



Infection of *Oesophagostomum columbianum* in Small ruminants of the Nigerian Sahel Region and its Economic Importance

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SUMMARY

Prospective and retrospective investigations were conducted to assess the prevalence and financial losses associated with *Oesophagostomum columbianum* infections of sheep and goats slaughtered at the Maiduguri metropolitan abattoir in the semi-arid zone of Northeastern Nigeria. Out of 184,554 small ruminants (56,739 sheep and 127,815 goats) recorded between June 1998 and July 2003, the intestines of 0.4%, 0.46 and 0.38% respectively, were condemned because of *Oesophagostomum* nodules. Of the 1,483 intestines examined by us (499 sheep and 984 goats) at the abattoir between August and November 2009, 67.6%, 60.1 and 71.3% respectively, had nodules which occurred as small, oval, dull white tubercles predominantly in the large, but sometimes in the small intestine. Nodules were more common ($P < 0.05$) in sheep than goats; in adult than young animals, in female than male goats, but male and female sheep had similar ($P > 0.05$) numbers, and in the dry than the rainy season. Out of 522 goat intestines examined between August and November 2009, 462 (88.5%) had adult *O. columbianum*. The mean worm burden was 47.9 ± 56.2 . Worm numbers were similar ($P < 0.05$) between male and female goats but greater worm populations were encountered in young than adult goats. Adult worm numbers were negatively correlated with the number of nodules, but not with weights of the intestines of infected goats. A total of 279.58 kg of intestinal tissue, amounting to N111,832, was condemned due to pimply gut in sheep and goats in the retrospective study but the loss was N143,408 in the prospective study. Losses were greater ($P < 0.05$) in female than male and adult than young animals. The losses were also greater in goats than sheep irrespective of the sex and age group of the animals or the months of study. The number of nodules positively correlated with the weight of the intestines and thus the financial losses in the animals. *Oesophagostomum columbianum* infections of small ruminants appear to constitute a serious health problem and a source of important financial loss due to the associated condemnation of the intestines of affected animals at post mortem as a result of nodules.

KEY WORDS: *Oesophagostomum*; prevalence; financial loss; sheep; goats; Nigeria

INTRODUCTION

Sheep and goats constitute a major source of animal protein in Nigeria (ILCA, 1979; Madu *et al.*, 2005). These animals have great economic potentials as a result of their high fertility, early maturity and easy adaptability to both humid and semi-arid environments (Ademosun, 1988). Their smaller size, relative to cattle, contributes to their widespread distribution in most rural communities and the ease of management by both children and women who provide the bulk of labour in small holder family farms in Nigeria (ILCA, 1987; Madu *et al.*, 2005). Consequently, a lot of social and economic importance is attached to ownership of small ruminants, which in some cases, may be the only realisable wealth of a rural household (Lebbie, 2004; Madu *et al.*, 2005; Nwosu *et al.*, 2007).

However, various diseases, especially parasitic gastroenteritis (PGE) caused by helminthosis, have been identified as a major limiting factor on the productivity of small ruminants in Nigeria (ILCA, 1979; Chiejina, 1986, 1987; Nwosu *et al.*, 2007; Mbaya *et al.*, 2009). Up-to-date statistics of the economic losses caused by PGE in ruminants in the country are lacking.

In Nigeria, the major nematodes responsible for PGE in small ruminants are species of the genera *Haemonchus*, *Trichostrongylus*, *Oesophagostomum*, *Bunostomum*, *Gaigeria* and *Strongyloides* (Chiejina, 1986, 1987; Nwosu *et al.*, 1996a, b; Nwosu *et al.*, 2007; Mbaya *et al.*, 2009). *Oesophagostomum* species, commonly known as 'nodular worms', are widely distributed in Nigeria with *O. columbianum* and *O. venulosum* as the common species parasitic in small ruminants (Chiejina, 1986; Nwosu *et al.*, 2007; Mbaya *et al.*, 2009).

