Journal of Animal and Veterinary Advances 8 (10): 1993-1998, 2009
ISSN: 1680-5593

The Effect of Helminthiasis on Weight Gains and Carcass Values of Young Indigenous Goats in Uganda

[1]K.O. Lapenga and [2]C. Rubaire-Akiiki
[1]Department of Wildlife and Animal Resources Management,
[2]Department of Parasitology and Microbiology,
Makerere University, P.O. Box 7062, Kampala, Uganda

Abstract: The objective of this study was to determine the effect of helminthiasis on weight gain and carcass value of goats. A study was carried out at Namulonge Agricultural and Animal Production Research Institute (NAARI), where 96 young goats of mixed sexes ranging in age between 8 and 20 weeks old were grouped at the age in weeks of 8-12 and 16-20 weeks old and randomly allocated to two treatments. The treatments were anthelmintic treatment with Albendazole (Albenzole®) given orally at the rate of 20 mg kg^{-1} body weight at interval of 2 weeks and no treatment to the experimental group. The investigations were replicated twice, the experimental unit being 12 goats on 4 paddocks each measuring 43.6×20.0 m with each paddock having 3 goats. The experimental plots were uniformly seeded with 0.5 kg of fresh feces containing 300 eggs g^{-1} every 2 weeks for 2 months. The goats were tethered and grazed within each paddock from 9.00 am to 6.30 pm for a period of 24 weeks. Live weights were measured at every successive 14 days and weight gains were calculated as the difference between final and initial body weights. At the end of the trials, body condition scores and carcass grades were assessed and carcass analysis was carried out. Helminthiasis caused weight loss of 2.7 kg in the 16-20 weeks old group goats and the difference in weight gains between the unexposed and exposed goats was significant ($p<0.05$). In the 8-12 weeks age group, helminthiasis caused weight loss of 0.3 kg and the difference in weight gain between the unexposed and exposed goats was significant ($p<0.05$). Helminthiasis reduced body condition score and carcass grades to 1 and 0, respectively and the dressing percentage was reduced by 7.5% in both age groups. Dry matter content in the carcasses of infected goats was reduced by 4.0%.

Key words: Helminthiasis, exposed goats, unexposed goats, weight gain, carcass value, dressing percentage, anthelmintic treatment, body condition score

INTRODUCTION

Helminthiasis is an important health constraint in goats, which l imits their productivity by impairing weight gain (Githigia *et al*., 2001), depressing milk production, altering body composition leading to condemnation of carcasses and organs (Coop, 1982) and death among kids.

Goats get infected by picking up harmful worm burdens (L_3) over a short period of time from the pasture and clinical disease is a consequence of exposing insufficiently resistant animals to heavily infected grazing so that animals pick the infective larvae at an excessive rate. The susceptible animals encounter heavy infections either when they graze a pasture contaminated by another group of animals (simple transmission) or when they themselves build up an infestation on pasture without in doing so, becoming resistant (auto-infection). Sometimes the disease producing infection is derived from both sources. Susceptibility of goats is enhanced by the environment in Uganda, which is favourable more or less throughout the year for the free-living stages of parasites. The limiting environmental variable controlling the translation of worm eggs to infective larvae is rainfall, because temperatures are always between 23-28°C to facilitate this process.

In Uganda, many small holder farmers in the rural areas keep goats mainly for meat production, but because of helminthiasis, they have not been able to get the expected output from their goats. Hitherto in Uganda no study has been done on the biological impact of helminth infection in goats. A study was conducted to determine the effect of helminthiasis on weight gain and the carcass values of goats.

Corresponding Author: K. Okello Lapenga, Department of Wildlife and Animal Resources Management, Makerere University, P.O. Box 7062, Kampala, Uganda

MATERIALS AND METHODS

The study was carried out at Namulonge Agricultural and Animal Production Research Institute (NAARI), located 27 km North of Kampala, within the bimodal rainfall region with the first rains falling from March to June and the second rains from August to November giving a total precipitation of 1.270 mm annum^{-1}. The station is at an elevation of 1.150 m above sea level and the mean maximum temperatures at day time is 28°C, while the mean minimum temperatures at night is 15°C. The vegetation is dominated by wooded savanna with tall trees and tall grasses consisting mainly of Elephant grass (*Pennisetum purpureum*) and Guinea grass (*Panicum maximum*).

