37±13.87	103.37±9.96	106.5±12.88
	W	□	94.75±3.24	91.5±1.70	105.00±3.46
		□	97.00±7.70	94.75±4.27	93.75±6.18
		□□	95.87±5.47	93.12±2.99	99.37±4.82
Liver weight(g)	NW	□	10.75±3.30 ^a	12.75±3.20 ^a	10.75±1.5 ^a
		□	7.75±2.21 ^a	12.00±1.41 ^b	9.75±0.75 ^{ab}
		□□	9.25±2.76 ^a	12.37±2.30 ^a	10.25±1.22 ^a
	W	□	7.75±1.48 ^a	11.25±1.18 ^b	8.5±0.57 ^a
		□	7.00±1.63 ^a	11.75±0.95 ^b	6.25±2.87 ^a
		□□	7.37±1.55 ^a	11.50±1.06 ^b	7.37±1.72 ^a
Small intestinal density (g/cm)	NW	□	0.10±0.01	0.10±0.01	0.10±0.02
		□	0.07±0.01	0.10±0.02	0.11±0.00
		□□	0.08±0.01	0.10±0.01	0.10±0.01
	W	□	0.10±0.02	0.10±0.01	0.10±0.01
		□	0.08±0.03	0.09±0.01	0.10±0.01
		□□	0.10±0.02	0.09±0.01	0.10±0.01
Caecal weight (g)	NW	□	53.00±6.48 ^a	39.00±3.16 ^b	52.00±4.54 ^a
		□	46.75±6.39 ^a	40.00±5.59 ^a	46.5±7.50 ^a
		□□	49.87±6.43 ^{aA}	39.50±4.37 ^{bA}	49.25±6.02 ^{aA}
	W	□	43.75±3.84 ^a	38.25±4.10 ^a	42.0 ±3.42 ^a
		□	47.50±6.60 ^a	37.00±1.41 ^b	45.75±6.65 ^a
		□□	45.62±5.22 ^{aA}	37.62±2.75 ^{aA}	43.87±5.05 ^{aA}

a,b,c :Means bearing the different letter in the same row are significantly different (P<0.05) A,B : Means(□□)bearing the different letter in the same column are significantly different (P<0.05). NW : North West, W :West.T0=P.clandestinum+ basal diet,T1= P.clandestinum +Galinsoga sp and Bidens Pilosa,T2= P.clandestinum + protein enriched ration

± 0.24 for the North West. There were no significant differences between these values for treatment T0 and T1. For ration T2, feed conversion ratio of animals from the North West was significantly (P < 0.05) higher (3.41 ± 0.28) than that of animals from the West (2.00 ± 0.30).

Carcass and gut characteristics

The results of carcass and gut characteristics are presented on table 4. Irrespective of origin, sex and diet, supplementation had no significant effect (P

>0.05) on the slaughtering and the carcass weights. However, animals of T1 recorded the highest values for these parameters (329.12 ± 43.49 and 141.00 ± 29.78 respectively).

When the origin was considered, there were no significant differences (P > 0.05) in carcass yield for animals from the North West. For animals from the West, carcass yields of T1 animals (44.38 ± 2.07) irrespective of the sex were significantly (P < 0.05) higher than that of T2 and comparable to that of lot T0 (P > 0.05). No significant differences (P> 0.05) were observed for the total weight of the viscera,

and the density of the gut whatever the origin, sex and ration (Table 5). In the case where origin was considered no significant difference ($P > 0.05$) was observed on the liver weight for animals of the North West although the Asteraceae diet tended to increase it. However for those from the West, the liver weight of T1 animals (which had received Asteraceae) was significantly ($P < 0.05$) higher (11.50 ± 1.06) than those of T0 (7.37 ± 1.55) and T2 (7.37 ± 1.72) for all the sexes. Supplementation with *Galinsoga* sp and *Bidens pilosa* (ration T1) decreased significantly ($P < 0.05$) the weight of the caecum of animals from the North West but for those from the West however, there were no significant differences ($P > 0.05$) for this parameter (Table 5).

Discussion

The mean daily consumption of *Galinsoga* sp, independent of sex and origin, was significantly higher than that obtained with *Bidens pilosa* and *Ageratum conyzoides* indicating a good palatability of *Galinsoga* sp for cavies. This is due to the fact that *Galinsoga* sp is a tender grass, all aerial parts are easily consumed. The palatability of *Galinsoga* sp has also been observed for small ruminants in Ethiopia (Belete *et al.*, 2011). The lesser preference for *Bidens* and *Ageratum* may be related to their physical characteristics and perhaps the presence of anti-nutritional factors in these plants (Alonza and Hilderband, 1999; Del-Vechio-Vieira *et al.*, 2009). These results are in disagreement with those reported by Katunga *et al.*, (2012) who observed a high preference for *Ageratum conyzoides* compared with *Bidens pilosa*, *Desmodium intortum* and *Canavalia brasiliensis* for cavies and rabbits.

The mean daily dry matter (DM) intake of cavies which received Asteraceae (T1) was significantly ($P < 0.05$) higher compared with those of T0 and T2, irrespective of the sex and origin. This can be explained by the fact that the T1 diet constituted of only forages has a lower concentration in essential nutrients therefore the animals are therefore obliged

to consume more to cover their needs. Increased intake of the ration T1 confirmed that good forage supplementation providing the missing nutrients allows micro-organisms in the caecum to digest better. This may be due to rapid fermentation of the forage leading to low congestion of the caecum and reduction in intestinal transit time (Sakaguchi *et al.*, 1997; Kouakou *et al.*, 2010). These results are in agreement with the observations of Kouonmenioc *et al.*, (2000) and Kenfack *et al.*, (2006) who argued that in order to optimize the use of energy rich grasses in cavy nutrition, it is important to provide supplements. Mean daily feed intake for both sexes obtained in T1 (187.77 ± 8.49 g) was superior to the value of 115.80 ± 6.70 g obtained by Egena *et al.*, (2010). The main daily feed intake was three times the figure obtained by Kouakou *et al.*, (2010) and Zougou (2013) which were 45.7 ± 16.30 g and 59.97 ± 3.97 g, respectively. In addition to a basal forage diet, a ration with surplus of energy and protein was provided for the cavies in the studies of these authors. However, the DM intake obtained in the T0 and T2 are comparable ($P > 0.05$) with those obtained by them.

Supplementation with Asteraceae or protein enriched ration did not induce a significant effect ($P > 0.05$) on body weight and daily weight gain of cavies although supplementation tended to increase both parameters. Body weight and daily weight gain for T1 is correlated with high feed consumption observed in this treatment. The increase of these parameters is also associated with a better utilization of forage. Furthermore, the increase observed in T2 (animals supplemented with proteins enriched ration) is due to its protein content, which could lead to a good muscle development. The results of body weight and daily weight gain are in agreement with the results obtained by other authors (Kouakou *et al.*, 2010; Egena *et al.*, 2010 and Bacigale *et al.*, 2013) using a variety of forages and agro-industrial by-products. Supplementation of basal grass diet with *Euphorbia hererophylla* or cotton seed cake (Kouakou *et al.*, 2010) or with a ration rich in protein (Egena *et al.*, 2010)

or with *Bidens pilosa* and *Crassocephalum vitelinum* (Bacigale *et al.*, 2013) did not have any significant effect on growth. The values for body weight and daily weight gain obtained in this study were higher than those obtained by Niba *et al.* (2004) but lower than those obtained by Pamo *et al.* (2005) and Zougou (2013). This difference is related to the source and the proportion of protein supplements used by these authors (multinutrient block -37.43 % CP and *Titonia diversifolia*-21% in 2005 and 2013 respectively).

The feed conversion ratio significantly ($P < 0.05$) increased with supplementation of Asteraceae or the proteins enriched ration. The treatment supplemented with the Asteraceae (T1) recorded a higher feed conversion ratio (7.59 ± 0.24 and 8.25 ± 0.31 for North West and West regions respectively) compared with T0 (2.07 ± 0.12 and 2.09 ± 0.56 for North West and West regions respectively) and T2 (3.41 ± 0.28 and 2.00 ± 0.30 for North West and West regions respectively). This increase was due to the lower energy content of the diet made of forages compared with the protein enriched diet. This can also be a consequence of increased feed intake without a proportional increase in weight gain of animals. The results obtained in this work for feed conversion ratio in ration T1 are comparable with 6.88 ± 0.11 obtained for cavies fed with *Bidens pilosa* and *Digitaria vestida* (Bacigale *et al.*, 2013). It is also comparable with the 6.72 ± 2.91 for animals fed with *Tridax procumbens* as basal diet and compound diet as supplement (Egena *et al.*, 2010). The feed conversion ratio values obtained with T2 ration are better compared with those obtained by Niba *et al.*, (2004) who recorded feed conversion ratio ranging from 11.88 to 23.65 with a protein content ranging from 24.1 to 28.8% CP

In this study supplementation had no significant effect ($P > 0.05$) on the slaughter weight, carcass weight and dressing percentage, whatever the sex or origin. These results are similar to those obtained by Niba *et al.*, (2004) and Zougou (2013) who observed no significant effect ($P > 0.05$) on the slaughter weight, the carcass weight and dressing percentage,

independent of the type of supplement.

A significant effect ($P < 0.05$) of feeding Asteraceae on liver weight was only observed in animals originating from the West region irrespective of the sex. A higher liver weight for T1 could indicate a toxicity in feeding with Asteraceae. Similar observations were made in cavies fed with cotton seed cake and *Titonia diversifolia* (Niba *et al.*, 2004; Zougou, 2013). The values observed in this study are higher than those reported by Niba *et al.* (2004) who recorded a liver weight ranging between 9.64 and 10.60 g.

The density of the small intestine was not significantly ($P > 0.05$) affected by diets. However, the densest intestine was observed with females from North West supplemented with the protein enriched ration. These values are similar to those reported by Niba *et al.*, (2004) but higher than those recorded by Zougou (2013). The caecal weight of cavies from the North West was significantly ($P < 0.05$) decreased by Asteraceae supplementation although they are known to be rich in fiber. The significant decrease in caecal weight with Asteraceae feeding is in disagreement with the observations of Niba *et al.*, (2004), who argued that the caecum, which is the main site of digestion of cellulose, increased in weight along dietary fiber content. However, Zougou (2013) observed no significant effect on caecal weight with *T. diversifolia* as supplement.

Conclusion

It can be deduced from this study that Asteraceae can be used as supplement and be valorized as well as a compound diet to improve forage based diets for growing cavies. These legumes can be used by farmers to reduce dependence on costly feed supplements as it is available in nature even during the dry season when conventional forages are hard to find. It could also be necessary to evaluate the anti-nutrient factors in this forages.

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References

- Alonzo DS, Hildebrand JW, 1999. Bidens L. In: de Padua LS, Bunyaphatsara, N & Lemmens, RH (Editors). Plant Resources of South-East Asia 12 (1). Medicinal and poisonous plants I. Backhuys Publishers, Leiden, Netherlands, Pp:150–155.
- A.O.A.C (Association of Official Analytical Chemist), 1990. Official methods of analysis. 15ed. Washington.
- Bacigale B, Ayagirwe B R, Mulemangabo L, Puchu C Maass BL, 2013. Effects of supplementing waste soybeans or palm kernel cake in usual diet combinations on the utilization of dry-season forages by growing cavies in Kabare territoire of Sud-Kivu province, DR Congo. In proceedings TSAP Conference Arusha, Tanzania , 22-25 October, 2013
- Belete S, Abubeker H, Abule E, Tadese A, Nura A, 2011. Identification of potential untapped herbaceous flora in the mid rift valley of Ethiopia and their nutritive value. African Journal of Agricultural Research 6 (17):4153-4158.
- Bindelle J, Ilunga Y, Delacollette M, Muland Kayij M, Umba di M'Balu J, Kindele E, Buldgen A, 2007 a. Voluntary intake, chemical composition and in vitro digestibility of refresh forages fed to Guinea pigs in periurban rearing system of Kinshasa (Democratic Republic of Congo). Tropical Animal Health Production, 39: 419-426.
- Bindelle J, Kinsama A, Dehoux JP, M'Balu JU, Kindele E, Geneviève J, Buldgen A, 2007b. A method combining enzymatic hydrolysis and in vitro fermentation to avoid in vivo trials to determine the nutritional value of forages and diets fed to Guinea pigs raised for meat production. In the proceedings of the 34th BCLAS symposium, Katholieke Hogeschool der Kempen, Geel,
- Del-vechion-vieira G, Sousa V, Yamamou To C, Kaplan M, 2009. Chemical composition and antimicrobial activity of *Agerantum* sp. Records of Natural Products 3(1)52-57
- Egena SSA, Alabi JO, Dikko HA, Stephen E, Silas AT, Musa C, 2010. Growth performance and nutrient digestibility of guinea pigs (*Cavia porcellus*) fed two levels of protein and energy. International Journal of Applied Biological Research, 2(2): 38-43.
- Katunga M, Bacigale B, Katunga B, Maass BL, 2012. Feeding Rabbits and Cavies with Improved Forage Legumes in South Kivu, DR Congo. Tropentag, September 19-21, 2012, Göttingen -Kassel/Witzenhausen.
- Kenfack A, Tchoumboué J, Kamtchouing P, Ngoula F, 2006. Effets de la substitution par l'arachide fourragère (*Arachis glabrata*) de l'herbe à éléphant (*Pennisetum purpurum*) sur le nombre d'ovulations et les mortalités prénatales chez le cobaye (*Cavia porcellus* L.) adulte. Tropicicultura 24 (3): 143-146.
- Kouakou N'GDV, Thys E, Assidjo EN, Grongnet JF, 2010. Ingestion et digestibilité in vivo du Panicum maximum associé à trois compléments: tourteau de *Jatropha curcas*, tourteau de coton (*Gossypium hirsutum*) et *Euphorbia heterophylla* chez le cobaye (*Cavia porcellus* L.). Tropicicultura 28 (3): 173-177.
- Kouakou N'GDV, Thys E, Assidjo EN, Danho M, Nogbou E A, Grongnet JF. 2012. Effets de Panicum maximum sur la productivité des femelles primipares durant le cycle de reproduction chez le cobaye (*Cavia porcellus*). Tropicicultura, 30 (1) : 24-36.
- Kouonmenioc J, Ngou Ngoupayou JD, Fotso JM, 2000. Consommation de quelques graminées tropicales par les cobayes : performance et détermination des surfaces nécessaires à l'entretien d'un cheptel. Tropicicultura 18 (2): 50-83.
- Metre ThK, 2011. Petit, bon pour la santé et très prolifique. Rural 21: 51-53
- Metre ThK, 2012. Possibilités d'amélioration de l'élevage de cobaye (*Cavia porcellus* L.) au Sud Kivu, à l'est de la République Démocratique du Congo. Unpublished MSc thesis, University of Liège, Belgique.

Nguizani B, 2001. Inventaire des fourrages utilisés dans l'alimentation de *Cavia porcellus* à Banzangu (Democratic Republic of Congo). Bulletin BEDIM (Bureau d'Echange et de Distribution de l'Information sur le Mini élevage) 10 (2), 28-29.