Oesophagostomum species are pathogenic,

causing anaemia, protein-losing enteropathy, hypoproteinaemia and pimply gut (Chiejina, 1987). Consequently, they contribute significantly to the economic losses associated with the PGE syndrome in small ruminants – through mortality, morbidity, cost of treatment and other control measures (Schillhorn van Veen, 1973; Akerejola *et al.*, 1979; Soulsby, 1982). Oesophagostomosis due to *O. columbianum*, also result in partial or total condemnation of both small and large intestines during meat inspection as a result of the nodules associated with the infections (Ahmed *et al.*, 1994; Nwosu *et al.*, 1996b). In spite of these losses, there is a dearth of information on the specific seasonal prevalence and distribution of pimply gut and an up-to-date estimate of the associated economic losses in small ruminants in Nigeria and especially the semi-arid region of Northeastern Nigeria which accounts for about 30% of the small ruminant flock in the country (Anon, 1980). In this study, both retrospective and prospective investigations were conducted to assess the seasonal prevalence and current economic losses due to naturally acquired infections of *O. columbianum* in sheep and goats slaughtered at the Maiduguri metropolitan abattoir in Nigeria.

MATERIALS AND METHODS

This study was conducted in Maiduguri, the largest urban centre in the semi-arid zone of Northeastern Nigeria. The zone is characterised by a short rainy season of 3 – 4 months duration from June followed by a prolonged dry season for the rest of the year (Hess *et al.*, 1995). The sheep and goats examined during this study were trade animals brought for sale and slaughter at the Maiduguri metropolitan abattoir from various parts of Northeastern Nigeria made up of Borno and the adjoining States. These states are located within the semi-arid zone of North-eastern Nigeria where the animals were originally raised predominantly by the extensive (range) management system. The sheep and goats examined were predominantly of the Udah and Borno White breeds respectively and comprise young (6 – 12 months) and adult (> 12 months – 5 years) animals. They were randomly selected from the slaughter slab of the abattoir and their clinical status, age, breed and sex recorded. As a result of the fact that predominantly adult animals are usually slaughtered at the abattoir, it was not possible to ensure the inclusion of equal numbers of adult and young animals in the study.

Retrospective study

The number of sheep and goats slaughtered and the number of intestines of such animals condemned as a result of pimply gut caused by *O. columbianum* infections were extracted from the records of inspection of animals at the abattoir between June 1998 and July 2003. Financial losses were estimated in the Nigerian naira (₦150 = US\$1) based on the prevailing market price (₦400/kg) for such tissue at Maiduguri in November 2009.

Prospective study

Following slaughter and evisceration, the small and large intestines of each sheep and goats randomly selected from the slaughter slab of the abattoir were carefully dissected out and ligated at both ends. They were placed in separate, labelled, plastic containers, transported to the laboratory for examination and examined for adult *O. columbianum* according to Hansen and Perry (1994). In all cases, the nematodes were identified using standard descriptions (MAFF, 1977; Soulsby, 1982; Hansen and Perry, 1994). Daily and weekly visits were made to the abattoir for examination between August and November 2009.

Following the removal of the contents, the weight of each selected small and large intestine were determined using a weighing balance. Each intestine was examined and graded depending on the extent of pathological lesions (nodules), classified as normal or for condemnation.

Statistical analysis of data

The data were summarized as means \pm standard errors of the means (Mean \pm S. E. M.) or percentages. The relationship between mean adult worm and nodule numbers and weight of condemned intestines were determined by the Spearman's Rank Correlation Test at the 5% ($P < 0.05$) level of significance (GraphPad, 2000).

RESULTS

Prevalence and counts of *Oesophagostomum* nodules in sheep and goats

The recording of the inspection and condemnation figures for the intestines of small ruminants was not available at the abattoir between August 2003 and December 2009. The available records at the Maiduguri metropolitan abattoir between June 1998 and July 2003, showed that a total of 184,554 small ruminants

made up of 127,815 goats and 56,739 sheep were slaughtered with the intestines of 744 (0.4%), 482 (0.38%) and 262 (0.46%) respectively, being condemned as a result of *O. columbianum* nodules or pimply gut (Table I). Only totally condemned intestines were included in the study. Intestinal condemnation for both sheep and goats was highest in 2000 and lowest in 2003. These condemnations were also relatively low throughout the rainy season (May to September) but increased sharply to a peak at the end of the rains in October; remaining relatively high for the rest of the dry season (Fig. 1). A similar pattern was recorded in both sheep and goats throughout the year although a relatively higher proportion of sheep than goat intestines were condemned for most of the months.