Ninety six young goats of mixed sexes ranging in age between 8 and 20 weeks old from various farms were grouped at the age in weeks of 8-12 and 16-20 weeks old and randomly allocated to two treatments. The treatments were anthelmintic treatment with Albendazole (Albenzole®) given orally at the rate of 20 mg kg^{-1} body weight at interval of 2 weeks and no treatment to the experimental group. The investigations were replicated twice, the experimental unit being 12 goats on 4 paddocks each measuring 43.6×20.0 m with each paddock having 3 goats. Each paddock was demarcated using barbed wire, with several strands fixed on reinforced posts 4 ft high. A goat shed measuring 3.0×2.5 m was constructed in each paddock to provide shelter to the goats from rain and sunshine. The experimental plots were uniformly seeded with 0.5 kg of fresh feces containing 300 eggs g^{-1} every 2 weeks for 2 months. The fecal samples for seeding the pastures were collected from infected goats. The set of paddocks for the two treatments were separated from each other by a corridor, 3 m wide to prevent extraneous fecal contamination. The goats were tethered and grazed within each paddock from 9:00 am to 6:30 pm for a period of 24 weeks. Water was given to them *ad libitum* and were sprayed weekly with acaricide, 50 mg mL^{-1} α-cypermethrin diluted with water at the rate of 1:20 to control ecto-parasites. Live weights were measured at every successive 14 days and weight gains were calculated as the difference between final and initial body weights.

Spectrum of infection: At monthly intervals, fecal samples were collected for coproculture to determine the generic composition of infection (Kaufmann, 1996). At autopsy, the number of adult and the immature stages of (L_3 and L_4) nematodes from 8 goats (from each age group) were recovered and counted according to the technique described by Mekonnen (2007).

Carcass analysis: At the end of the trial, the body condition score was assessed according to Petit *et al.* (1988) before slaughter. The carcass grade of the goats was assessed after slaughter. Goats in both treatments were fasted overnight and each goat was decapitated using a sharp knife at the joint between the occipital bone and the first cervical vertebrae and hoisted by hind quarters to enhance bleeding. Blood was drained into a bucket and weighed. The decapitated animals were flayed carefully to ensure that fat and tissues did not adhere to the skin and the legs were cut at the fetlock joints. The carcass grade was assessed on the scale 0-3 and defined as follows:

- Scale 0 = Emaciated
- Scale 1 = Lean carcass
- Scale 2 = Moderate fatty carcass
- Scale 3 = Full fatty carcass

The carcass yield was calculated in terms of dressing percentage as the ratio of dressed weights and live weights based on empty body weight. The chemical composition of carcass was determined by cutting samples of meat from the longismus dorsi muscle, as well as from the liver of each carcass and subjecting them to proximate analysis (AOAC, 1990) to determine dry matter, moisture content, ash, fat and crude protein.

Statistical analysis: The Statistical Analysis System (SAS) institute carry NC version 8 statistical package was used. Dressing percentage, ratios of body parts and organs were analyzed by t-test. The t-test was done to detect differences between treated (unexposed) and non treated (exposed) goats.

RESULTS AND DISCUSSION

Spectrum of infection: Results from fecal larval identification and worm burden recovered at autopsy are shown in Fig. 1, Table 1 and 2, respectively. It shows that *Haemonchus contortus* is the predominant nematode affecting all goats followed by *Oesophagostomum* and *Trichostrongylus* in that order. Horton (1990) noted that gastrointestinal helminths almost invariably accompany grazing ruminants and mixed infection is the rule. *Haemonchus contortus* has been reported as the main nematode that affects small ruminants in the tropics and subtropical areas (Charles 1989; Anene *et al.*, 1994; Baker *et al.*, 1998). It is the most pathogenic parasite and considered to be a major threat to goats due to the fact that it has a very high biotic potential and can build upto dangerous levels within a short time (Gatongi *et al.*, 1997). Given the high cost of anthelmintic and to avoid anthelmintic resistance, FAMACHA© system would