Niba AT, Djoukam J, Teguia A, Kudi AC, Loe JO, 2004. Influence of Level of Cottonseed Cake in the Diet on the Feed Intake, Growth Performance and Carcass Characteristics of Guinea Pigs in Cameroon. *Tropicicultura* 22 (1): 32-39.

Niba AT, Meutchieye F, Fon D, Laisin AG, Taboh H, Njakoi H, Bela Tomo A, Maass BL, Djikeng A, Manjeli Y, 2012. Current situation of cavy production in Cameroon: Challenges and opportunities. *Livestock Research for Rural Development*, 24(11):194-201.

Nuwanyakpa M, Lukefahr S D, Gudahl D, Ngoupayou JD, 1997. The current stage and future prospects of guinea pig production under smallholder conditions in West Africa; Cameroon case. *Livestock Research for Rural Development*, 5(9) :45-51.

Pamo TE, Niba AT, Fonteh FA, Tedonkeng F, Kana JR, Boukila B, Tsachoung J, 2005: Effet de la supplémentation au Moringa oleifera ou aux blocs multinutritionnels sur l'évolution du poids post partum et la croissance pré-sevrage des cobayes (*Cavia porcellus* L.). *Livestock Research for Rural Development*. Volume 17, Art. #46., June, 2013 from <http://www.cipav.org.co/lrrd/lrrd17/4/tedo17046.htm>.

Sakaguchi E, Itoh I, Kohno T, Ohshima S, Mizutani K, 1997. Fiber digestion and weight gain in Guinea pigs fed diets containing different fiber sources. *Exp. Animal*, 46, 297-302

Zougou, TG, 2013. Effet de différents niveaux de supplémentation aux feuilles de *Tithonia diversifolia* sur les performances de croissance et les caractéristiques de la carcasse chez le cochon d'Inde (*Cavia porcellus*). Unpublished Msc thesis, Dschang University.

EFFECT OF MORINGA OLEIFERA LEAF MEAL ON HAEMATOLOGICAL PARAMETERS, SERUM BIOCHEMICAL INDICES AND HAEMAGGLUTINATION POTENTIAL OF BROILER BIRDS RAISED ON DEEP LITTERS

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Abstract

Moringa oleifera leaf meal (MOLM) was included in broiler chickens' diets at graded levels of 0, 5, 10, 15, and 20% to make 5 treatments to assess haematology, serum biochemistry and haemagglutination potential in broiler chickens fed the experimental diets. The diets were formulated to be iso-caloric and iso-nitrogenous. Two hundred (200) day-old Cobb broiler chicks were randomly allotted to the treatments in a completely randomized design having 10 birds and four replications per treatment. Water and feed were given ad libitum. Blood samples were collected from the animals through the wing vein for haematology, serum biochemistry and haemagglutination potential. The results showed that packed cell volume (PCV), red blood cell (RBC), neutrophils, lymphocytes, monophils and eosinophils were significantly ($p < 0.05$) influenced by the different inclusion levels of MOLM. Highest mean of PCV and RBC was recorded at 15% level of inclusion ($28.63 \pm 1.19\%$ and $3.66 \pm 0.16\%$ respectively). The serum proteins examined were not significantly ($p > 0.05$) affected by the dietary treatments except cholesterol which was significantly ($p < 0.05$) affected by different levels of inclusion.

Key Word: It was concluded that inclusion of Moringa oleifera up to 20% in the diet of broiler chickens can be adopted to replace soybean meal without any adverse effect on blood indices.

EFFET DE LA FARINE DE FEUILLES DE MORINGA OLEIFERA SUR LES PARAMETRES HEMATOLOGIQUES, LES INDICES DE SERUM BIOCHIMIQUES ET LE POTENTIEL D'HEMAGGLUTINATION DES OISEAUX DE CHAIR ELEVES SUR LITIERES PROFONDES

Résumé

La farine de feuilles de Moringa oleifera (MOLM) a été incorporée dans les régimes des poulets de chair aux niveaux progressifs de 0 ; 5 ; 10 ; 15 ; et 20%, en vue de préparer 5 traitements destinés à être utilisés pour évaluer l'hématologie, la biochimie du sérum et le potentiel d'hémagglutination chez les poulets de chair soumis aux régimes expérimentaux. Les régimes ont été préparés de manière à être isocaloriques et isonitrogènes. Deux cents (200) poussins de chair Cobb âgés d'un jour ont été répartis de manière aléatoire aux divers traitements, dans un schéma complètement aléatoire, avec 10 oiseaux et quatre répétitions par traitement. Les oiseaux ont reçu de l'eau et des aliments ad libitum. Des échantillons de sang ont été prélevés sur les animaux dans la veine de l'aile, en vue de déterminer l'hématologie, la biochimie du sérum et le potentiel d'hémagglutination. Les résultats ont montré que l'hématocrite (PCV : packed cell volume), les globules rouges (RBC), les neutrophiles, les lymphocytes, les monocytes et les éosinophiles ont été significativement ($p < 0,05$) influencés par les différents niveaux d'inclusion de MOLM. La moyenne la plus élevée de PCV et de RBC a été enregistré au niveau d'inclusion de 15% (respectivement $28,63 \pm 1,19\%$ et $3,66 \pm 0,16\%$). Les protéines sériques analysés n'ont pas été significativement ($p > 0,05$) affectés par les traitements alimentaires, à l'exception du cholestérol qui a été significativement ($p < 0,05$) affecté par les différents niveaux d'inclusion.

Mots-clés : poulets de chair, potentiel d'hémagglutination, farine de feuilles de Moringa, hématologie

Introduction

In developing countries like Nigeria, scarcity and high prices of feedstuffs have led animal nutritionists and researchers to look for alternative, unconventional, and cheap sources of feeding materials (Adeniji 2000; Esonu *et al* 2005). This problem is probably due to the perpetual human population increase, resulting in great demand for food, particularly foods of animal origin and products (Smith 1998). In order to control these challenges militating against animal production in Nigeria, several attempts have been made with novel crops and shrubs to produce feed materials for livestock.

One of such non-conventional feedstuff, which could be of value for poultry feeding, is the leaves of moringa. Moringa (*Moringa oleifera*) is a rapidly-growing tree which was used by the ancient Romans, Greeks and Egyptians as animal forage (leaves and treated seed-cake). All parts of the Moringa tree are edible and have long been consumed by humans. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, and carotenoids suitable for utilization in many developing regions of the world where undernourishment is a major concern (Oduro *et al.*, 2008). Results of analyses by Oduro *et al.* (2008) revealed that moringa leaf meal contains 76.53, 27.51, 19.25, 7.13, 2.23, and 43.38% of Dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract.

Haematological and biochemical analyses, respectively become highly significant in the assessment of the nutritional effects of feedstuffs on the animals. As the quest for unconventional and cheap sources of feedstuffs for livestock continues, it becomes imperative to always investigate the health and physiological implications of such materials on the animals. Much information is still needed on the nutritional effects of Moringa leaf meal on the haematological and serum biochemical parameters of broiler chickens since food or feed components affect body constituents (Harper *et al.*, 1979). This study, therefore, was designed to investigate the effect of moringa

leaf meal on the haematological and serum biochemical parameters of broiler chickens.

Materials and Methods

Experimental site

The experiment was carried out at the Directorate of University Farms, Federal University of Agriculture, Abeokuta. It is located in 76m above sea level and falls within Latitude 70N and Longitudes 30E. The climate is humid and located in the forest zone of South Western Nigeria. The mean precipitation and the temperature are 1,112.7mm and 23.50C respectively. Relative humidity averaged 81.5% throughout the year. Seasonal distribution of rainfall is approximately 110.9mm (9.97%) in the late dry season (Jan-March), 462.1mm (41.53%) in the early wet season (April- June), 376.6mm (33.85) in the late wet season (July – September) and 163.1mm (14.66%) in the early dry season (October – December) (ORBDA, 2011).

Experimental animals and management

Two hundred (200) Cobb Broiler chicks were procured at day-old from Zartech Farms in Ibadan, Oyo State. The chicks were initially brooded together for two weeks and at two weeks; they were divided into five dietary treatment groups [0% (control), 5%, 10%, 15% and 20%] with four replicates of 10 birds each per treatment. Feed and water were provided *ad libitum* and all required managerial practices were the same for each treatment group. Birds were subjected to one feeding programme (i.e straight diet) from day old to 8 weeks as showed in Table I below. The birds were housed on deep litter and routinely managed as any other commercial broiler flock.

Preparation of Moringa oleifera Leaf Meal (MOLM)

Moringa oleifera leaves were harvested by hand-plucking the leaves from the trees within Abeokuta metropolis. The leaves were air-dried at room temperature until the moisture content was low and the dried leaves were grinded with grinding machine to form leaf meal.

Table 1: Ingredients inclusion levels and the chemical contents of the experimental diets (100kg)

Ingredients	Control	(5%)	(10%)	(15%)	(20%)
Maize	55.00	55.00	55.00	55.00	55.00
Soybean meal	23.00	21.85	20.70	19.55	18.40
MOLM	0.00	1.15	2.30	3.45	4.60
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Wheat offal	3.85	3.85	3.85	3.85	3.85
Bone meal	3.00	3.00	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00	1.00	1.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients composition (%)					
ME (kcal/kg)	3104.87	3066.92	3028.97	2991.02	2948.35
Crude protein	21.83	21.33	20.83	20.32	20.08
Crude fat	4.20	4.18	4.14	4.10	4.12
Crude fibre	3.51	3.44	3.37	3.29	3.22
Calcium	1.63	1.63	1.62	1.62	1.62
Phosphorus	0.94	0.93	0.93	0.92	0.91
Ash	3.00	2.95	2.89	2.83	2.80

MOLM = *Moringa oleifera* leaf meal, ME = Metabolizable Energy, TRT = treatment

Haematology and Serum Biochemistry Analysis
 At the end of 4th and 8th weeks, blood samples were obtained from two birds per replicate making a total of eight per treatment by inserting a new sterile needle into the wing vein of the birds and extracting 2mls of blood which was placed inside sterile test tubes containing Ethylene Diamine Tetra Acetic Acid (EDTA). The blood samples were gently mixed with the EDTA in order to prevent coagulation. The samples were then analyzed for Red Blood Cells (RBC), Packed Cell Volume (PCV) and White Blood Cells (WBC) e.t.c using the Abbott Diagnostics Cell Dyn 3500 (Abbott Diagnostics, Abbott Park, IL) automated haematology analyzer. Again, blood samples were obtained from each bird by the same procedure mentioned above and drawn into vacuumed capillary tubes into plain bottles without EDTA determine the

blood cholesterol, total protein, albumin and globulin. After coagulation, blood samples were centrifuged and then serum was collected for analysis. Serum biochemistry was determined by using Cobas integral 400 plus chemistry analyzer manufactured by Roche Diagnostics Ltd., Switzerland.

Collection of Haemolymph, Erthrocytes and Haemagglutination Test

Haemolymph was collected from the mantle (oxygenated) cavity region of the snail (*Archachatina marginata*), and temporarily stored in universal bottle before the commencement of haemagglutination assay for agglutinin evaluation.

Three to five millimetres of chicken blood was obtained from wing vein aseptically into EDTA bottles. Blood was centrifuged at

900g for 5 minutes to harvest erythrocytes. Erythrocytes were washed three times in phosphate buffer saline (PBS), diluted to 2%v/v and stored at 4°C (Schluter *et al.*, 1980).

Serial dilution of haemolymph was prepared using 0.85% PBS (pH 7.2). Diluted haemolymph was aliquoted into wells of microtitre plates at 100µl per well. Equal volumes of a 2% chicken red-blood cell suspension were then added. The plates were covered, mixed gently, and incubated at 30, 60, 90, and 120 minutes at room temperature to determine the reaction time, after which titre values were recorded. Each test consisted of eight replicates. Red-blood cell in PBS served as the control.

Statistical analysis

The data were subjected to analysis of variance in a 2 x 5 factorial design using Statistical Analysis System (SAS, 2007). Duncan Multiple Range Test was used to separate significant treatment means.

$$Y_{ijk} = \mu + M_i + N_j + \sum_{ijk}$$

where,

Y_{ij} = Dependent variables

μ = population mean

M_i = Effect of i th age of sampling

N_j = Effect of j th concentrate with Moringa inclusion at different levels of inclusions ($j=0\%$, 5%, 10%, 15%, 20%).

\sum_{ij} = residual error.

Results

Effect of graded levels of Moringa oleifera leaf meal on haematological parameters of broiler chickens is shown in table 2. Inclusion levels of Moringa had significant ($P<0.05$) effect on PCV, RBC, neutrophils, lymphocytes, monocytes and eosinophils. In contrast, WBC and basophils were not significantly ($P>0.05$) affected by different inclusion levels of moringa. It was observed that 5, 10, 15 and 20% inclusion recorded higher values for PCV compared to the control (0%) but not significantly different from each other. Similarly, RBC, neutrophils, lymphocytes, monocytes and eosinophils followed the same trend.

Table 2: Effect of graded levels of Moringa oleifera leaf meal on haematological parameters of broiler chickens

Parameter	Levels of inclusion				
	0%	5%	10%	15%	20%
PCV (%)	10.63±5.32 ^b	24.50±4.29 ^a	21.00±3.74 ^{ab}	28.63±1.19 ^a	22.12±5.25 ^{ab}
WBC(x109/dl)	3.56±1.40	5.46±1.40	5.89±1.22	7.38±0.91	4.44±1.15
RBC(x106µL)	1.34±0.67 ^b	3.05±0.55 ^{ab}	2.65±0.46 ^{ab}	3.66±0.16 ^a	3.39±1.01 ^a
Neutrophils (%)	9.75±4.86 ^b	30.13±5.18 ^a	27.25±2.40 ^a	33.00±1.56 ^a	24.63±5.76 ^a
Lymphocytes (%)	25.38±12.41 ^b	53.38±8.07 ^a	55.63±8.26 ^a	61.00±1.40 ^a	46.50±10.28 ^{ab}
Monophils (%)	1.25±0.77 ^b	2.30±0.57 ^{ab}	2.88±0.55 ^{ab}	3.50±0.42 ^a	2.13±0.67 ^{ab}
Eosinophils (%)	0.75±0.37 ^b	1.13±0.40 ^a	1.25±0.41 ^{ab}	2.13±0.30 ^a	1.50±0.42 ^{ab}
Basophils (%)	0.13±0.13	0.63±0.18	0.13±0.13	0.38±0.18	0.38±0.18

^{ab} Means along the same row with different superscript differs significantly ($p<0.05$). *Means ± SEM

Table 3: Effects of graded levels of Moringa olifera leaf meal on biochemical parameters of broiler chickens

Parameters	Levels of inclusion				
	0%	5%	10%	15%	20%
Total protein (mg/dl)	3.81±0.51	4.20±0.30	3.91±0.21	4.01±0.21	3.86±0.12
Albumin (mg/dl)	2.00±0.17	2.06±0.10	1.93±0.21	2.15±0.11	2.06±0.10
Globulin (mg/dl)	1.82±0.20	2.14±0.03	1.99±0.33	1.86±0.26	1.80±10.18
Cholesterol(mg/dl)	129.44±8.97 ^{ab}	106.38±7.37 ^b	104.45±6.86 ^b	128.85±5.70 ^{ab}	145.14±16.78 ^a

^{ab} Means along the same row with different superscript differs significantly ($p<0.05$). *Means ± SEM

Table 3 shows effects of graded levels of *Moringa olifera* leaf meal on biochemical parameters of broiler chickens. Considering parameters measured, *Moringa* inclusion levels had no significant influence on total protein, albumin and globulin. However, different inclusion levels had significant effect on cholesterol values. Inclusion at 20% had the highest means compared to other levels but not significantly different from the control (0%).