TABLE I. Condemnation of sheep and goat intestines due to pimply gut and associated financial loss at the Maiduguri abattoir between June 1998 and July 2003

Animal species	Year	Number slaughtered	Condemnation		
			No. (%)	Weight (kg)	Amount lost (N)*
Goat	1998	3,650	28 (0.77) ^b	9.24	3,696
	2000	7,371	67 (0.91) ^a	22.11	8,844
	2001	23,364	118 (0.51) ^b	38.94	15,576
	2002	66,810	200 (0.30) ^c	66.00	26,400
	2003	26,620	69 (0.26) ^c	22.77	9,108
	Sub-total	127,815	482 (0.38)	159.06	63,624
	Sheep	1998	2,734	21 (0.77) ^a	9.66
2000		5,211	34 (0.65) ^a	15.64	6,256
2001		12,906	70 (0.54) ^a	32.20	12,880
2002		22,781	90 (0.40) ^b	41.40	16,560
2003		13,107	47 (0.36) ^b	21.62	8,648
Sub-total		56,739	262 (0.46)	120.52	48,208
All animals		1998	6,384	49 (0.77) ^a	18.90
	2000	12,582	101 (0.80) ^a	37.75	15,100
	2001	36,270	188 (0.52) ^b	71.14	28,456
	2002	89,591	290 (0.32) ^c	107.40	42,960
	2003	39,727	116 (0.29) ^c	44.39	17,756
	Grand total	184,554	744 (0.40)	279.58	111,832

*Financial losses were calculated based on the mean weight of 0.46 kg and 0.33 kg respectively for sheep and goat intestines and a market price of N400/kg for such tissue in Maiduguri at the time of the study (N150 = US\$1).

In the prospective study, a total of 1,483 small ruminants made up of 984 goats and 499 sheep were examined for *O. columbianum* nodules between August and November 2009 (Table II). Out of these, 1,002 (67.6%) had nodules and these included 702 (71.3%) goats and 300 (60.1%) sheep ($P > 0.05$). The number of nodules was similar among the sex and age groups of sheep ($P > 0.05$) but female goats had more nodules than the males ($P < 0.05$). Sheep consistently had a greater ($P < 0.05$) number of nodules than goats irrespective of the sex and age group of the animals and month of the year (Tables II and III).

TABLE II. Prevalence and counts of *Oesophagostomum* nodules and associated financial loss according to the sex and age of sheep and goats examined at the Maiduguri abattoir between August and October 2009

	Number examined	Prevalence No. (%)	Mean \pm S.D.	Range	Financial loss* Weight (kg)	Amt (N)
Goat						
All goats	984	702 (71.3)	197.7 \pm 479.1 ^j	1 - 5500	231.66	92,664
Male	299	204 (68.2) ^a	116.6 \pm 289.5 ^{aj}	1 - 3000	67.32	26,928
Female	685	498 (72.7) ^a	231.0 \pm 534.6 ^{bj}	1 - 5500	164.34	65,736
Young	45	24 (53.3) ^a	49.0 \pm 105.0 ^{aj}	1 - 500	7.92	3,168
Adult	939	678 (72.2) ^a	203.0 \pm 486.3 ^{aj}	1 - 5500	223.74	89,496
Sheep						
All goats	499	300 (60.1)	274.7 \pm 600.4 ^j	1 - 3800	138.00	55,200
Male	44	25 (55.8) ^a	126.6 \pm 300.5 ^{ak}	2 - 1500	11.50	4,600
Female	455	275 (60.4) ^a	288.1 \pm 619.1 ^{ak}	1 - 3800	126.50	50,600
Young	17	7 (41.7) ^a	244.7 \pm 554.5 ^{ak}	2 - 1500	3.22	1,288
Adult	482	293 (60.8) ^a	275.4 \pm 602.3 ^{ak}	1 - 3800	134.78	53,912
All animals						
All goats	1483	1002 (67.6)	220.8 \pm 221.2	1 - 5500	369.66	147,864
Male	343	229 (66.8) ^a	117.7 \pm 290.0 ^a	1 - 3000	78.82	31,528
Female	1140	773 (67.8) ^a	251.3 \pm 566.3 ^a	1 - 5500	290.84	116,336
Young	62	31 (50.0) ^a	93.2 \pm 277.3 ^a	1 - 1500	11.14	4,456
Adult	1421	971 (68.3) ^a	224.9 \pm 524.8 ^b	1 - 5500	358.52	143,406