Table 1: Genera of adult worm harvested at different GIT locations from the exposed goats of age 8-12 weeks

GIT locations	*Haemonchus contortus*	*Oesophagos columbianum*	*Trichuris* sp.	*Trichostrongylus* sp.	*Monezia* sp.
Abomasum	22	0	0	0	0
Small intestine	2	13	0	0	0
Large intestine	0	22	0	0	0
Caecum	10	53	1	1	0

Table 2: Genera of Adult worm harvested at different GIT locations from the exposed goats of age 16-20 weeks

GIT locations	*Haemonchus contortus*	*Oesophagos columbianum*	*Trichuris* sp.	*Trichostrongylus* sp.	*Monezia* sp.
Abomasum	625	0	0	20	0
Small intestine	5	26	0	8	74
Large intestine	14	41	0	0	0
Caecum	3	34	1	0	0

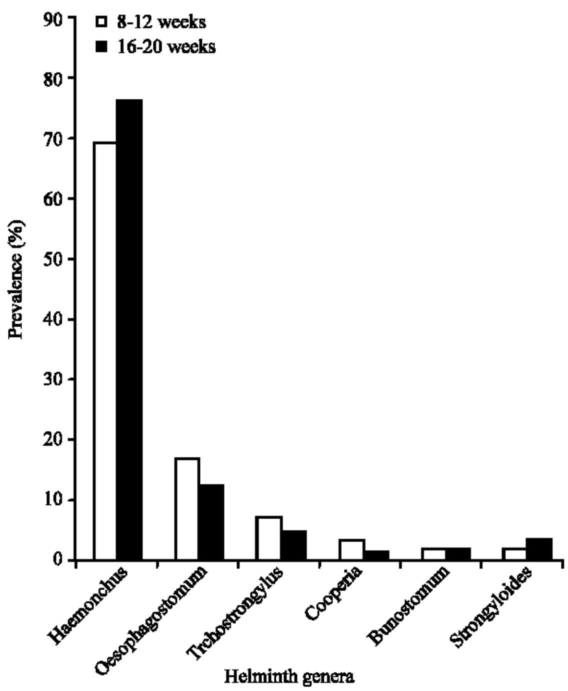

Fig. 1: Prevalence (%) of helminth infection by worm genera among 8-12 weeks and 16-20 weeks old goats

be the most appropriate method of controlling helminthiasis in goats. This is the method, where only those animals showing white ocular membrane due to extreme anaemia caused by Hemonchosis are treated and all goats from category 3 upwards in the FAMACHA© system anaemia chart should be treated (Van Wyk *et al*., 1997).

Body weight gains: One of the visible losses due to helminth infection is loss of body weight of animals (Coop, 1982). In the current study, weight gain was monitored because it is one of the most important traits in meat production, as it has implication in the amount of meat output obtained at target age. Helminthiasis caused weight loss of 2.7 kg in the 16-20 weeks old group goats and the difference in weight gains between the unexposed and exposed goats was significant ($p<0.05$). In the 8-12 weeks age group, helminthiasis caused weight loss of 0.3 kg and the difference in weight gain between the unexposed and exposed goats was significant ($p<0.05$). Loss of body weight could have been a result of reduced voluntary feed intake (Faizal *et al*., 2004; Holmes, 1987; Blackburn *et al*., 1991). The reason for the reduction in feed intake is not clear. Several factors have been implicated-local pain and inflammation causing disinclination to forage, changes in hormone levels, alterations in gut physiology and associated changes in digestion and availability of amino acids (Coop, 1982; Bremner, 1982). All the exposed animals showed signs of gastroenteritis.

Body condition score and carcass grades: The body condition score is subjective assessment, which helped in ranking the goats before slaughter and reflects subcutaneous fat deposit and muscular development and coverage of the ribs (Naude and Hofmeyr, 1981; Petit *et al*., 1988). Similarly, carcass grade was assessed according to visible subcutaneous fat covering of the carcass and leanness of the meat as demanded by consumers. The body condition scores for exposed goats were very poor, averaging 1 and the goats showed signs of gastroenteritis had diarrhea, pale mucous membranes, starry coat, lost weights and were physically debilitated. Their carcass grades were correspondingly poor (averaging 0) and lacked any fat cover. However, the treated goats had full body conformation and they had fatty carcasses. Their carcass grades were correspondingly good (averaging 2.5). This showed that helminthiasis negatively affected both the body condition score and carcass grades of the goats.