Effect of age on haematological parameters of broiler chicken fed graded levels of *Moringa olieifera* leaf meal is shown in table 4. Result showed that PCV, WBC and RBC were significantly influenced by age while neutrophils, lymphocytes, monocytes, eosinophils and basophils were not significantly affected. PCV, WBC and RBC at week 8 were significantly higher than week 4.

Effect of age on biochemical parameters of broiler fed with graded levels of *Moringa oleifera* leaf meal is presented in table 5. Total protein and globulin at week 8 were significantly higher than those values recorded at week 4. For albumin, the trend was different. Value recorded at week 4 was significantly higher compared to week 8. However, cholesterol at both week 4 and 8 were not significantly affected.

Haemagglutination titre of broiler erythrocytes fed with different levels of *Moringa oleifera* is shown in table 6. At reaction time of 30 and 60 minutes, haemagglutination titres were not different for the five levels of inclusions. But at 90 and 120 minutes, inclusion level at 5% had the highest titre (1:32), followed by 10% and 20% levels of inclusions (1:8, 1:8) while 0% recorded the least titre (1:2).

Table 4: Effect of age on haematological parameters of broiler chicken fed graded levels of *Moringa olieifera* leaf meal

Parameters	AGE	
	4 Weeks	8 Weeks
Packed Cell Volume (%)	16.95±2.68 ^b	25.80±2.78 ^a
White Blood Cell (x10 ⁹ /dl)	3.83±0.70 ^b	6.86±0.91 ^a
Red Blood Cell (x10 ⁶ µL)	2.17±0.34 ^b	3.46±0.45 ^a
Neutrophils (%)	23.95±3.77	25.95±2.86
Lymphocytes (%)	42.60±6.48	54.15±5.38
Monophils (%)	2.00±0.40	2.90±0.40
Eosinophils (%)	1.15±0.25	1.55±0.25
Basophils (%)	0.35±0.11	0.30±0.11

^{a,b} Means along the same row with different superscript differs significantly (p<0.05)

Table 5: Effect of age on biochemical parameters of broiler fed with graded levels of *Moringa oleifera* leaf meal

Parameters (mg/dl)	4 Weeks	8 Weeks
Total protein	3.70±0.08 ^b	4.23±0.14 ^a
Albumin	2.28±0.07 ^a	1.80±0.07 ^b
Globulin	1.42±0.10 ^b	2.43±0.12 ^a
Cholesterol	117.52±5.40	128.19±8.12

^{a,b} Means along the same row with different superscript differs significantly (p<0.05)

Table 6: Haemagglutination titre of broiler erythrocytes fed with different levels of *Moringa oleifera*

Reaction Time(minute)	Haemagglutination titre of different levels of % inclusion of <i>Moringa</i>				
	0%	5%	10%	15%	20%
30	10 (1:1024)	10 (1:1024)	10 (1:1024)	10 (1:1024)	10 (1:1024)
60	10 (1:1024)	10 (1:1024)	10 (1:1024)	10 (1:1024)	10 (1:1024)
90	2 (1:4)	5 (1:32)	4 (1:16)	3 (1:8)	3 (1:8)
120	1 (1:2)	5 (1:32)	4 (1:16)	3 (1:8)	3 (1:8)

Discussion

Packed cell volume is an indication of total red blood cell in a whole blood compared to proportion of plasma and buffy coat/white blood cell portion. It gives certain indication of the health status of the animal. In this study inclusion level of moringa at 15% gave the highest packed cell volume although not significantly different from 5%. This result is an indication that moringa has substance (s) which promotes erythrocyte production. The findings of this study can be supported by the report of Melesse et al.(2012) who asserted that moringa leaves are not only rich in protein but also contain substantial amount of essential amino acid. Higher number of RBC at 15 and 20% is also an indication that birds under these two treatments will have the ability to transport higher number of oxygen in their system which may enhance their health status (Olugbemi et al., 2010). Elevated values of white blood cell differentials are indicators of stress, tissue damage, chronic inflammation, presence of both parasitic and non-parasitic infection in the system of animals (Douglas et al., 2010; Martinez-Silvestre et al., 2013; Pendl, 2013; Wolfensohn and Lloyd, 2013). Elevated values from 5% up to 20% compared to control (0%) may be as a result of presence of lectin which has been reported to modulate defense system of animal (Jayavardhanan et al., 1994).

Serum biochemical parameters are useful markers for the evaluation of health status of birds. It also shows alterations in organs and tissues of birds fed with unconventional feed sources (Kudair and Al-Hussary, 2010). In this study, *Moringa olifera* inclusion at varying levels did not significantly affect most of the

biochemical parameters measured except for cholesterol in which inclusion level at 20% recorded the highest means compared to 5% and 10%. This observation is a reflection of non-harmful nature of moringa as values gotten were in the same range with the control in most of the parameters measured. However, this result also negate the report of Teye et al. (2013) who reported increased serum total proteins in chickens fed *Moringa olifera* meal diet. Values recorded for cholesterol at 20% inclusion is also evidence that *Moringa olifera* is rich in fat which may be an alternative source of energy for broiler birds. It may also caveat that inclusion at this level or above may also affect the health status of the birds due to excessive fat accumulation.

Considering the two phases of production used in this study (Weeks 4&8), it was glaring that packed cell volume, white blood cells and Red blood cells were significantly higher at week 8 compared to week 4. This observation is a true reflection of body capacity of the animal i.e capacity to cope with body requirement as bird increases in size and weight which is expected if the normal body function is not compromised. Increase in total protein and globulin also followed similar trend in term of body function and requirements.

Result of haemagglutination titre of broiler erythrocyte fed different levels of *Moringa olifera* which showed that 5% inclusion level gave the highest titre is an indication that inclusion at this level modulates the immune function most, although, 10 and 20% were also good but not as efficient as 5%. The reason for this observation may be as a result of over-reactivity at these levels. On the overall basis, immune boosting effect of *Moringa olifera* may

be as a result of the presence of lectins which are found mostly in legumes. The report of Abiona (2012) on haemagglutination titre of layer birds raised on three housing methods using natural agglutinins showed that birds raised on legumes recorded the highest titre compared to concentrate feeding.

Conclusion

The inclusion of *Moringa oleifera* in the broiler diets up to 20% is tolerated without any adverse effect on haematology and serum biochemistry of the animal. However, its inclusion at 5% level was shown to positively influence immune function most.

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References

Abiona, J. A., Oke, O. E., Akinduti, P. A., Abioja, M. O. and Onagbesan, O. M. (2012). Haemagglutination potential of layers raised on three rearing methods using natural agglutinins from giant African land snails (*Archachatina marginata*). World Poultry Science Association (Togo Branch) International Seminar 22-24 May, 2012, Universite de Lomé, Lomé, Togo. Pp.25-29. Published by World's Poultry Science Association- Togo (WPSA-Togo).

Adeniji, A. A. (2000). A survey on the prices of conventional feedstuffs compared with the unutilized wastes (unpublished work). Dept. of Animal Production, University of Ilorin.

Douglas, J. W., Weiss, K., Wardrop, J., (2010). Schalm's veterinary hematology. 6th edition. Wiley-Blackwell, Iowa 50014-8300, USA, p. 1181.

Esonu, B. O., Izukanne, K. O. and Inyang, O. A. (2005). Evaluation of cellulolytic enzyme supplementation on production indices and nutrient utilization of

laying hen fed soyabean hull based diets. International Journal of Poultry Science. 4(4):213-216

Harper, A. F., Rodwell, V. W. and Mayes, P. A. (1979). Review of Physiological Chemistry. 17th Ed. Lang. Medical, Los Altos, California p. 9422

Jayavardhanan, K. K., Suresh, K., Panikkar, K. R. and Vasudedan, D. M. (1994). Modular potency of drumstic lectin on host defense. In journal of Experimental Clinical Cancer Research, Vol.13, p. 205-209.

Kudair, I. M. and Al-Hussary, N. A. J. (2010). Effect of vaccination on some biochemical parameters in broiler chickens. Iraqi Journal of Veterinary Science, 24: 59-64. <http://agris.fao.org/agris-search/search.do?recordID=DJ2012047668>

Martínez-Silvestre, A., Lavín, S. and Cuenca, R. (2013). La bioquímica sanguínea en clínica de reptiles (in Spanish). Consulta Difusión Vet. 200, 31-40.

Martínez-Silvestre, A., Marco, I., Rodríguez-Dominguez, M. A., Lavín, S., Cuenca, R., (2005). Morphology, cytochemical staining, and ultrastructural characteristics of the blood

Melesse, A., Steingass, H., Boguhn, J., Schollenberger, M. and Rodehutsord, M. (2012). "Effects of elevation and season on nutrient composition of leaves and green pods of *Moringa stenopetala* and *Moringa oleifera*." Agroforest System. 2012: 505-518.

ORBDA, (2011). Ogun Osun River Basin Development Authority.

Oduro I., Ellis, W. O. and Owusu, D. (2008). Nutritional potential of two leaf vegetables: *Moringa Oleifera* and *Impomoea batatas* leaves. Scientific Research and Essay. Vol. 3(2), pp. 057-060.

Olugbemi, T. S., Mutayoba, S. K. and Lekule, F. P. (2010). Effect of *Moringa (Moringa oleifera)* inclusion in cassava based diets fed to broiler chickens. International Journal of Poultry Science. 9(4): 363-367.

Pendl, H., (2013). Hematology In birds and reptiles For Beginners. International Conference on Avian, Herpetological & Exotic Mammal Medicine I, pp. 59-63.

SAS, (2007). Statistical Analysis Systems Package. SAS for Windows 9.1.3 portable version. Statistical Systems Institute Inc., Cary, NY, USA

Smith, J.W. (1998). Animal Agriculture in West Africa: The subtamability question; Keynote address, Joint Silver Anniversary Conference of Nig. Soc. Anim. Prod. (NSAP) and West African Society of Anim. Prod. Pp I – II.

Wolfensohn, S., Lloyd, M., (2013). Handbook of Laboratory Animal Management and Welfare. 4th edition. Wiley-Blackwell, p. 390.

PERFORMANCE, CARCASS CHARACTERISTICS AND MEAT QUALITY OF TWO BROILER STRAINS REARED OUTDOOR IN TROPICAL CLIMATES

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Abstract

Due to the dearth of information on the response of poultry managed in alternative production systems to seasonal fluctuations, a total of 240 day old chicks from Arbor acre and Marshall strains were used for both dry and wet seasons trials. Birds were brooded for 3 weeks and thereafter acclimatized in outdoor runs for a week before the commencement of the experiment. Sixty birds each of both strains which were sub-divided into three replicates of 20 birds each were used for both dry and wet seasons. At the end of the experiments, two birds per replicate were selected and slaughtered for carcass yield and meat quality comparison. Data obtained were subjected to analysis of variance in a Completely Randomized Design. Higher total feed intake (4,107.94 g/bird) and poorer Feed Conversion Ratio (FCR) (3.80) were recorded in birds reared in the wet season while mortality was significantly ($p < 0.05$) higher (17.87%) in the dry season. Also, strain significantly ($p < 0.05$) influenced the final weight, weight gain and FCR. Interaction between season and strain significantly ($p < 0.05$) influenced all performance parameters except feed intake. Similarly, live, plucked and dressed weights, dressing percentage and breast were significantly ($p < 0.05$) higher (1928.00 g, 1782.50 g, 1413.50 g, 73.32% and 21.02 %, respectively) in Arbor acre broiler chickens. Also, ether extract content of the pectoralis major was significantly ($p < 0.05$) higher (14.44%) in birds reared in the dry season but on the contrary, High Density Lipoprotein content was higher (60.78 mg/dl) in the wet season. Hence, outdoor rearing of Arbor acre broilers in wet season had better feed conversion and carcass yield with pectoralis major meat rich in high density lipoprotein content than obtainable in the dry season.

Keywords: Broilers, season, strain, performance, Carcass, Meat quality

PERFORMANCE, CARACTERISTIQUES DES CARCASSES ET QUALITE DE LA VIANDE DE DEUX SOUCHES DE POULETS DE CHAIR ELEVES EN PLEIN AIR DANS LES CLIMATS TROPICAUX

Résumé

En raison du manque d'information sur la réaction des volailles élevées en systèmes alternatifs à cause des fluctuations saisonnières, un total de 240 poussins des souches Arbor acre et Marshall, âgés d'un jour, a été utilisé pour des essais en saisons sèche et humide. Les oiseaux ont été couvés pendant 3 semaines et ensuite acclimatés au milieu extérieur pendant une semaine avant le commencement de l'expérience. Soixante oiseaux pour chacune des deux souches, subdivisés en trois répétitions de 20 oiseaux chacune, ont été utilisés à la fois pendant la saison sèche et la saison humide. A la fin des expériences, deux oiseaux par répétition ont été sélectionnés et abattus en vue de déterminer le rendement en carcasse et faire une comparaison des qualités de leurs viandes. Les données obtenues ont été soumises à une analyse de variance dans un schéma complètement aléatoire. Un taux total élevé de consommation alimentaire (4,107.94 g/oiseau) et un faible indice de consommation (FCR : Feed Conversion Ratio) (3,80) ont été enregistrés pour les oiseaux élevés en saison humide tandis que la mortalité s'est révélée significativement ($p < 0,05$) plus élevée (17,87%) en saison sèche. De plus, la souche a significativement ($p < 0,05$) influencé le poids final, le

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gain pondéral et le FCR. L'interaction entre la saison et la souche ont significativement ($p < 0,05$) influencé tous les paramètres de performance, à l'exception de la consommation alimentaire. De même, les poids vif, plumé et manipulé, le rendement en carcasse et le tour de poitrine étaient significativement ($p < 0,05$) très élevés (respectivement 1928,00 g, 1782,50 g, 1413,50 g, 73,32% et 21,02 %) chez les poulets de chair Arbor acre. De plus, on a noté que la teneur de l'extrait à l'éther du grand pectoral était significativement ($p < 0,05$) plus élevée (14,44%) chez les oiseaux élevés en saison sèche, mais par contre, la teneur en lipoprotéines à haute densité était plus élevée (60,78 mg / dl) pendant la saison des pluies. Ainsi, l'élevage des poulets de chair Arbor acre en plein air, pendant la saison des pluies, a eu une meilleure conversion alimentaire et un meilleur rendement en carcasse, la viande du grand pectoral étant riche en lipoprotéines de haute densité par rapport à celle obtenue en saison sèche.