^{ab} Figures in the same column with different superscripts among sexes and age groups within sheep or goats are significantly different ($P < 0.05$)

^{jk} Figures in the same column with different superscripts for all, sexes and age groups between sheep and goats are significantly different ($P < 0.05$)

*Financial losses were calculated based on the mean weight of 0.46 kg and 0.33 kg respectively for sheep and goat intestines and a market price of N400/kg for such tissue in Maiduguri at the time of the study (N150 = US\$1).

TABLE III. Monthly prevalence and counts of *Oesophagostomum* nodules and associated financial loss in sheep and goats examined at the Maiduguri abattoir between August and October 2009

	Number examined	Prevalence No. (%)	Mean ± S.D.	Range	Financial loss* Weight (kg)	Amt (N)
Goat						
August	226	158 (69.9)	92.7 ± 282.2 ^a	1 - 2500	52.14	20,856
Sept.	454	306 (67.4)	261.6 ± 621.3 ^{bj}	1 - 5500	100.98	40,392
October	214	168 (78.5)	177.6 ± 331.8 ^{ci}	3 - 2000	55.44	22,176
Nov.	90	70 (77.8)	203.9 ± 366.3 ^{dj}	1 - 1605	23.10	9,240
Sheep						
August	325	172 (52.9)	321.0 ± 664.8 ^{ak}	1 - 3800	79.12	31,648
Sept.	131	96 (73.3)	203.4 ± 522.2 ^{bk}	2 - 3000	44.16	17,664
October	43	32 (74.4)	239.4 ± 417.1 ^{ck}	1 - 1500	14.72	5,888
All animals						
August	226	158 (69.9)	92.7 ± 282.2 ^a	1 - 2500	52.14	20,856
Sept.	779	478 (61.4)	283.0 ± 637.2 ^b	1 - 5500	186.22	72,040
October	345	264 (76.5)	187.0 ± 410.6 ^c	1 - 3000	99.60	39,840
Nov.	133	102 (76.7)	215.1 ± 381.2 ^d	1 - 1605	37.82	15,128

^{abc} Figures in the same column with different superscripts within sheep or goats are significantly different (P<0.05)

^{jk} Figures in the same column with different superscripts for the same months between sheep and goats are significantly different (P<0.05)

*Financial losses were calculated based on the mean weight of 0.46 kg and 0.33 kg respectively for sheep and goat intestines and a market price of N400/kg for such tissue in Maiduguri at the time of the study (N150 = US\$1).

TABLE IV. Adult *Oesophagostomum columbianum* recovered from the intestines of goats examined at Maiduguri between August and November 2009

		Number examined	Prevalence No. (%)	Number of adult worms Mean ± S.D.	Range
All goats		522	462 (88.5)	47.9 ± 56.2	0 - 400
Sex	Male	170	156 (91.8)	49.8 ± 56.9 ^a	0 - 400
	Female	352	306 (86.9)	49.4 ± 75.4 ^a	0 - 1000
Age	Young	24	24 (100)	79.1 ± 68.6 ^a	0 - 280
	Adult	498	438 (88.0)	46.3 ± 55.1 ^b	0 - 400
Months	August	142	130 (91.5)	41.1 ± 47.6 ^a	0 - 300
	Sept.	213	190 (89.2)	45.1 ± 48.9 ^b	0 - 230
	October	135	113 (83.7)	54.3 ± 65.4 ^{bcd}	0 - 334
	Nov.	32	29 (90.6)	68.9 ± 83.7 ^c	0 - 400

^{abc} Figures in the same column with different superscripts among sexes, age groups of goats or months of the year are significantly different (P<0.05).