Carcass yield: Table 3 and 4 show the mean dressing percentage, weights of organs (liver and pluck) body parts and gut content expressed as percentage of slaughter weights by treatment groups for the two age groups. Since in evaluating goat meat, particular attention

Table 3: Dressing percentage and ratios of body parts and organs to slaughter weight (%) by treatment groups for mean age group of goats 16-20 weeks old

Variables	Unexposed	Exposed	p-value
Dressing percentage	51.30±1.71	43.80±0.85	0.0008**
Full gut	19.73±0.39	7.25±0.34	0.0000**
Empty gut	12.60±0.20	9.07±0.08	0.0002**
Gut content	9.69±0.12	7.25±0.08	0.0001**
Feet	32.33±0.43	16.32±0.42	0.0000**
Blood	4.74±0.06	3.90±0.11	0.0075*
Liver	2.73±0.09	2.04±0.09	0.0500
Head	2.02±0.05	1.81±0.08	0.1638
Skin	4.74±0.06	3.90±0.11	0.0075*
Pluck	9.78±0.19	5.89±0.06	0.0000**

**: $p<0.01$; *: $p<0.05$; p-value obtained from two sample test

Table 4: Dressing percentage and ratios of body parts and organs to slaughter weight (%) by treatment groups for mean age group of goats 8-12 weeks old

Variables	Unexposed	Exposed	p-value
Dressing percentage	51.30±1.71	43.80±0.85	0.0008**
Full gut	26.17±0.35	18.13±0.28	0.0021**
Empty gut	9.74±0.18	9.97±0.14	0.3899
Gut content	16.42±0.22	8.16±0.14	0.0020*
Blood	3.74±0.04	3.67±0.10	0.5355
Liver	2.27±0.04	1.36±0.07	0.0063*
Head	7.47±0.05	5.89±0.07	0.0003**
Skin	7.02±0.12	4.99±0.07	0.0085*
Pluck	2.04±0.08	1.36±0.07	0.1287

**: $p<0.01$; *: $p<0.05$; p* value obtained from two sample test

is mainly paid to dressing percentage and muscling (Murray and Taylor, 2004), it was important to know the effect of helminthiasis on dressing percentage. The mean dressing percentages of the unexposed goats of the 16-20 weeks old and 8-12 weeks old were similar, i.e., 51.3% and were significantly ($p<0.05$) higher than of the exposed goats, which were also similar, 43.8% in both age groups. This showed that helminthiasis reduced the dressing percentage by 7.5% and the difference in dressing percentage between unexposed and exposed goats was significant ($p<0.01$). Bell *et al.* (1990) carried out carcass evaluation of parasitized calves and those, which were treated with anthelmintic boluses and found that both the live weight and dressing percentage of the calves in the treated group were higher than those of the treated group.

This is because live weight is a factor vital in increasing dressing percentage values (Mahgoub and Lodge, 1998). Live weight was reduced in infected goats.

The chemical composition: Table 5 and 6 show the chemical composition of the longismus dorsi muscle of the 8-12 and 16-20 weeks old goats, respectively. The dry matter of the unexposed 16-20 weeks old goats was significantly ($p<0.05$) higher than the mean dry matter of the exposed goats. This showed that the water content

Table 5: Chemical composition percentage of longismus dorsi muscle by treatment group for mean age group of goats 8-12 weeks old

Variables	Unexposed	Exposed	p-value*
Longismus ash	7.4286±4.4082	19.250±12.6570	0.4070
Longismus crude protein	82.3710±1.7036	71.700±10.8890	0.3967
Longismus dry matter	26.5570±0.5682	23.450±3.32340	0.4108
Longismus fat	11.1430±0.8997	11.000±1.41420	0.8622

Table 6: Chemical composition (percentage) of longismus dorsi muscle by treatment group for mean age group of goats 16-20 weeks old