Mots-clés : poulets de chair, saison, souche, performance, carcasse, qualité de la viande

Introduction

In recent years, there has evolved several production systems for raising flocks of meat birds. These systems vary in how the birds are housed, fed and managed. Alternative housing systems (free-range and outdoor rearing) accommodates for most of the welfare concerns that are found in battery cages. They provide physical space and greater environmental complexity (Sogunle *et al.*, 2014). Birds are allowed to spread out to preferred distances when foraging (Savory *et al.*, 2006), and greatly expand behavioral options, especially if the range offers a variety of plant types. Birds spend much of their active day engaged in foraging; selecting, extracting, and ingesting preferred food items (e.g. grass seeds, earthworms and flying insects). More so, there has been a growing countervailing trend where farmers and consumers show renewed interest in food products from alternative production systems (organic, free-range, outdoor rearing) because these systems are environmentally friendly, sustain animals in good health with high welfare standards and results in higher quality products and more flavoursome products (Lichovníková *et al.*, 2009).

However, despite the fact that range birds are able to express their natural behaviours, they are exposed to a variety of environmental stimuli and are susceptible to problems caused by inclement weather (Appleby and Hughes, 1991; Fossum *et al.*, 2009). There exist paucity of information on the effect of climate on the carcass yield and quality of products

from outdoor systems but previous studies showed that changes in seasonal conditions substantially influenced the availability of scavengeable feed resources and the overall performance of poultry (Goromela *et al.*, 2007). This was further confirmed by Akyuz (2009) who reported that high temperatures due to increased ambient temperature reduced the feed intake drastically and hence the reduction in body weight and body weight gain. According to Rajini *et al.* (2009), ambient temperature rise also reduces the breast muscle, liver, gizzard and intestine weights of broilers. Also, less protein levels and higher moisture and fat contents were reported in chickens' meat produced in hot conditions (Bianchi *et al.*, 2007; Rosa *et al.*, 2007; Barbour *et al.*, 2010).

Hence, this study was designed to compare the growth performance, carcass characteristics and pectoralis major quality of two broiler strains reared outdoor in dry and wet seasons.

Materials and Methods

Experimental Site

The research was conducted at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta while carcass quality assessment was carried out in the Animal Products and Processing Laboratory, Department of Animal Production and Health, Federal University of Agriculture, Abeokuta.

Experimental Birds and Management

A total of 240 day-old broiler chicks from two strains (Arbor acre and Marshall) were used for this study. The birds were brooded for 3 weeks and acclimatized in the outdoor run for a week before the commencement of the experiment. Thus, the experiment was conducted from the 5th week to the 8th week. The birds were differentiated on strain basis (Arbor acre and Marshall) with each strain further divided into three replicates containing 20 birds each for both dry and wet seasons. The fenced run provided per replicate had an area of 70 m² each to allow the birds access to ample space, sunlight and fresh air. However, mini-shelters with provision for perching were provided to protect the birds from predators and harsh weather conditions. Also, all necessary sanitation and management practices were carried out and birds were provided with water and commercial broiler finisher diets ad libitum throughout the experimental periods.

Meteorological Observations

Meteorological data were monitored and obtained from the Agro-meteorological station, College of Environmental Resources Management, Federal University of Agriculture, Abeokuta. The daily mean ambient temperature and relative humidity at 0800 h and 1600 h were monitored throughout the experimental periods (dry and wet season).

Performance Characteristics

Data were taken weekly on the performance of the birds: feed intake and weight gain. Feed conversion ratio, protein intake, protein efficiency ratio and mortality were also calculated. The feed conversion ratio was determined by calculating the ratio of feed intake to weight gain. Protein intake was calculated by multiplying the percentage protein content of the feed by the actual intake while the protein efficiency ratio was the ratio of the weight gain to the protein intake. Mortality rate was calculated by subtracting the number of live birds at the end of the experiment from the total number of birds at the beginning of the

experiment. The resultant figure was divided by the total number of birds at the beginning of the experiment and was multiplied by 100 to obtain the percentage of mortality rate.

Carcass Yield Evaluation

At the last day of the experiment (8 weeks old broilers) at both dry and wet season, two birds per replicate were selected. The birds were fasted overnight before slaughtering by severing the carotid artery and the jugular vein. The birds were bled completely followed by scalding in water at 60 °C and evisceration. The weights of the carcasses were recorded and the dressing percentages were estimated by dividing the dressed weight of carcasses by the live weight and multiplied by 100. The heads and shanks were removed and weighed. After evisceration, the dressed weights were recorded. The weight of cut-up parts, organs and intestines were determined using an electronic scale. The values obtained were recorded in grams and were further expressed as a percentage of the live weight.

Meat Composition Analysis

Known quantities (20 grams) of pectoralis major fillets were collected from dressed carcasses per replicate for proximate composition. Moisture, crude protein, ether extract, and ash contents of the flesh were determined by the procedures described AOAC (2005). Lipids were extracted in Soxhlet apparatus while protein contents were calculated as nitrogen amount multiplied by 0.625 per 100 g of meat. The nitrogen contents were determined by the Kjeldahl procedure (AOAC, 2005). Value for the nitrogen free extract was obtained by subtracting the sum of the values of moisture, crude protein, ether extract and ash from 100%.

Meat Cholesterol Profile

About 2 g of each sample were saponified according to a modified version of the method described by Stewart et al. (1992), with 4 ml of 50% potassium hydroxide and 6 ml of 95% ethanol absolute heated for complete solubilization at 40 °C, and then heated for 10

Table 1: Meteorological observations during the experimental periods (dry and wet season)

Season	Mean Temperature (°C)	Relative Humidity (%)	SEM
DRY	30.53 ^a	59.25 ^b	1.05
WET	27.59 ^b	69.02 ^a	0.61

^{a,b} Means on the same row having different superscript are significantly ($p < 0.05$) different

Table 2: Effect of season and strain on the growth performance of broiler chickens reared in outdoor run

Parameter	Season			Strain			Season*Strain
	Dry	Wet	SEM	Marshall	Arbor acre	SEM	
Initial weight (g/bird/day)	590.00	604.50	5.45	608.50	595.00	5.76	NS
Final weight (g/bird/day)	1775.67	1720.00	69.55	1627.83 ^b	1867.83 ^a	46.98	S
Weight gain (g/bird/day)	1176.67	1115.50	69.33	1019.33 ^b	1272.83 ^a	44.02	S
Feed intake (g/bird/day)	3624.27 ^b	4107.94 ^a	107.25	3941.13	3791.08	164.35	NS
Feed Conversion Ratio	3.10 ^a	3.80 ^b	0.23	3.92 ^b	2.98 ^a	0.18	S
Protein intake (g/bird/day)	748.41 ^b	848.29 ^a	22.15	813.84	782.86	33.94	NS
Protein Efficiency Ratio	1.58 ^a	1.32 ^b	0.09	1.27 ^b	1.63 ^a	0.07	S
Mortality (%)	17.87 ^a	0.00 ^b	1.89	10.23	7.64	4.66	S

^{a,b} Means on the same row having different superscript are significantly ($p < 0.05$) different.

Season*Strain = interaction between season and strain

NS = Not significant

S = Significant

min at 60 °C. Afterwards, 5 ml of water were added and the samples were cooled. The non-saponifiable fractions were extracted thrice using 10 ml of hexane. Aliquots of hexane extracts (3 ml) were dried under a nitrogen flow. After saponification, samples were analyzed by high-performance liquid chromatography (HPLC).

Statistical Analysis: The experimental layout was a 2 × 2 factorial arrangement and the data generated were subjected to Completely Randomized Design. Significantly ($p < 0.05$) different means were separated using Duncan's Multiple Range Test as contained in SAS (2010) package.

Results

Meteorological observations during experimental periods

Table 1 shows the meteorological observations during the experimental periods (dry and wet seasons). Higher average values for relative humidity was recorded in the wet season (69.02%). However, ambient temperature was highest (30.53 °C) in the dry season.

Effect of season and strain on the growth performance of broiler chickens reared outdoor

The effects of season and strain on the growth performance of broiler chickens reared outdoor are presented in Table 2. Feed intake

(g/bird), Feed Conversion Ratio (FCR), Protein intake (g/bird), Protein Efficiency Ratio (PER) and mortality rate (%) were significantly affected by season. Higher mean values (4107.94 g, 848.29 g and 3.80) for feed and protein intakes and FCR, respectively were recorded in the wet season while the higher mean values (1.58 and 17.87%) for PER and mortality were recorded in the dry season. Furthermore, strain of the experimental birds had significant ($p < 0.05$) effects on the final weight (g/bird), Weight gain

(g/bird), FCR and PER. The higher mean values (1867.83 g, 1272.83 g and 1.63, respectively) for Final weight (g/bird), Weight gain (g/bird) and PER respectively were observed in the Arbor acre Strain while FCR was poorer (3.92) in Marshall broilers. Also, interaction between season and strain significantly ($p < 0.05$) influenced all parameters measured across the treatments except for the feed and protein intakes.

Table 3: Effects of season and strain on the carcass characteristics of broiler chickens reared outdoor

Parameter	Season			Strain			Season*Strain
	Dry	Wet	SEM	Marshall	Arbor acre	SEM	
Live weight (g)	1812.25	1765.50	83.69	1649.75 ^b	1928.00 ^a	64.32	S
Plucked weight (g)	1605.75	1655.50	43.04	1478.75 ^b	1782.50 ^a	58.53	S
Dressed weight (g)	1292.25	1251.75	85.57	1130.50 ^b	1413.50 ^a	47.95	S
Dressing (%)	71.24	70.62	1.81	68.54 ^b	73.32 ^a	1.09	NS
Abdominal fat (%)	1.44	0.56	0.31	1.33	0.67	0.35	NS
Cut-up parts¹							
Head	2.04 ^b	2.78 ^a	0.17	2.54	2.28	0.28	NS
Neck	6.30	5.61	0.48	6.32	5.60	0.44	NS
Wings	8.86	8.80	0.38	9.20	8.46	0.34	NS
Thigh	11.39	10.78	0.21	11.20	10.97	0.29	NS
Drumstick	10.85	10.70	0.51	10.32	11.24	0.38	NS
Shank	4.36	4.46	0.35	4.42	4.40	0.33	NS
Breast	18.35	20.48	1.16	17.81 ^b	21.02 ^a	0.98	S
Back	14.77	13.93	0.96	14.86	13.84	1.00	NS
Organs²							
Heart	0.43	0.44	0.04	0.45	0.41	0.04	NS
Lungs	0.34 ^b	0.57 ^a	0.04	0.49	0.42	0.08	S
Liver	1.40	1.75	0.19	1.53	1.63	0.19	NS
Spleen	0.08	0.13	0.03	0.11	0.10	0.03	NS
Gizzard	2.83	2.75	0.28	3.05	2.53	0.24	NS
Gastrointestinal Tract	5.12	5.66	0.24	5.55	5.23	0.29	NS

^{a,b} Means on the same row having different superscript are significantly ($p < 0.05$) different.

^{1,2}: values are expressed as percentages of the live weight.

Season*Strain = interaction between season and strain

NS = Not significant

S = Significant

Table 4: Effect of season and strain on the pectoralis major quality of broiler chickens reared outdoor.

Parameter	Season			Strain		SEM	Season*Strain
	Dry	Wet	SEM	Marshall	Arbor acre		
Proximate Composition (%)							
Moisture	65.58	62.00	1.82	63.16	64.42	2.32	NS
Crude Protein	19.83	25.10	2.27	22.57	22.37	2.80	NS
Ether Extract	14.44 ^a	10.29 ^b	0.28	12.71	12.01	1.21	NS
Ash	0.98	0.74	0.17	1.14	0.57	0.17	S
Nitrogen Free Extract	64.76	63.87	2.28	63.58	65.05	2.33	NS
Cholesterol Profile (mg/dl)							
Total Cholesterol	65.25	88.73	9.44	74.40	79.58	11.48	NS
High Density Lipoprotein	37.25 ^b	60.78 ^a	5.54	47.50	50.53	8.57	S
Low Density Lipoprotein	14.25	11.22	1.99	14.33	11.14	2.01	NS
Very Low Density Lipoprotein	13.75	16.23	2.02	12.53	17.45	1.79	S

^{a,b} Means on the same row having different superscript are significantly ($p < 0.05$) different.

Season*Strain = interaction between season and strain

NS = Not significant

S = Significant

Effect of season and strain on the carcass characteristics of broiler chickens reared outdoor

Table 3 shows the effects of season and strain on the carcass characteristics of broiler chickens reared outdoor. All parameters measured were not significantly ($p > 0.05$) influenced by season except for the values recorded for head and lungs. The observed values for head and lungs, respectively ranged from 2.04% to 2.78% and 0.34% to 0.57%, respectively with the higher values recorded during the wet season. However, strain significantly ($p < 0.05$) influenced live weight (g), plucked weight (g), dressed weight (g), dressing percentage and breast (%). The live, plucked and dressed weights, dressing percentage and breast were higher (1928.00 g, 1782.50 g, 1413.50 g, 73.32% and 21.02 %, respectively) in Arbor acre Broilers than the values (1649.75 g, 1478.75 g, 1130.50 g, 68.54% and 17.80 %, respectively) in Marshall Broilers. In addition, effects of season

× strain interaction significantly ($p < 0.05$) affected observed values for live, plucked and dressed weights as well as breast and liver.

Effect of season and strain on the pectoralis major quality of broiler chickens reared outdoor

The effects of season and strain on pectoralis major quality of broiler chickens reared outdoor are presented in Table 4. There were no significant ($p > 0.05$) effect of season on all parameters measured except for ether extract (EE) and high density lipoprotein (HDL). EE of the pectoralis major was higher (14.44%) in birds reared in the dry season compared to those reared (10.29%) in the wet season. High Density Lipoprotein (HDL) values significantly ($p < 0.05$) ranged from 37.25 mg/dl in the dry season to 60.78 mg/dl in the wet season. However, strain did not significantly ($p > 0.05$) influence any of the breast meat parameters measured. More so, ash, HDL and Very Low

Density Lipoprotein contents of pectoralis major were significantly ($p < 0.05$) influenced by the interaction between season and strain.

Discussion

The detrimental effect of high temperature on the performance of broiler chickens is already well documented, principally through reducing feed intake and feed conversion (Har *et al.*, 2000; Öskan *et al.*, 2003; Abu-Dieyeh, 2006). This tallies with results of this study that showed that feed intake, feed conversion ratio (FCR), protein intake, protein efficiency ratio (PER) and percentage mortality were greatly affected by changes in season. This is also in support with the study conducted by Bonnet *et al.* (1997) who stated a decrease in feed consumption in hot season. Lu *et al.* (2007) also confirmed that the feed intake and feed gain ratio were lower in birds subjected to higher temperature compared to those in controlled temperature irrespective of the breed or strain of the chickens used. Besides, high mortality rate observed in the dry season could be as a result of heat caused by increase in ambient temperature and exposure of birds reared outdoor to direct solar radiation. Results is in agreement with the reports of Hassan and Reddy (2012) who opined that hot weather condition in the dry season leads to high mortality rates. Also, previous studies confirms heat impairs growth performance and increases mortality in broiler chickens (Niu *et al.*, 2009; Attia *et al.*, 2011; Ghazi *et al.*, 2012; Imik *et al.*, 2012).