Adult worm recovery from goats

Table IV shows the prevalence and counts of adult *O. columbianum* recovered from goats examined post mortem at the Maiduguri abattoir between August and November 2009. Out of 522 goat intestines examined, 462 (88.5%) harboured adult worms. Prevalence of infection and number of adult worms were similar between male (91.8%) and female (86.9%) goats but prevalence and worm numbers were significantly

(P < 0.05) higher in young (100%) than adult (88%) goats. The prevalence of infection with adult worms was high and similar (P > 0.05) during all months of the study but worm numbers varied significantly (P < 0.05) between the months; rising from 41.1 ± 47.6 in August to a peak of 68.9 ± 47.6 in November. The number of adult worms was negatively correlated with the number of nodules in infected goats (n = 462; r = -0.1809; P < 0.0001) but there was no correlation between adult worm numbers and the weight of the intestines and thus the financial loss from infected goats (n = 462; r = -0.006191; P = 0.8944).

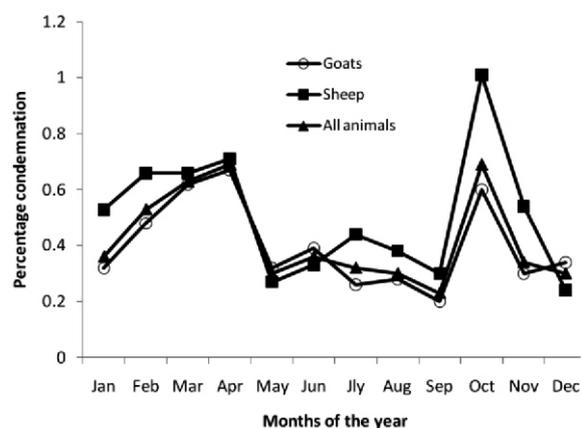


Fig. 1. Monthly condemnation of sheep and goat intestines due to pimply gut at Maiduguri between June 1998 and July 2003

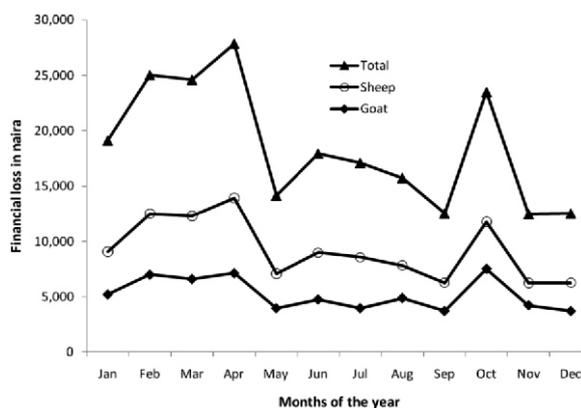


Fig. 2. Monthly financial loss from condemnation of sheep and goat intestines due to pimply gut at Maiduguri between June 1998 and July 2003

Financial loss from condemnation of intestines

The mean weight of the large and small intestines of sheep and goats were respectively 0.46 ± 0.11 kg and 0.33 ± 0.10 kg. The prevailing market price for sheep and goat intestines at Maiduguri during the study was N400/kg. Based on the above, 279.58 kg of intestinal tissue amounting to

₦111, 832 was condemned as a result of pimply gut in both sheep and goats between June 1998 and July 2003 (Table I). The losses increased from ₦7, 560 in 1998 to a peak of ₦42, 960 in 2002. The same pattern was observed in either sheep or goats during the period although the overall loss and losses during individual years were greater in goats than sheep. The overall financial loss and those due to sheep or goat followed the same seasonal pattern; being relatively low during the rainy than dry season with a peak in April (Fig. 2).

In the prospective study, 369.66 kg of intestinal tissue estimated at ₦147, 864 was condemned from both sheep and goats between August and November 2009 (Table II). Greater losses ($P < 0.05$) were recorded in female than male and in adult than young animals. The same pattern was noted in sheep or goats although greater ($P < 0.05$) losses were generally recorded in goats than sheep irrespective of age or sex of the animals or the month of study. The number of nodules in the host positively influenced the weight of the intestines and thus the associated financial loss in both animal species ($n = 1002$; $r = 0.1122$; $P = 0.0004$).