Variables	Unexposed	Exposed	p-value*
Longismus ash	5.8667±3.3313	8.7500±0.4435	0.0324*
Longismus crude protein	80.9890±4.9883	83.5000±3.1166	0.3786
Longismus dry matter	27.9220±1.5873	22.9750±2.5734	0.0012*
Longismus fat	2.8125±1.4436	3.5333±1.0693	0.4568

*($p<0.05$)

of the parasitized animals was higher than that of uninfected animals. This finding agrees with previous reports by Bell *et al.* (1990), Vercruysse and Dorny (1999) and Entrocasso *et al.* (1986). However, the difference in the water content of the muscles of the unexposed and exposed goats in the 8-12 weeks old age group was not significant. The reason for lack of significant difference is unclear however, physiologically younger animals normally have more body fluid and therefore, the effect of helminthiasis on the carcass water content, probably could not be detected.

Helminthiasis also affects other parameters other than dry matter. Maclean *et al.* (1992) showed that protein as a percentage of body weight was higher in the animals free of internal parasites than in the infected ones. This is because, helminth infection lowers the efficiency with which digested and metabolized nitrogen is retained (Akinbamijio *et al.*, 1996). In the current study, however, there were no significant differences in the protein content of the longismus dorsi muscle of the unexposed and exposed goats in both age groups. This was not expected.

The liver compositions in the study showed that ash, crude protein and fat percentages were significantly ($p<0.05$) higher in the exposed goats than in the unexposed animals in the 16-20 weeks old age group, while in the 8-12 week old age group there were no significant ($p>0.05$) differences in the compositions between the two treatments (Table 7 and 8). The reason for the compositions of the liver of the 16-20 weeks old age group could have been due to impaired metabolism as a result of helminthiasis, hence the accumulation of these metabolites in the liver. However, the compositions of the liver of the 8-12 weeks old age group showed that probably due to fast metabolism in young animals, the metabolites were utilized in the liver irrespective of treatments.

Table 7: Chemical composition percentage of liver by treatment groups for mean age group of goats 16-20 weeks old

Variables	Unexposed	Exposed	p-value*
Liver ash	7.7000±2.5554	11.7000±0.4899	0.0014**
Liver crude protein	62.2560±3.6807	68.5000±2.7068	0.0117*
Liver fat	5.5250±1.2685	8.6333±0.3786	0.0101*
Liver dry matter	28.9330±2.3633	26.0500±3.3491	0.0996

Table 8: Chemical composition percentage of liver by treatment groups for mean age group of goats 8-12 weeks old

Variables	Unexposed	Exposed	p-value*
Liver ash	11.7710±3.7451	8.4500±0.0707	0.0573
Liver crude protein	64.6430±4.1166	56.5950±1.2021	0.4100
Liver fat	6.2833±3.2854	6.2500±2.8991	0.9903
Liver dry matter	29.0570±1.3782	29.4000±1.9799	0.8494

CONCLUSION

The study has shown that helminthiasis affects goat production by reducing live weight gains, body conditions and carcass values in terms of quantity and quality.

However, the goats protected by anthelmintic intervention were not affected. It is therefore, important that the rural communities, who keep goats should be made aware of the dangers caused by gastrointestinal nematodes to their goats and appropriate steps should be taken to mitigate problems associated with helminthiasis in their goats. Anthelmintic intervention in the short term scenario would provide the solution. However, its use should not be abused as it may cause anthelmintic resistance in nematodes. In this respect, use of the FAMACHA© system would be appropriate in the case of *Haemonchus* infection.

ACKNOWLEDGEMENTS

The researchers would like to thank DANIDA through its Livestock System Research Program and Makerere University for supporting and funding this research.

REFERENCES

Akinbamijio, O.O., A. Lahlou-Kassi and S. Tembely, 1996. Fascioliasis and Nutrient Metabolism in Pregnant and Non-pregnant Sheep. In: Lebbie, S.H.B. and E. Kagwini (Eds.). Small Ruminant Research and Development in Africa. Proceedings of the Second Biennial Conference of the African Small Ruminant Research Network (UICC) Kampala, Uganda, pp: 143-148. Dec. 5-9. PMID: 18823. www.fao.org/wairdocs/ilri/x5473b/x5473b15.htm.