Moreover, this study revealed that growth rates were significantly affected by the strains of broilers reared. This is in line with the work of Ajayi and Ejiofor (2009) who found significant differences between strains and sexes in body weight and body dimensions of broiler chickens. These authors' findings are consistent with other studies reported in literature (Razuki *et al.*, 2007; Razuki *et al.*, 2011). Also, statistically significant effect of strain on FCR and weight gain observed in this study is in accordance with findings of Olawunmi *et al.* (2012) who reported significant differences in

body weight and feed to gain ratio of different strains of broiler chickens. Significant strain effects on feed conversion have also been reported (Berrong and Washburn, 1998; Razuki and Al-Rawi, 2007). Adebambo *et al.* (2008) and Olawumi and Dudusola (2011) also observed significant effect of strain on feed efficiency in commercial layer strains.

In addition, season had no effect on dressing percentages of birds reared in this current study. This corroborated the findings of Goromela *et al.* (2008) who reported no differences in dressing percentage of scavenging birds in both wet and dry seasons. However, head and lungs were significantly lower in the dry season. This could be as a result of loss of water from the lungs via panting in the hot weather. DEFRA (2005) stated that poultry birds lose water from the lungs when panting as a result of heat. Similarly, strain effect was greatly observed in live, plucked and dressed weights, dressing percentage and breast of broilers. This agrees with reports of Sogunle *et al.* (2010) that live weight and dressing percentage were significantly affected by strains of broiler chickens. Also, Kokoszyński *et al.* (2013) opined in a study that chickens from three strains differed significantly in dressing percentage. Significant differences in the breast of strains in this study could be as a result of body conformation of the strains and meat to bone ratio in the breast region of the birds. This strain difference was also reported by Sogunle *et al.* (2012) between Harco black cockerels and Novogen cockerels

Furthermore, the elevated ether extract content of pectoralis major observed in the dry season could be due to the direct effect of ambient temperature. According to Baziz *et al.* (1996), high temperatures can increase the carcass fat, while low temperatures have opposite effect. Bogosavljevic-Boskovic *et al.* (2006) also observed higher percentage of lipids in breasts, thighs and drumsticks in broilers reared in hot weather. This was further confirmed by Barbour *et al.* (2010) who reported in their study that meat from heat acclimatized birds had higher fat contents. Conversely, High Density Lipoprotein was

higher in the wet season than in the dry season. Literature is consequently limited regarding seasonal effects on pectoralis major cholesterol profile of broilers. However, results indicated that the hypocholesterolemic effect in breast muscle increases with increase ambient temperature. Besides, insignificance of strain effect on the quality assessment of pectoralis major measured in this study is however in contradiction with previous studies such as the findings of Berri et al. (2001) who observed statistically significant differences in protein content between commercial and some experimental broiler hybrids. Sogunle et al. (2010) also reported significant differences between the strains in protein and dry matter compositions of breast muscles. Also, the observed non-significance of strain on breast cholesterol profile in this study contradicted the findings of Tanzeela et al. (2000) who observed statistically significant differences in cholesterol content of breast and thigh of different classes of chicken. Sinku et al. (2003) also reported significant effect of age and breed on cholesterol content of breast of culled birds. Cholesterol profile in this present study was measured in broiler chickens of similar ages at slaughter and this could be the cause of the contradiction with previous studies.

Conclusion

- Broiler chickens reared outdoor in the dry season had better feed conversion ratio compared to those raised in the wet season but mortality was greater.
- Outdoor rearing of Arbor acre broilers in wet season had better feed conversion and carcass yield with pectoralis major meat rich in high density lipoprotein content than obtainable in the dry season.

Impact

This study emphasized the consequences of inclement weather on broiler production in alternative production systems. It further lends credence to the limitation in outdoor broiler husbandry for the production

of wholesome and high quality meat.

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References

- Abu-dieyeh Z H M. 2006. Effect of chronic heat stress and long-term feed restriction on broiler performance. *International Journal of Poultry Science*, 5(2): 185-190.
- Adebambo A O, Ikeobi C O N, Ozoje M O, Oduguwa O O, Adebambo O A. 2008. Genetic variation in feed efficiency among pure and crossbred meat type. *Nigerian Poultry Science Journal*, 5(2): 61 – 69.
- Ajayi F O, Ejiofor O. 2009. Effects of genotype x sex interaction on growth and some development characteristics of Ross and Anak broiler strains in the high rainforest zone of Nigeria. *Asian Journal of Poultry Science*, 3: 51-56
- Aksit M, Yalcin S, Ozkan S, Metin K, Ozdemir D. 2006. Effects of temperature during rearing and crating on stress parameters and meat quality of broilers. *Poultry Science*, 85: 1867-1874.
- Akyuz A. 2009. Effects of some climates parameters of environmentally uncontrollable broiler houses on broiler performance. *Journal of Animal and Veterinary Advances*, 8(12): 2608-2612.
- AOAC. 2005. Official method of Analysis (18th ed.). Washington, DC: Association of Officiating Analytical Chemists
- Appleby M C, Hughes B O. 1991. Welfare of laying hens in cages and alternative systems: Environmental, physical and behavioural aspects. *Worlds Poultry Science Journal*, 47: 109-128.
- Attia Y A, Al-hanoun A, Bovera F. 2011. Effect of different levels of bee pollen on performance and blood profile of New Zealand White bucks and growth performance of their offspring during summer and wither months. *Journal of Animal*

Physiology and Animal Nutrition, 95(1): 17-26.

Barbour E K, Tayeb I, Shaib H, Abraham I M. 2010. Physiological and carcass traits in heat stressed broilers differing in heat acclimatization, chemical or feed restriction treatments. *Agriculture and Biology journal of North America*, 1(2), 65-74

Baziz H, Geraert P, Padilha J, Guillaumin S. 1996. Chronic heat exposure enhances fat deposition and modifies muscle and fat partition in broiler carcasses. *Poultry science*, 75: 505-513.

Berri C, Wacrenier N, Millet M, Le Bihan-duval E. 2001. Effect of selection for improved body composition on muscle and meat characteristics of broiler from experimental and commercial lines. *Poultry Science*, 80: 833-838.

Berrong S L, Washburn K W. 1998. Effects of genetic variation on total plasma protein, body weight gains and body temperature responses to heat stress. *Poultry Science*, 77: 379-385.

Bianchi M, Petracci M, Sirri F, Folegatti E, Franchini A, Melazzi A. 2007. The influence of season and market class of broiler chickens on breast meat quality traits. *Poultry Science*, 86: 959-963.

Bogosavljevic-Boskovic S, Kurcubic V, Petrovic M, Radovic V. 2006. The effect of season and rearing systems on meat quality traits. *Czech Journal of Animal Science*, 51(8): 369-374.

Bonnet S, Geraert PA, Lessire M, Carre B, Guillaumin S. 1997. Effect of high ambient temperature on feed digestibility in broilers. *Poultry Science*, 76: 857-863.

Chen H, Huang R L, Zhang H X, Di K Q, Pan D, Hou, Y G. 2007. Effects of photoperiod on ovarian morphology and carcass traits at sexual maturity in pullets. *Poultry Science*, 86: 917-920.

DEFRA. 2005. Heat stress in poultry: solving the problem. Department of environment, food and rural affairs. www.defra.gov.uk. pp1-24.

Fossum O, Jansson D S, Etterlin P E, Vågsholm I. 2009. Causes of mortality in laying hens in different housing systems in 2001 to 2004. *Acta Veterinaria Scandinavica*, 51: 1-19.

Ghazi SH, Habibian M, Moeini MM, Abdolmohammadi A R. 2012. Effects of different levels of organic and inorganic chromium on growth performance and immunocompetence of broilers under heat stress. *Biological Trace Element Research*, 146: 309-317.

Goromela E H, Kwakkel R P, Verstegen M W A, Katule A M. 2008. Effect of season and farming system on the quantity and nutritional quality of scavengable feed resources and performance of village poultry in central Tanzania. *Journal of Cell and Animal Biology*, 2(3): 063-071

Har L, Rong D, Zhang ZY. 2000. The effect of thermal environment on the digestion of broilers. *Journal of Animal Physiology and Animal Nutrition*, 83: 57-64.

Hassan A M, Reddy P G. 2012. Early Age Thermal conditioning improves broiler chicks response to acute heat stress at marketing Age. *American Journal of Animal and Veterinary Science*, 7: 1-6

Imik H, Atasever M A, Urgan S, Ozlu H, Gumus R, Atasever M. 2012. Meat quality of heat stress exposed broilers and effect of protein and vitamin E. *British Poultry Science*, 53: 689-698.

Kokoszyński D, Bernacki Z, Korytkowska H, Wilkanowska A, Frieske A. 2013. Carcass Composition and Meat quality of grey partridge (*Perdix perdix* L.). *Journal of Central European Agriculture*, 14(1): 378-387

Lichovnikova M, Jandasek J, Juzl M, Draekova E. 2009. The meat quality of layer males from free range in comparison with fast growing chickens. *Czech Journal of Animal Science*, 54: 490-497.

Lu Q, Wen J, Zhang H. 2007. Effect of chronic heat exposure on fat deposition and meat quality in two genetic types of chicken. *Poultry Science*, 86: 1059-1064.

Niu Z Y, Liu F Z, Yan Q L, Li W C. 2009. Effects of different levels of vitamin E on growth performance and immune responses of broilers under heat stress. *Poultry Science* 88: 2101-2107.

Olawumi S O, Dudusola I. 2011. Assessment of long-term production traits of three breeds of exotic commercial layers in the derived savannah zone of Nigeria. *Journal of Applied and Natural Science* 3(1): 20-24.

- Öskan S, Akbas Y, Altan Ö, Altan A, Ayhan V, Özkan K. 2003. The effect of short-term fasting on performance traits and rectal temperature of broilers during the summer season. *British Poultry Science*, 44: 88-95.
- Rajini R A, Narahari D, Kumararaj R. 2009. Influence of season, form of feed, dietary energy, age and sex on broiler organ biometry. *Indian Journal of Poultry Science*, 44(15): 346-348
- Razuki W M, AL-Rawi A A. 2007. The response of two broiler genotypes to various dietary protein levels. *Iraqi Poultry Science Journal*, 2: 234-245.
- Razuki W M, Mukhlis S A, Jasim F H, Hamad R F. 2011. Productive performance of four commercial broiler genotypes reared under High Ambient temperatures. *International Journal of Poultry Science*, 10(2): 87-92.
- Rosa P F, Faria Filho D E, Dahlke F, Vieira B S, Macari M, Furian R L. 2007. Effect of energy intake on performance and carcass composition of broiler chickens from different genetic groups. *Brazilian Journal of Poultry Science*, 9: 117-122.
- SAS (Statistical Analysis System). 2010. Version 9.3, SAS, Institute Inc. Carry NC., USA.
- Savory C J, Jack M C, Sandilands V. 2006. Behavioural responses to different floor space allowances in small groups of laying hens. *British Poultry Science*, 47:120-124.
- Sinku R P, Prasad R L, Pal A K, Jadhao S B. 2003. Effect of plant proteolytic enzyme on the physico-chemical properties and lipid profile of meat from culled, desi and broiler chicken. *Asian-australian Journal of Animal Science*, 16(6): 884-888.
- Sogunle O M, Egbeyale L T, Alajo O A, Adeleye O O, Fafiolu A O, Onunkwor O B, Adegbite J A, Fanimu A O. 2010. Comparison of meat composition and sensory values of two different strains of broiler chickens. *Archivos de zootecnia*, 59(226): 311-314.
- Sogunle O M, Okusolubo O X, Olaniyi O A, Safiyu K K, Akinola O S, Ladokun A O. 2014. Effects of Different Housing Systems on Growth Performance, Reproductive Organ Development and Faecal Egg Worm Counts of Two Strains of Egg-Type Chicken. *Nigerian Journal of Animal Science*, 16(1): 67-75.
- Sogunle O M, Olaniyi O A, Shittu T A, Abiola S S. 2012. Performance and meat sensory attributes of cockerel chickens reared on deep litter and free range production systems. *Archivos de zootecnia*, 61(236): 569-576
- Tadelle D. 1996. Studies on village poultry production systems in the Central Highlands of Ethiopia M.Sc. Thesis. Swedish University of Agricultural Sciences. Uppsala, Sweden. pp70.
- Tanzeela T, Bhatti B M, Rehman A. 2000. Estimation of Cholesterol contents in breast and thigh muscles of different strains of chicken (*Gallus domesticus*). *Pakistan Veterinary Journal* 20(4): 206-208.

PREVALENCE OF MAJOR SKIN DISEASES OF CATTLE AND ASSOCIATED RISK FACTORS AROUND AMBO TOWN, ETHIOPIA

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Abstract

Across-sectional study was conducted on 384 cattle to identify skin diseases and associated risk factors in cattle in and around Ambo town, Ethiopia. Thorough clinical examination was made followed by collection of skin scrapping and visible ecto-parasites for laboratory identification. The overall prevalence was 73.7%, of which 69.01% was ecto-parasite infestation, 4.36% skin wart and 2.6% dermatophilosis. Among ecto-parasites ticks, lice and mange mites accounted for 64.3%, 14.6% and 10.16%, respectively. The tick genera identified were *Boophilus* (51.6%), *Rhipicephalus* (28.4%), *Amblyomma* (8.6%) and *Hyalomma* (3.4%); whereas lice and mange mite genera detected were [*Linognathus* (12.8%) and *Haematopinus* (1.6%)] and [*Psoroptes* (9.4%) and *Demodex* (0.8%)], respectively. Univariable logistic regression analysis showed significantly higher ($p < 0.001$) prevalence of tick infestation in males, local breeds and poor body conditioned animals under extensive management system. Only age of cattle showed significant association with mange mite and lice infestations. Dermatophilosis was significantly ($p < 0.05$) higher in animals 2-5 years of age, cross breed and semi-intensively managed cattle. Generally, the prevalence of tick was high, that of lice and mange mite was moderate prevalence whereas the prevalence of dermatophilosis, skin wart, LSD and photosensitization was low. These findings call for urgent, coordinated and organized ecto-parasite and skin disease control at all level starting from the farm up until the tanneries.

Keywords: Ambo; Cattle; Prevalence; Skin Diseases; Risk Factors.