DISCUSSION

The results of this study suggest that *Oesophagostomum columbianum* nodules (pimply gut) occur in high prevalence among sheep and goats in the semi-arid zone of Northeastern Nigeria. The overall prevalence of 67.6% recorded for pimply gut in sheep and goats in the prospective study is very significantly ($P < 0.05$) higher than the 0.4% recorded in the retrospective analysis of abattoir records between June 1998 and July 2003. This variation may essentially be due to the fact that the abattoir records included only very heavy infections that warranted the total condemnation of such intestines whereas the prospective study included every case of pimply gut encountered during that period. Furthermore, the lower prevalence could have been contributed to by poor record keeping and the lack of commitment on the part of the abattoir staff that result in irregular pre and post slaughter inspection of animals at the abattoir.

The 0.4% condemnation of sheep and goat intestines due to pimply gut as obtained from the abattoir records during this study is essentially similar to the 0.23% reported by Ahmed *et al.* (1994) in a similar study at the same abattoir

between 1982 and 1998. On the other hand, the prevalence of 67.7% recorded in the prospective study is higher than the 38.3% reported in Sokoto red goats raised in a similar geographical zone in Northwestern Nigeria although mean worm (25.2 ± 23.3) and nodule (229 ± 473.2) numbers were similar in the two studies (Nwosu, 1995). The greater number of nodules in sheep than goats may be due to the fact that sheep generally receive better feeding and veterinary attention than goats which are frequently left to roam about and scavenge for food on their own. Ewes and does are usually kept for very long periods for the purposes of reproduction whereas most rams and bucks are fattened and sold off during religious and other ceremonies when they attract very high prices to the owners.

The significantly greater adult worm burdens recorded in the young than adult goats may be a reflection of the absence or lower levels of acquired immunity in the younger goats. Immune response to parasitic nematodes, including *Oesophagostomum* species, usually manifests itself by a reduction in the number of infecting larval worms that survive and eventually establish as adults within the host (Soulsby, 1982; Tizard, 1987). Adult animals, as a result of repeated infections, develop acquired immunity to re-infection so that most of the infective larvae are inhibited in the nodules and fail to develop to adults. According to Soulsby (1982), such adult animals may therefore have several nodules but only few or no adult worms in the intestine. The same observations were made during this study.

In general, the goats examined post mortem during this study harboured low (young goats) to moderate (adult goats) burdens of adult *O. columbianum*. This observation agrees with earlier reports in this and other geographical areas of Nigeria with respect to *Oesophagostomum* and other nematode species responsible for PGE in small ruminants (Nwosu, 1995; Nwosu *et al.*, 1996b, 2007). The mean worm counts recorded in the goats were generally below the 80 – 90 and 200 – 300 worms reported to respectively cause moderate (in yearlings) to severe (in adults) infections in sheep (Gordon, 1950). In the Nigerian savannah, animals graze over a large expanse of land in the extensive (range) system of management so that contamination with infective larvae is widely

dispersed in the pasture (Nwosu *et al.*, 1996b). Consequently, most animals in the field, harbour low to moderate worm burdens as was noted in the present study.

The economic losses recorded in this study were assessed through the weight of intestinal tissue condemned at post mortem. The results showed that the number of nodules present in the animals positively influenced the weight of the intestinal tissue and thus the associated financial loss through condemnation of such infected intestine. The development of nodules results in increases in the overall weight of the intestines probably due to the intense inflammatory and immunological reactions and the subsequent deposition of fibrous tissues usually associated with the formation of nodules in the animals. This study has also shown that the presence and number of nodules in the host significantly influenced the presence and number of adult *O. columbianum* that eventually established in the animals. The young animals that harboured significantly less nodules also had significantly more adult worms in their intestines. This inverse relationship between the number of nodules and the population of adult *O. columbianum* was also reflected in the financial losses recorded in adult or young goats. The losses were significantly higher in adult goats that harboured significantly more nodules than the young ones. The results also showed that nodules were more predominant in the animals during the dry than rainy season and that the financial losses followed the same pattern. These losses will therefore supplement production and other forms of losses that are usually more prevalent during the dry season when grazing animals may be malnourished due to the scarcity of fodder and grazing.

CONCLUSION

In conclusion, therefore, the results of this study suggest that infection with *O. columbianum* occurs in high prevalence and that besides the health problems, they may constitute important financial loss through the condemnation of the intestines of infected animals due to the associated nodules or pimply gut.

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