Anene, B.M., E.O. Onyekwodri, A.B. Chime and S.M. Anika, 1994. Gastrointestinal parasites in sheep and goats of Southeastern Nigeria. Small Rumin. Res., 13: (2) 187-192. DOI: 10921-4488(93)E0079-8. http://www.unn.edu.ng/index.php/Download-document/24210-Gastrointestinal-Parasites-in-Sheep-and-Goats-of-Southeastern-Nigeria.html.

AOAC, 1990. Official Methods of Analysis Association of Official Analytical Chemist, 15th (Edn.). Arlington Virginia. ISBN: 0-935584-42-0.

Baker, R.L., D.M. Mwamachi, J.O. Audho, E.O. Aduda and W. Thorpe, 1998. Resistance of galla and small East African goats in the sub-humid tropics to gastrointestinal nematode to infections and the peri-parturient rise in fecal counts. Vet. Parasitol., 79 (1): 53-64. DOI: 10.1016/S0304-4017(98)00151-4. linkinghub.elsevier.com/retrieve/pii/S0304401798001514.

Bell, S.L., R.J. Thomas and M.T. Ferber, 1990. Appetite, digestive efficiency, feed utilization and carcass evaluation of housed calves naturally infected with gastrointestinal nematodes. Vet. Parasitol., 34: 323-333. DOI: 10.1016/S0304-4017(98)00151-4. PMID: 2316177. www.ncbi.nlm.nih.gov/pubmed/2316177.

Blackburn, H.D., J.L. Rocha, E.P. Figueiredo, M.E. Berne, L.S. Vieira, A.R. Cavalcante and J.S. Rosa, 1991. Interaction of parasitism and nutrition and their effects on production and clinical parameters in goats. Vet. Parasitol., 40: 99-112. PMID: 17633494. http://www.labmeeting.com/paper/19805919/blackburn.

Bremner, K.C., 1982. The Pathophysiology of Parasitic Gastroenteritis of Cattle. 10th Edn. In: Symons, L.E.A., A.D. Donald and J.K. Dineen (Eds.). Biology and Control of Endoparasites, Academic Press, London, pp: 277-289. ISBN: 0126801207. http://www.amazon.com/Biology-Control-Endoparasites-Anniversary-Parasitology/dp.

Charles, T.P., 1989. Seasonal prevalence of gastrointestinal nematodes in Pernambuco State, Brazil. Vet. Parasitol., 30: (4) 335-343. PMID: 2728324. http://www.ncbi.nlm.nih.gov.

Coop, R.L., 1982. The Impact of Sub-clinical Parasitism in Ruminants. In: Methrick, D.F. and S.S. Desser (Eds.). Parasites their world and the Amsterdam. Elsevier Biochemical Press Publishers, The Netherlands, pp: 439-447. ISBN: 0444804331. PMID: 9830503651. http://www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=19830503651.

Entrocasso, C.M., J.J. Parkins, J. Armour, K. Bairden and P.N. McWilliam, 1986. Production, parasitological and carcass evaluation studies in steers exposed to Trichostrongyle infection and treated with a morantel bolus of Fenbendazole in two successive grazing seasons. Res. Vet. Sci., 40: 76-85. PMID: 19458264. https://www.researchgate.net/publication/19458264.

Faizal, A.C.M., W.R.A.J.S. Rajapaksha and R.P.V.J. Rajapakse, 2004. Comparative weight gains in anthelmintic treated crossbred (Native x Boer) goats turned out in the rainy and dry seasons in the dry zone of Sri Lanka. Proceedings of the 7th International Conference in Goats. Tours in France, May 15-21st. Tours International Goat Association. Publisher: International Goat Association 1 World Avenue, Little Rock, AR 72202, USA, pp: 259-267. www.heiferchina.org/.../COMPARATIVE%20WEIGHT%20GAINS.htm.