PRÉVALENCE DES PRINCIPALES MALADIES CUTANÉES DES BOVINS ET FACTEURS DE RISQUES ASSOCIÉS DANS LES ENVIRONS DE LA VILLE D'AMBO EN ETHIOPIE

Résumé

Une étude transversale a été réalisée sur 384 bovins, dans le but d'identifier les maladies cutanées et les facteurs de risque associés chez les bovins élevés dans et autour de la ville d'Ambo en Éthiopie. Un examen clinique approfondi a été réalisé, suivi d'un frottis cutané et d'un prélèvement d'ecto-parasites visibles pour identification au laboratoire. La prévalence globale était de 73,7%, établie de la manière suivante : infestation par des ectoparasites 69,01% ; verrues cutanées 4,36% ; et dermatophilose 2,6%. Parmi les ectoparasites, les tiques, les poux et les sarcoptoidés représentaient respectivement 64,3%, 14,6% et 10,16%. Les genres de tiques identifiés étaient *Boophilus* (51,6%), *Rhipicephalus* (28,4%), *Amblyomma* (8,6%) et *Hyalomma* (3,4%) ; tandis que les genres de poux et d'acariens détectés étaient respectivement [*Linognathus* (12,8%) et *Haematopinus* (1,6%)] et [*Psoroptes* (9,4%) et *Demodex* (0,8%)]. L'analyse de régression logistique univariable a montré une prévalence significativement plus élevée ($p < 0,001$) de l'infestation de tiques chez les mâles, les races locales et les animaux au mauvais état corporel élevé en système d'élevage extensif. Seul l'âge des bovins a montré une association significative avec les infestations d'acariens de la mange et de poux. La dermatophilose était significativement ($p < 0,05$) plus élevée chez les animaux âgés de 2 à 5 ans, chez les races croisées et chez les bovins élevés en systèmes semi-intensifs. En général, la prévalence des tiques était élevée, celle des poux et des acariens était modérée, tandis que la prévalence de la dermatophilose, de verrues cutanées, de LSD et de la photosensibilisation était faible.

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Ces résultats appellent à un contrôle urgent, coordonné et organisé des maladies ectoparasitaires et des maladies cutanées, à tous les niveaux, de la ferme aux tanneries.

Mots-clés : Ambo ; bovins ; prévalence ; maladies cutanées ; Facteurs de risque

Introduction

Ethiopia has huge livestock population estimated to be about 53.99 million cattle, 24.06 million goats, 25.5 million sheep, 1.91 million horses, 6.75 million donkeys, 0.35 million mules and 50.38 million poultry (CSA, 2013) and 2.314 million Camel (CSA, 2004). The livestock sub-sector contributes an estimated 12% total gross domestic product (GDP) and over 45% to agricultural GDP (MOA, 2010). The highland, agricultural based system of livestock production includes some 80% of cattle population which provides draught power, milk, meat, fiber, fuel and fertilizer. They also provide hide and skin which is either exported partially processed or tanned and finished in the country for making leather goods. The developing leather industry requires high quantity hide and skin from the livestock industry. Leather and semi-processed hides and skins have constituted the second major export product of the country which contributes 10 to 20% of the total foreign earnings during the last decades (Theo, 2003). However, a considerable portion of pre-slaughter defects of skin are directly related to skin diseases or secondary damage that occurs when the animal scratches itself to relieve the itching associated with skin diseases (Kassa et al. 1998).

Cattle are affected by various skin problems, some of which are easy to cure while others are more complicated with zoonotic importance. The existence of various skin diseases affecting cattle is frequently reported from different parts of Ethiopia. The most common cattle skin diseases reported in Ethiopia are dermatophilosis, lumpy skin disease, dermatophilosis, lice infestation, acariasis, photosensitivity and warts (Yacob et al., 2008; Tadesse et al., 2011). Besides their impact on leather quality, skin diseases impose economic losses as a result of reduction in body weight gain and milk yield, occasional

mortality, reduction of performance in draft animals, losses associated with treatment and prevention of diseases and zoonosis (Aiello and Mays, 1998).

For appropriate intervention, nationwide knowledge about the epidemiology of the potential skin diseases of cattle at various localities in Ethiopia is necessary. Therefore, the objectives of the present study were to identify major skin diseases, their prevalence and associated risk factors in cattle in and around Ambo town, West Shewa Zone, Oromia region, Ethiopia.

Materials and Methods

Description of the Study Area

The study was conducted in and around Ambo town. Ambo is situated at latitude and longitude of 8°59'N 37°51'E at elevation of 2101 meters above sea level, 114 km West of Addis Ababa. The temperature ranges from 15°C-29°C (22°C average). It receives a mean annual average rainfall of 900 mm, the highest rainfall occurring from June to September and the mean monthly relative humidity varies from 64.6% in August to 35.8% in December, which is comfortable for livestock and human life. Livestock are major agricultural resource and Ambo district has 144,243 cattle, 95,661 sheep and goat, 23,100 equine and 92,030 poultry population (MOA, 2010).

Target population and study animals

The target populations were cattle kept under semi-intensive and extensive management systems including all age, sex and breeds. The study animals were both indigenous/local and Holstein Frisian crossbreed cattle belonging to volunteer owners.

Study design and sampling strategy

A cross-sectional study was conducted

from October 2013 to March 2014. The sample size calculated was 384, as there was no previous study conducted in the area 50% expected prevalence, 5% desired accuracy level and 95% confidence interval was considered according to Thrusfield (2005). Three kebeles (the smallest formal administrative organ) were randomly chosen, and small holders/households in the selected kebeles were chosen randomly. The total sample size was divided to the three kebeles equally (128 each) as the cattle population of the kebeles is proportional. Since the average cattle holding rate of households in West Shewa is 5, 26 (128/5) households were included from each kebele. All cattle from the selected owners were examined for skin diseases. Determination of age was made according to Aiello and Mays (1998) and body condition scored following the recommendation of Nicholson and Butterworth (1986). The breed of the animals was recorded as local (indigenous breed) and cross (hybrid with Holstein Friesian breed) and management system as extensive (free grazing with no feed supplement) and semi-intensive (kept for milk production with feed supplement and better management).

Ethical statement

All animals in this study were treated according to the ethical standards of Ambo University, and all animal handlings was assessed and approved by the Ambo University Animal Research Ethics Review Committee (ARERC) with its reference number RCCSD/AREC/005/2014. The farmers were informed about the purpose and the methods of the study. Oral consent was obtained from each farmer before commencement of the study.

Epidemiological data collection

Clinical examination and laboratory investigation

Detailed husbandry and health history was taken from the owner of the animals followed by visual inspection and palpation of individual for skin lesions and ecto-parasites. The putative risk factors such as sex, age, breed, and body condition and management

system were recorded while examining animals. Depending upon the clinical presentation skin scrapings, scabs, abscesses and exudates were collected from at least two sites covering the adequate depth and peripheral edges. Externally visible parasites were collected and subjected to the visual detection under lower magnification power of a microscope/stereomicroscope in Ambo University veterinary laboratory technology laboratory. Observable characteristic wide spread nodular skin lesions; lymphadenitis and fever were used to diagnose Lumpy Skin Disease (LSD) (Radostits *et al.*, 2007). Photosensitization was diagnosed based on their clinical and gross pathological manifestations (Yaqob *et al.*, 2008), whereas lesions due to hot iron branding was by visual inspection. For suspected cases of dermatophilosis samples of skin scraping were checked using Giemsa stain and direct microscopy according to the procedure used by Woldemeskel and Taye, (2002). For skin scrapings from suspected cases of mange 10% KOH was added to the specimen to release mites from scabs and crusts before examination, followed by direct examination under low power microscope (Soulsby, 1982). Pus was direct microscopy examination to detect demodex based on the morphological characteristics (Urquhart *et al.* 1996). Lice and ticks were collected in 70% alcohol and identified (Soulsby, 1982).

Data analysis

All data collected were entered in to Microsoft excel spreadsheet and coded and statistical analysis was made using STATA software version 11.0 (Stata Corp., College Station, TX, USA). Descriptive statistics was used to summarize the data. Logistic regression was used to assess the association of risk factors with the prevalence of skin diseases. Dummy variables were created for those explanatory variables with more than two categories. Categorization of age was made as <2, 2–5 and >5 years and body condition scoring as good, medium and poor. For all risk factors, the level with the lowest prevalence was used as a reference category. Those variables with

p-value less than 0.25 by univariable analysis were further analyzed by multivariable logistic regression after checking for multi-collinearity. Chi-square/Fischer's exact test was used to assess the association risk factors with skin disorders with lower prevalence. In all the cases, 95% confidence intervals and $p < 0.05$ were set for significance.

Results

Out of the 384 cattle examined, 73.7% were with one or more skin problems, among which 68.0% were infested with ecto-parasites. Ticks (64.3%) were the major ecto-parasites followed by lice (14.6%) and mange mites (10.2%). The prevalence of skin wart, dermatophilosis, photosensitization, lumpy skin disease and branding was 4.7%, 2.6%, 1.3%, 1% and 1%, respectively. *Boophilus* (51.6%) was the leading tick genera followed by *Rhipicephalus* (28.4%), *Amblyomma* (8.6%) and *Hyalomma* (3.4%). *Linognathus* (12.8%) and *Hematopinus* (1.6%) were the lice and *Psoroptes* (9.4%) and *Demodex* (0.8%) were the mange mite genera detected (Fig. 1).

The univariable logistic regression analysis of overall ecto-parasite infestation with risk factors in Table 1 shows that cattle of age less than 2 years ($P=0.002$), local breed, medium and poor body condition animals and those under extensive management system were at higher risk ($P<0.001$) of acquiring skin diseases.

Similar analysis of risk factors showed that all of the recorded variables except age are significantly associated ($P<0.001$) with tick infestation (Table 2). Likewise, for mange mite infestation only age was found to be significantly associated ($P<0.001$), i.e. significantly higher prevalence observed in cattle of 2-5 years of age (Table 3). Lice infestation was found to be significantly associated with age, i.e., cattle under 2 years of age being more infested than cattle above 2 years of age (Table 4). The multivariable logistic-regression analysis (Table 1, 2, 3 and 4) showed skin disease to be associated with age ($P<0.05$) and body condition ($P<0.001$). Tick infestation was significantly associated with ($P<0.001$) body condition, whereas mange mite and lice infestation were significantly associated ($P<0.001$) with age.

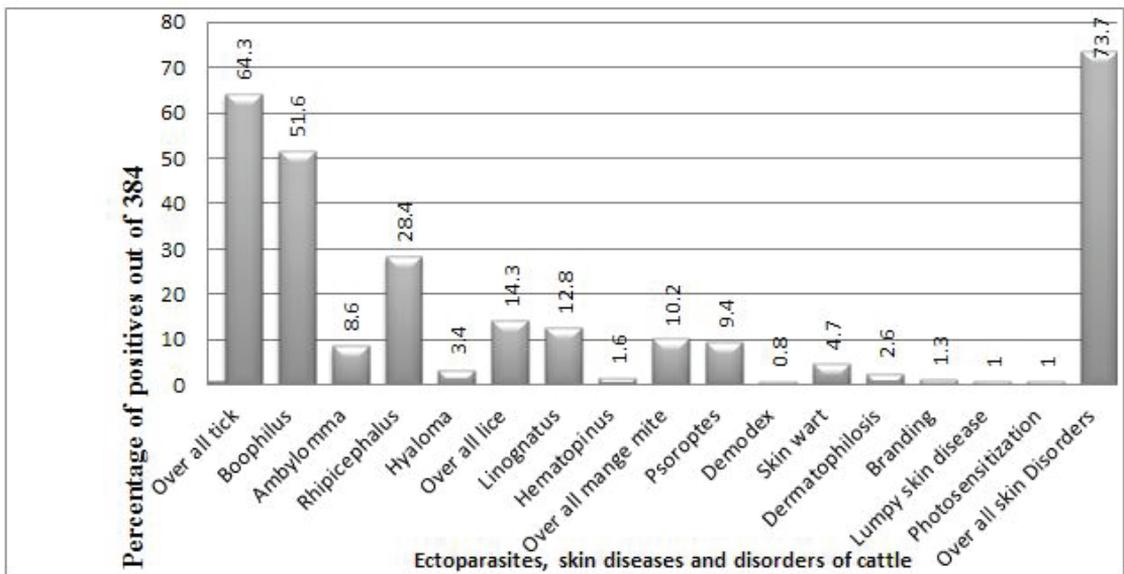


Figure 1: prevalence of major ecto-parasites and skin diseases and disorders of cattle

Table 1: The association of risk factors on overall ecto-parasites infestation using logistic regression analysis

Variable	Level	N	Prevalence %	Univariate logistic analysis		Multivariable logistic regression	
				OR (95 % C I)	P-value	OR (95 % C I)	P-value
Age in years	<2	110	81.8	2.86(1.45,5.64)	0.002	2.29(1.09,4.80)	0.029
	2-5*	72	61.1	-	-	-	-
	>5	202	62.9	1.08(0.62,1.87)	0.791	1.33(0.72,2.46)	0.360
Sex	Male	164	76.2	1.99(1.26,3.11)	0.003	1.58(0.93,2.68)	0.088
	Female*	220	61.8	-	-	-	-
Breed	Local	325	73.5	4.67(2.61,8.37)	0.000	3.63(0.41,32.3)	0.248
	Cross*	59	37.3	-	-	-	-
	Good*	217	53.45	-	-	-	-
Body condition	Medium	117	83.78	4.49(2.57,7.85)	0.000	3.89(2.17,6.98)	0.000
	Poor	50	94	13.64(4.12,45.2)	0.000	12.62(3.71,42.9)	0.000
	Extensive*	327	73.4	4.73(2.62,8.54)	0.000	0.82(0.09,7.41)	0.858
Management	Semi-intensive	57	36.8	-	-	-	-

*=Reference category, N= number of animal examined, CI= confidence interval, OR= odds ratio

Table 2: Influence of risk factors on prevalence of tick infestation in cattle using logistic regression

Variable	Level	N	Prevalence %	Univariate logistic analysis		Multivariable logistic regression	
				OR (95 % C I)	P-value	OR (95 % C I)	P-value
Age in years	<2	110	75 (68.18)	1.28 (0.69,2.39)	0.429	-	-
	2-5*	72	45(62.5)	-	-	-	-
	>5	202	127(62.87)	1.02(0.58,1.77)	0.955	-	-
Sex	Male	164	121(73.78)	2.10 (1.35,3.26)	0.001	1.59(0.98, 2.59)	0.062
	Female*	220	126(57.27)	-	-	-	-
Breed	Local	325	227(69.84)	4.52(2.51-8.14)	0.000	2.83(0.36, 22.49)	0.324
	Cross*	59	20(33.89)	-	-	-	-
	Good*	217	113(52.07)	-	-	-	-
Body condition	Medium	117	91(77.77)	3.22(1.93,0.37)	0.000	2.88(1.70,4.87)	0.000
	Poor	50	43(86)	5.65(2.44,13.12)	0.000	5.33(2.25,12.6)	0.000
	Extensive*	327	228(69.72)	4.61(2.53- 8.39)	0.000	0.32(0.14,9.24)	0.907
Management	Semi-intensive	57	19(33.33)	-	-	-	-

*=Reference category, N= number of animal examined, CI= confidence interval, OR= odds ratio

Table 3: Influence of risk factors on prevalence of mange mite infestation in cattle using logistic regression

Variable	Level	N	Prevalence %	Univariate logistic analysis		Multivariable logistic regression	
				OR (95 % C I)	P-value	OR (95 % C I)	P-value
Age in years	<2	110	5(4.55)				
	2-5*	72	19(26.38)	4.47(2.13, 9.39)	0.000	4.58(2.14,9.80)	0.000
	>5	202	15(7.43)	0.59(0.21,1.68)	0.326	0.48(0.17,1.40)	0.182
Sex	Male	164	22(13.41)	1.85(0.95,3.61)	0.071	1.56(0.76,3.26)	0.224
	Female*	220	17(7.72)	-	-	-	-
Breed	Local	325	37(11.38)	3.66(0.86,15.6)	0.080	4.03(0.02,929.0)	0.615
	Cross*	59	2(3.39)	-	-	-	-
	Good*	217	21(9.68)	1.15(0.52,2.52)	0.734	1.15(0.50,2.63)	0.748
Body condition	Medium	117	10(8.55)	-	-	-	-
	Poor	50	8(16)	2.04(0.75,5.52)	0.161	2.69(0.93,7.77)	0.067
	Extensive*	327	37(11.31)	3.51(0.82,14.98)	0.090	0.91(0.01,212.5)	0.974
Management	Semi-intensive	57	2(3.51)	-	-	-	-

*=Reference category, N= number of animal examined, CI= confidence interval, OR= odds ratio

Table 4: Influence of risk factors on prevalence of lice infestation in cattle using logistic regression

Variable	Level	N	Prevalence %	Univariate logistic analysis		Multivariable logistic regression	
				OR (95 % C I)	P-value	OR (95 % C I)	P-value
Age in years	<2	110	37(33.63)	8.62(2.92,25.45)	0.000	9.26(3.09,27.73)	0.000
	2-5*	72	4(5.55)	-	-	-	-
	>5	202	15(7.42)	1.36 (0.44,4.25)	0.593	1.30(0.42-4.08)	0.649
Sex	Male	164	21(12.80)	1.29(0.72,2.32)	0.395	-	-
	Female*	220	-	-	-	-	-
Breed	Local	325	56(17.23)	-	-	-	-
	Cross*	59	0	-	-	-	-
	Good*	217	31(12.29)	0.48(0.20,1.15)	0.101	0.45(0.18,1.15)	0.097
Body condition	Medium	117	14(11.96)	-	-	-	-
	Poor	50	11(22)	0.59(0.27,1.27)	0.180	0.097(0.38,2.06)	0.782
	Extensive*	327	56(17.12)	-	-	-	-
Management	Semi-intensive	57	0	-	-	-	-

*=Reference category, N= number of animal examined, CI= confidence interval, OR= odds ratio

Table 5: Influence of risk factors on prevalence of some skin diseases in cattle using Chi square/ Fischer's exact test

Variable	Level	N	Skin problems (No of positives and prevalence)							
			Skin wart	X2 & P value	Dermatophytosis	X2 & P value	Photosensitization	X2 & P value	LSD	X2 & P value
Age in years	<2	110	11(10)		0	5.769 0.033	2(1.8)		0	2.307 0.314
	2-5	72	2(2.8)	9.749 0.009	1(1.4)		2(2.8)		0	
Sex	>5	202	5(2.5)		9(4.5)		0		4(2)	
	Male	164	12(7.3)	4.430 0.035	4(2.4)	0.031 0.861	0		4(2.4)	5.422 0.033
Breed	Female	220	6(2.7)		6(2.7)		4(1.8)		0	
	Local	325	15(4.6)	0.025 0.875	5(1.5)	9.472 0.002	4(1.2)		4(1.2)	0.734 0.625
Body condition	Cross	59	3(5.1)		5(8.5)		0		0	
	Good	217	4(1.84)	9.873 0.006	5(2.3)	2.699 0.346	4(1.8)		4(1.8)	1.961 0.440
Management	Medium	117	11(9.4)		5(4.3)		0		0	
	Poor	50	3(6)		0		0		0	
Management	Extensive	327	15(4.6)	0.050 0.824	5(1.3)	10.039 0.002	4(1.2)		4(1.2)	0.705 0.631
	Semi-intensive	57	3(5.3)		5(8.7)		0		0	

Table 5 shows Chi-square/Fischer's exact test analysis of skin disorders and associated risk factors. Hence skin wart was significantly associated with age, sex, breed and body condition. Dermatophilosis was also significantly associated with age, sex, and breed and management system. However, branding, LSD and photosensitization were not significantly associated with any of the factors investigated.

Discussion

The overall prevalence of major skin problems in cattle encountered in the current study was 73.7%. This was higher compared to 15.41% reported by Yaqob et al. (2008). This high prevalence might be associated with the number of skin diseases and infections considered in the current study. The traditional communal grazing and watering points that favor transmission and establishment of parasites and infections and the unsatisfactory ecto-parasite control practices in the area could favor for the endemicity. Ecto-parasite infestation was the outstanding problem (68.0%) which is comparable with the reports by Tadesse et al. (2011) (73.3%) from Ethiopia and Islam et al. (2009) (65.5%) from Bangladesh. However, it was much higher compared to the 27% prevalence reported from Southwest of Ethiopia (Onu and Sheferaw, 2013). The disparity among the reports might be due to variation in locations, management practices and ecto-parasite control practices of the study sites.

In this study tick infestation (64.3%) was the outstanding ecto-parasites and the genera identified were *Boophilus*, *Rhipicephalus*, *Ambylomma* and *Hyalomma*. The identified genera were similar with those detected by Yaqob et al. (2008) and Tadesse et al. (2011). The dominance of tick infestation among others is in agreement with the work of Onu and Sheferaw (2013). The relatively higher prevalence of tick infestation in this study might be due to the humidity and tropical climate that favors the survival and reproduction of ticks (Pangui, 1994). Significantly higher prevalence of tick

infestation in males than females, local cattle than crosses, poor body conditioned cattle than good body conditioned animals and animals in extensive system than in semi-intensive system in the present study is comparable with Kleindorfer et al. (2006) who reported similar risk factors and trend of association. More than 84.6% of the cattle in this study were from traditional management system where males are used for traction, crop trashing etc., such work load might suppress the natural defense mechanism against tick and other diseases. The poor tick control in the area might also have contributed for higher prevalence of tick in indigenous cattle. In line with this, reports have indicated high level of tick infestation in poorly managed cattle during wet season (Shiferaw and Abebe, 2006 and Gedilu et al. 2014). Severe tick infestation causes loss of blood, which in turn affect appetite and leads to poor body condition (Bianchi et al. 2003).

The current study also revealed 10.16% prevalence of mange mite infestation, which is comparable with 10.7% reported by Agumas et al. (2015) from northern Ethiopia. The relatively higher prevalence in the current study could be associated with favorable climatic and environmental condition in the area. Similarly the prevalence of lice infestation recorded in this study was 14.3%, which is higher as compared to the 3.94% reported previously by Yacob et al. (2008). According to Urquhart et al. (1996), heavier lice infestation is usually seen on calves, yearlings and older unthrifty animals and those under poor husbandry conditions. In line with this, the current study revealed significantly higher ($P < 0.05$) proportion of lice (33.63%) in younger animals less than 2 years of age, which could be due to their inefficient grooming behavior and other defense capabilities (Melauncon, 1993).

According to Woldemeskel and Taye (2002), dermatophilosis is a treat to livestock production in Ethiopia. In line with, 2.6% prevalence in this study is considerable, even though it is relatively lower than the 5.22% and the 8.7% reported by Kassaye et al. (2003) from Ethiopia and Awad et al. (2008) from Egypt. Higher prevalence in cross breed cattle

might be due to the less adaptation compared to indigenous breed and higher prevalence in cattle >5years could be associated with the prolonged exposure to predisposing factors such as rain and tick infestation (Berhanu and Woldemeskel, 1999; Woldemeskel 2000; Abdo and Pal, 2013). It was already known that the damage to the skin by thorn, wooden splinter, wire or by ecto-parasites and the wetting of skin by prolonged rain facilitate the movement of zoospores and the transmission of the disease.

Bovine papilloma viruses (BPV) induce papillomatosis of skin, genitalia, eye and some internal structures such as the upper gastrointestinal tract and urinary tract (Borzacchiello and Roperto, 2008). The current study revealed considerable prevalence of skin wart (4.69%) significantly higher in younger as compared to older cattle, which is in agreement with Salib and Farghali, (2011) who reported higher frequency of multiple papillomatosis of skin and mucosal surfaces in younger animals. The prevalence of lumpy skin disease [LSD] (1.04%) in cattle in the current study is lower than similar study conducted in Woliso by Beshahwured (1991) who reported 27.9% prevalence. LSD occurs as an outbreak and has been reported from different parts as a cause of production losses, although the mortality rate is usually low. However, more recently, severe disease in *Bos taurus* breeds with wide spread epidemics and higher mortality has been reported, which might be indicative of the existence of highly pathogenic strain. Severely affected dairy cattle may experience up to 50% drop in milk production, abortion and mastitis due to lesions on the teats (Radostits et al. 2007). Photosensitization is most severe in animals with non-pigmented skin and those not protected from exposure to sunlight (Quinn et al., 2014). In the present study, about 4 cases (1%) of skin damage suspected to be due to photosensitization were encountered. Lastly, 5 cases (1.3%) were found with branding marks. Branding is made by owner for animal identification and traditional healing purpose. Urgessa (2013) reported 2.5% of the defects in the hide in the tanneries of Addis Ababa and

Modjo to be due to branding.

In conclusion, among skin diseases ecto-parasites were the leading of which tick was the most prevalent. Although their prevalence is low skin wart, dermatophilosis and lumpy skin disease were observed. Generally, cattle of young to middle age group and those under poor management system were found to be at risk of acquiring the majority of skin diseases. According to this study skin diseases are widespread in the study area suggesting the presence of considerable loss of milk production and draught power, which has an implication on the country's food security program and country's foreign exchange as it is responsible for skin and hides rejection in the tanneries. Therefore, close attention to the health of cattle is necessary and specific control strategies for each skin diseases need be implemented at all level.

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References

- Abdo J, Pal M, 2013. Dermatophilosis in Cross-Bred Dairy Cattle in Debre Zeit, Ethiopia. *International Journal of Livestock research*, 3(1): 78-80.
- Agumas KS, Nega BH, Mengistu BA, 2015. Prevalence of Mange Mite Infestation on Cattle in South Achefer District, Northwest Ethiopia. *American-Eurasian Journal of Scientific Research*, 10 (4): 186-192.
- Aiello SE, Mays A, 1998. *The Merck Veterinary Manual*, 8th ed. Merck and Co, Inc, White house station, NJ, USA, pp. 131-133.

- Awad W S, Nadral-Elwgoud MI, Abdou El-Sayed AA, 2008. Diagnosis and treatment of bovine, ovine and equine dermatophilosis. *Journal of Applied Scientific research*, 44: 367–374.
- Berhanu D, Woldemeskel M, 1999. Bovine dermatophilosis and its influencing factors in central Ethiopia. *Journal of Veterinary Medicine*, 46: 593-597.
- Beshahwured S, 1991. Outbreak of lumpy skin disease in and around Wolliso. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.
- Bianchi MW, Barre N, Messad S, 2003. Factors related to cattle infestation level and resistance to acaricides in *Boophilus microplus* tick populations in New Caledonia. *Veterinary Parasitology*, 112(1): 75-89.
- Borzacchiello G, Roperto F, 2008. Bovine papillomaviruses, papillomas and cancer in cattle. *Veterinary Research, BioMed Central*, 39 (5): 45.
- CSA, 2004. Livestock population of Ethiopia, Central Statistical Authority. Statistical bulletin, Addis Ababa Ethiopia
- CSA, 2013. Federal Democratic Republic of Ethiopia, Agricultural sample survey. Statistical bulletin, April 2013 Addis Ababa Ethiopia.
- Gedilu M, Mohamed A, Kechero Y, 2014. Determination of the prevalence of ixodid ticks of cattle breeds, their predilection sites of variation and tick burden between different risk factors in Bahir Dar, Ethiopia. *Global Veterinaria*, 13 (4): 520-529.
- Islam MS, Rahman SA, Sarker P, Anisuzzaman MMH, 2009. Prevalence and population density of ectoparasitic infestation in cattle in Sirajgonj district, Bangladesh. *Bangladesh Research and Publication Journal*, 2: 332-339.
- Kassa B, Bisrat M, Aseggedech S, Africa J, 1998. Control of “Ekeke” skin defects in sheep by insecticides and shearing. EVA proceeding 12th annual conference; Addis Ababa, Ethiopia, pp. 104-109.
- Kassaye E, Moser I, Woldemeskel M, 2003. Epidemiological study on clinical bovine dermatophilosis in Northern Ethiopia. *Deutsche Tierärztliche Wochenschrift*, 110: 422-425.
- Kleindorfer S, Lambert S, Paton DC, 2006. Ticks (*Ixodes* species) and blood parasites (*Haemoproteus* spp.) in new Holland honey eaters (*Phylidonyris novaehollandiae*): Evidence for site specificity and fitness costs. *Emu. Australian Ornithology*, 106: 2.
- Melauncon J, 1993. Lice. Large Animal veterinarian; Mt. Morris, IL Wesley Ave: United State of America.
- MOA, 2010. Federal Ministry of Agriculture, Animal and Plant Health Regulatory Directorate (APHRD). Addis Ababa, Ethiopian. Animal Health Year Book (2009/10).
- Nicholson MJ, Butterworth MH, 1986. A guide to condition scoring of Zebu cattle. International Livestock Center for Africa, Addis Ababa.
- Onu SH, Shiferaw TZ, 2013. Prevalence of ectoparasite infestations of cattle in Bench Maji zone; southwest Ethiopia, *Veterinary World*, 6(6): 291-294.
- Pangui LJ, 1994. Mange in domestic animals and methods of control. *Rev. Sci. Tech. Off. Int. Epiz.*, 13 (4): 1227-1243.
- Quinn C Jane, Allan Kessell, Leslie A Weston, 2014. Secondary Plant Products Causing Photosensitization in Grazing Herbivores: Their Structure, Activity and Regulation. *International Journal of Molecular Science*, 15: 1441-1465.
- Radostits OM, Gray CC, Hinchichiff KW, Constable PD, 2007. *Veterinary Medicine, a Text Book of the Diseases of Cattle, Sheep, Pigs, Goats and Horses*. 10th ed. Philadelphia: Saunders, Pp. 1048-1050.
- Salib FA, Farghali HA, 2011. Clinical, epidemiological and therapeutic studies on Bovine Papillomatosis in Northern Oases, Egypt in 2008. *Veterinary World*, 4(2): 53-59
- Shiferaw D, Abebe G, 2006. Cattle tick dynamics indifferent agro-ecological Zones of Wolayta, southern Ethiopia. *Ethiopian Veterinary Journal*, 10: 85–99.
- Soulsby EJ, 1982. Helminthes, Arthropods and protozoa of domestic animals, 7th ed., Bailliere and Tindall (eds), London, England, pp. 357-504.

Tadesse A, Fentaw E, Mekbib B, Abebe R, Mekuria S, Zewdu E, 2011. Study on the prevalence of ectoparasite infestation of ruminants in and around Kombolcha and damage to fresh goat pelts and wet blue (pickled) skin at Kombolch Tannary, Northeastern Ethiopia, *Ethiopian Veterinary Journal*, 15:87-101.

TheoV 2003 The importance of the leather footwear sector for development in Ethiopia. Addis Ababa University printing press, Addis Ababa, Ethiopia.