Gatongi, P.M., M.E. Scott, S. Ranjan, J.M. Gathuma, W.K. Munyua, H. Cheruiyot and R.K. Prichard, 1997. Effects of three nematode anthelmintic treatment regimes on flock performance of sheep and goats under extensive management in semi-arid Kenya. Vet. Parasitol., 68 (4): 323-336. DOI: 10.1016/S0304-4017(96)01080-1. PMID: 4979798. http://www.sciencedirect.com/science.

Githigia, S.M., S.M. Thamsborg, N. Maingi, W.K. Munyua and P. Nanseen, 2001. The impact of gastrointestinal helminths on production in goats. Small Rumin. Res., 4 (1): 21-29. DOI: 10.1016/S0921-4488(01)00240-1. http://www.sciencedirect.com/science.

Holmes, P.H., 1987. Pathophysiology of Nematode Infections. In: Howele, M.J.H. (Ed.). Parasitology Quavadit? Proceedings of 6th International Congress of Parasitology, Canberra, Australia. Australia Academy of Sciences, pp: 443-451. PMID: 3294656. http://www.ncbi.nlm.nih.gov/pubmed/3294656.

Horton, R.J., 1990. Benzimidazole in a wormy world. Parasitol. Today, 6 (4): 106. PMID: 15463312. http://www.ncbi.nlm.nih.gov/pubmed/15463312.

Kaufmann, J., 1996. Parasitic infections of domestic animals. Examination of fecal specimens. Publishers, Birkhauser, Verlag, Berlin pp: 5-9. ISBN: 636.089696075. http://orton.catie.ac.cr.

Maclean, J.F., K. Bairden, P.H. Holmes, W. Mulligan and P.N. MacWilliam, 1992. Sequential *in vivo* measurements of body composition of calves exposed to natural infection with gastrointestinal nematodes. Res.Vet. Sci., 53: 381-389. PMID: 1465514. www.ncbi.nlm.nih.gov.

Mahgoub, O. and G.A. Lodge, 1998. A comparative study on growth, body composition and carcass tissue distribution in Omani sheep and goats. J. Agric. Sci., 131: 329-339. DOI: 10.1017/S0021859698005887. http://journals.cambridge.org.

Mekonnen, S.M., 2007. Helminth parasites of sheep and goats in Eastern Ethiopia: Epidemiology and anthelmintic resistance and its management. Doctoral Thesis. Swedish University of Agricultural Sciences, Uppsala, pp: 50. http://diss-epsilon.slu.se/archive/00001435/02/Final_Thesis_(pdf)_2007-52.pdf.

Naude, R.T. and H.S. Hofmeyr, 1981. Meat Production. In: Goat Production. Gall, C. (Ed.). Academic Press, London, pp: 285-307. ISBN: 0.12.273980.9. DOI: 10.1016/0301-6226(83)90024-6.htt://dx.doi.org/10.1016/0301-6226(83) 90024-6.

Murray, N.M.WP.P.J. and D.G. Taylor, 2004. Meat quality of entire and castrated male Boer goats raised under Australian conditions and slaughtered at different weights: Physical characteristics, shear force values and eating quality profiles. Anim. Sci., 79 (2): 213-219. ISBN: 1357-7298. PMID: 74247. http://espace.library.uq.edu.au/view/UQ:74247.

Petit, H., N. Honhold and R.W. Halliwell, 1988. A condition scoring scheme for Small East African goats in Zimbabwe. The Small Rumin. Res. Network, 13: 1-7. DOI: 10.1007/BF02236191. http://www.springerlink.com/content/l85g17577003518u/.

Van Wyk, J.A., F.S. Mallan and J.L. Randles, 1997. How long before resistance makes it impossible to control some field strains of *Haemonchus contortus* in South Africa with any of the modern anthelmintic? Vet. Parasitol., 70: 111-122. DOI: 10.1016/S0304-4017(96)01147-8. linkinghub.elsevier.com/retrieve/pii/S030440179601147 8.

Vercruysse, J. and P. Dorny, 1999. Integrated control of nematode infections in cattle: A reality? A need? A future? Int. J. Parastol., 29 (1): 165-175. DOI: 10.1016/S0020-7519(98)00192-1. PMID: 497998. linkinghub.elsevier.com/retrieve/pii/S0020751998001921.