Thrusfield M 2005 *Veterinary epidemiology*. 3rd ed. Blackwell Science Ltd, London. pp. 281-282.

Urgessa BG, 2013. Defect Assessment of Ethiopian Hide and Skin: The Case of Tanneries in Addis Ababa and Modjo, Ethiopia. *Global Veterinaria* 11 (4): 395-398.

Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW, 1996. *Veterinary Parasitology*, Blackwell Science Ltd, UK, pp. 141-205.

Woldemeskel M, 2000. Dermatophilosis: A threat to livestock production in Ethiopia. *Deutsche Tierärztliche Wochenschrift*, 107: 144-146.

Woldemeskel M, Taye T, 2002. Prevalence of bovine dermatophilosis in tropical highland region of Ethiopia. *Tropical Animal and Health and Production*, 34: 189-194.

Yacob HT, Nesanet B, Dinka A, 2008. Part II: Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia regional state, *Revue de Médecine Vétérinaire*, 159: 455-461.

SHORT COMMUNICATION

Prevalence Of Bovine Cysticercosis In Zimbabwe

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Bovine cysticercosis (beef measles) is a zoonotic disease of socio-economic and public health importance that threatens food security and safety (OIE, 2006). In Africa high prevalences of beef measles have been reported in Ethiopia, DRC, Kenya and Nigeria (Gracy and Collins, 1999). Bovine cysticercosis is caused by *Cysticercus bovis*, the larval stage of the human tapeworm *Taenia saginata*. This condition results in economic losses with the impact being most severe on resource-poor rural farmers who sell their cattle to provide for daily necessities. The adult stage of the tapeworm can also infect human beings when they ingest inadequately cooked beef, and this leads to conditions such as diarrhea, depression and weakness (Kumar and Tadesse, 2011).

Taenia saginata eggs are disseminated by humans as they are the definitive host of the tapeworm. Poor hygiene practices, poverty, increased contact between cattle and humans and low levels of awareness among the human population are some of the risk factors associated with bovine cysticercosis (Dorny *et al.*, 2000). Other factors like uncontrolled defecation and inadequate destruction of taeniid eggs which remain viable in sewage play important roles in the spread of *T. saginata* infection. In addition, the use of raw sewage or its effluent to fertilize pastures or land where fodder is grown can also be a risk factor.

Surveying of livestock conditions and condemnation rates at slaughter are an important, convenient and inexpensive way of gathering data on the epidemiology of less acute, chronic, mild, and subclinical diseases like bovine cysticercosis (Mukaratirwa *et al.*, 2009). As the disease is zoonotic, data on the disease can be used to locate the origin of infected

humans, educate farm workers or other infected humans, and advise cattle producers (USAHA, 2011). This information can also be used to establish relationships between veterinary and public health and thus advance One Health (USAHA, 2011).

In Zimbabwe, post mortem examination procedures of carcasses for beef measles include incisions into the masseter, heart, tongue, diaphragm, gracilis and shoulder muscles. Economic losses from beef measles result from the extensive trimmings at post mortem, the prolonged storage of mildly infected carcasses during freeze treatment, whole carcass condemnations of severely infested carcasses as well as the cost of inspection.

The prevalence of bovine cysticercosis infections can be reduced by avoiding the use of raw sewage as fertilizer on pastures where cattle graze, provision and use of proper ablution facilities, public education on the importance of the disease, and efficient meat inspection. Previous work on bovine cysticercosis in Zimbabwe has focused on Matabeleland Provinces only, hence this study aimed at determining the prevalence of bovine cysticercosis in all the provinces of Zimbabwe.

Abattoir data on bovine cysticercosis cases for the period January 2014 to December 2015 were obtained from the weekly reports of the Division of Veterinary Services. The data were from all abattoirs with meat inspection services from all the provinces of Zimbabwe. Data were captured into Microsoft Excel and collated according to province of origin, total cattle slaughtered and cases positive for bovine cysticercosis. For each province, data was entered according to year, month, season, number of slaughtered cattle and cases.

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Season was classified as wet and dry with the wet season ranging from November to April and dry season from May to October. Descriptive statistics for monthly, seasonal and annual variation in cases at national level were done in Microsoft Excel. The Chi-square test was used to test for seasonal differences in occurrence of cases.

A total of 325 007 cattle were slaughtered in all centers receiving meat inspection services in Zimbabwe during the study period. Of the total slaughtered cattle, 2380 were positive for bovine cysticercosis giving a combined prevalence of 0.73% (CI=0.70-0.76). The annual prevalence in 2014 was 0.73% (CI=0.69-0.78) and in 2015 it was 0.73% (CI=0.69-0.77) with no significant

difference in the prevalences (Table 1). There was a significant difference between the dry and wet season, with the dry season recording a higher prevalence of 0.76% (CI=0.72-0.80) than the wet season with 0.69% (CI=0.69-0.74; P=0.02).

The prevalence of bovine cysticercosis in all provinces ranged from 0.01%-2.17% (Figure 1). Harare Province had the lowest prevalence and Mashonaland Central the highest prevalence. Occurrence of bovine cysticercosis had no significant difference (P=0.45) between Manicaland and Mashonaland East and also between Midlands and Mashonaland West (P=0.58). In all other provinces there was a significant difference in the occurrence of bovine cysticercosis (P<0.0001).

Table 1: Annual prevalence of bovine cysticercosis

Year	Census	Cases	Prevalence	Confidence Interval (95%)
2014	154 790	1133	0.73%	0.69-0.78
2015	170217	1247	0.73%	0.69-0.77
Total	325007	2380	0.73%	0.70-0.76

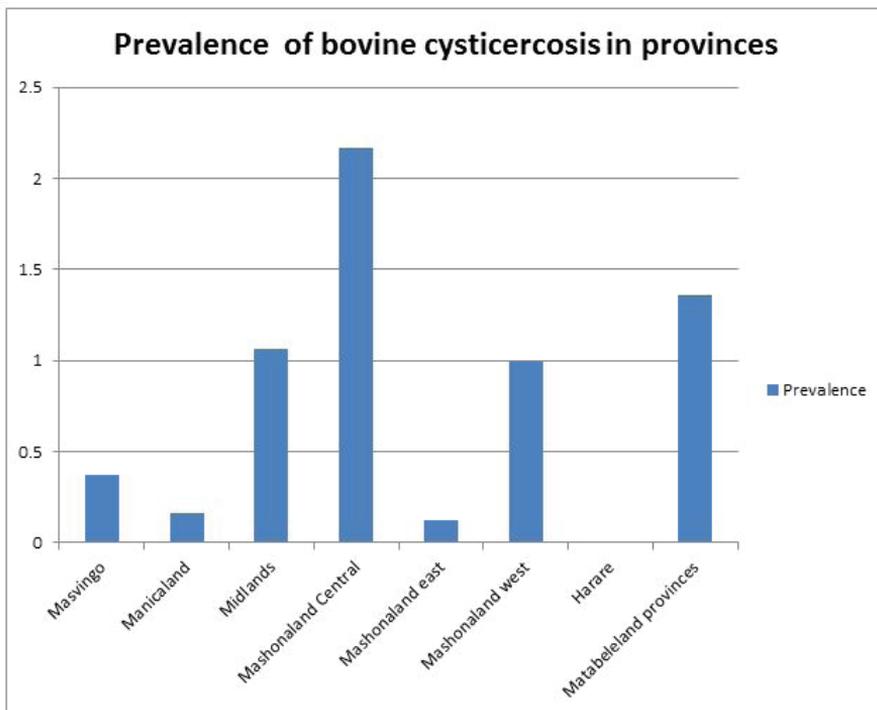


Figure 1: Prevalence of bovine cysticercosis in provinces

This report shows the prevalence of bovine cysticercosis in Zimbabwe is low compared to other African countries (Semie *et al.*, 2015; Asaava *et al.*, 2009) and is similar to other findings (Dzoma *et al.*, 2011). The relatively low prevalence might be due to lower infestation which might reflect better use of ablution facilities in communities where the slaughter cattle are kept. In addition, cultural factors like consumption of well cooked beef may contribute to the low prevalence. However, it has been reported that the invasive meat inspection method normally detects less than 10% of the positive cases (Kumar and Tadesse, 2011). This is supported by Dorny *et al.* (2010), who suggested that low prevalence may be attributed to a low infestation or the fact that on routine meat inspection the cysticerci could easily be missed as most cases of cysticercosis occur in light infestations. According to Opara (2006), inexperienced meat inspectors are more likely to miss a number of viable cysticerci resulting in the beef being passed for human consumption. Therefore, due to the low sensitivity of the invasive meat inspection method, low figures do not necessarily mean that there is low infestation and thus better methods with higher sensitivity are still needed for screening this zoonotic disease (Sungirai *et al.*, 2014).

The significantly higher prevalence in Mashonaland Central and Matabeleland provinces could be attributed to poor waste disposal, bush defecation, low levels of public awareness and presence of background slaughtering practices leading to contamination of the environment in general, or it could be a reflection of more illegal mining activities compared to other provinces as reported in a number of media outlets (www.sundaynews.co.zw). Illegal mining practices have been implicated as a predisposing factor for bovine cysticercosis as there are no ablution facilities in these areas. This leads to increased contamination of grazing pastures and thus increased exposure of cattle to human faecal material.

The significantly higher prevalence in the dry season could be a result of more

exposure in the dry season compared to the wet season due to higher host-parasite contact as cattle herds congregate around contaminated stagnant water sources (Ofukwu *et al.*, 2009).

This report has shown that there is a low prevalence of bovine cysticercosis in Zimbabwe; however more public awareness of the disease, regular deworming of members of communities most at risk and more sensitive tests to reduce false negatives are still needed. Further, all abattoir data should always be captured and documented accurately to ensure availability of such data for future use.

References

- Asaava LL, Kitala PM, Gathura PB, Nanyingi MO, Muchemi G, Schelling E, 2009. A survey of bovine cysticercosis/human taeniosis in Northern Turkana District, Kenya. *Preventive Veterinary Medicine*, 89, 197-204.
- Dorny P, Vercammen F, Brandt J, Vansteenkiste W, Berkvens D, Geerts S, 2000. Sero-epidemiological study of *Taenia saginata* cysticercosis in Belgian cattle. *Veterinary Parasitology*, 88(1), 43-49.
- Dzoma BM, Setlhodi EK, Molefe MM, Motsei ME, Bakunzi FR, Ndou RV, Nyirenda M, 2011. Prevalence of bovine cysticercosis in North West province of South Africa from 2000 to 2010. *Journal of Human Ecology*, 36, 9-12.
- Gracey J, Collins DS, Huey R, 1999. *Meat Hygiene*, 10th Ed. Saunders, UK.
- Kumar A, Tadesse G, 2011. Bovine cysticercosis in Ethiopia: A Review. *Ethiopian Veterinary Journal*, 15, 15-35.
- Mukaratirwa S, Dzoma BM., Matongo C, Nyahuma M, 2009. Some Causes of Organ and Carcass Condemnations in Ostriches Slaughtered at the Only Ostrich Abattoir in Zimbabwe from 1999-2005. *International Journal of Poultry Science*, 8(11), 1096-1099.

Ofukwu RA, Akwuobu CA, Okwori AI, 2009. Epidemiology and public health importance of bovine cysticercosis in Makurdi, North-Central Nigeria. *Tanzania Veterinary Journal*, 26(1), 37-43.

Opara MN, Ukpong UM, Okoli IC, Anosike JC, 2006. Cysticercosis of slaughter cattle in southeastern Nigeria. *Annals of the New York Academy of Sciences*, 1081, 339-346.

Pawlowski ZS, 2002. *Taenia solium*: basic biology and transmission. In *Cysticercosis: Present State of Knowledge and Perspectives*, Eds., Flisser A, Willms K, Lacleste JP, Larralde C, Ridaura C, Beltran F: Academic Press, New York, pp: 69-86.

Semie K, Assefa A, Getu A, 2015. Review Work on Bovine Cysticercosis and its Public Health Importance in Ethiopia. *Acta Parasitologica Globalis*, 6, 20-28.

Sungirai M, Masaka L, Mbiba C, 2014. The prevalence of *Taenia saginata* cysticercosis in the Matabeleland Provinces of Zimbabwe. *Tropical Animal Health and Production*, 46, 623-627.

www.usha.org/portal/6Meeting/2014/2014_Cysticercosis-Beckett.pdf

OIE, 2006. Guidelines for the surveillance, prevention and control of taeniosis/cysticercosis.

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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.
- Because the guidelines are updated as appropriate, authors should check them again before they submit their articles. Manuscripts submitted for publication will be considered for acceptance on the understanding that they present original work which has not been published or submitted for publication elsewhere and that they are subject to peer review.

Types of contribution

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

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

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

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

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

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

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

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

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

Submission Guidelines

Full papers of original research

All manuscripts submitted to BAHPA should include the following features:

1. On cover page of the manuscript, the following should be clearly written/inserted: the corresponding author, name of the institution, title of the manuscript, names of the authors, the addresses of the authors and the e-mail address of the corresponding author. The corresponding author should ensure that all the other authors consent to their names being included. The consent should be sent directly by co-authors to the editor via email.
2. Each original article should be divided into Abstract and Keywords, Introduction, Materials and Methods, Results, Discussion, conclusion, Acknowledgments and References. A textbox containing a public brief on the study for the benefit of policy makers should also be provided. This textbox will not be included in the published article but will be compiled and published in a separate edition at the end of the year.
3. Title, which should be concise, preferably not more than 15 words long, followed by the author(s) name(s) and institution(s) to which work should be attributed and address for correspondence, if different.
4. The Abstract should not be longer than 300 words giving a synopsis of the work and should contain the objectives, briefs description of materials and methods, highlights of significant results, conclusions and recommendations. Up to six keywords should be provided..
5. The Introduction should contain the problem statement, the hypothesis and the objective of the work and cite recent important work undertaken by others.
6. Materials and Methods should describe materials, methods, apparatus, experimental procedure and statistical methods (experimental design, data collection and data analysis) in sufficient detail to allow other authors to reproduce the results. This part may have subheadings. The experimental methods and treatments applied shall conform to the most recent guidelines on the animal's treatment and care. For manuscripts that report complex statistics, the Editor recommends statistical consultation (or at least expertise); a biostatistician may review such manuscripts during the review process. Cite only textbooks and published article references to support your choices of tests. Indicate any statistics software used.
7. Results should be presented clearly and concisely, in a non-

repetitive way. Subheadings may be accepted.

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

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

Sequence of Preparation

1. The data files must be PC/Windows-compatible. The text should be prepared using standard software (Microsoft Word) format; do not use automated or manual hyphenation. Please do not include footnotes.
2. Use Times New Roman 12 point font for all text except for tables and figures where Times New Roman 10 font should be used.
3. Use 1 inch margins on top, bottom, left and right margins,
4. Every line on the text should be numbered.
5. Use double line spacing for body of text. For Abstract, Figures, Tables and References use single line spacing.
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7. Run "the spell check" and "grammar check" on the entire file before submission using either the UK English or French standard.
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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>

Illustrations

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

Abbreviations, Symbols and Nomenclature

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

Ethical guidelines

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

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