New Zealand Society of Animal Production online archive

This paper is from the New Zealand Society for Animal Production online archive. NZSAP holds a regular annual conference in June or July each year for the presentation of technical and applied topics in animal production. NZSAP plays an important role as a forum fostering research in all areas of animal production including production systems, nutrition, meat science, animal welfare, wool science, animal breeding and genetics.

An invitation is extended to all those involved in the field of animal production to apply for membership of the New Zealand Society of Animal Production at our website www.nzsap.org.nz

View All Proceedings | Next Conference | Join NZSAP

The New Zealand Society of Animal Production in publishing the conference proceedings is engaged in disseminating information, not rendering professional advice or services. The views expressed herein do not necessarily represent the views of the New Zealand Society of Animal Production and the New Zealand Society of Animal Production expressly disclaims any form of liability with respect to anything done or omitted to be done in reliance upon the contents of these proceedings.

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

You are free to:

Share— copy and redistribute the material in any medium or format

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for commercial purposes.

NoDerivatives — If you remix, transform, or build upon the material, you may not distribute the modified material.

http://creativecommons.org.nz/licences/licences-explained/

Comparative intake of digestible organic matter and water by sheep and goats

M.R. ALAM, D.P. POPPI AND A.R. SYKES

Department of Animal Science
Lincoln College, Canterbury

ABSTRACT

Three experiments involving a total of 7 forages ranging in N content from 6.6 to 26.8 g/kg DM were conducted to examine comparative *ad libitum* digestible organic matter intake (DOMI) in goats and sheep. Digestibility trials were conducted for 7 to 10 d during each trial when water consumption and rumen NH_3N concentration were also monitored.

DOMI in goats was higher than in sheep with forages of less than 0.6 OM digestibility (OMD). The relationship between the DOMI ($g/kgW^{0.75}/d$) of goats and sheep was described as DOMI (goats) = 0.74 DOMI (sheep) + 10.6. The ratio of DOMI (goats)/DOMI (sheep) was greater than 1.15 for forages of OMD less than 0.6 and close to 1 for forages of OMD greater than 0.6.

Goats maintained higher rumen NH_3N concentration (109 mg NH_3N/l) than did sheep (80 mg NH_3N/l). Of the 5 forages with OMD <0.6, 2 resulted in rumen $NH_3N>50$ mg NH_3N/l, considered the critical level for microbial digestion. The other 3 forages resulted in rumen $NH_3N<50$ mg NH_3N/l (15 to 41 mg NH_3N/l) in sheep whilst goats were able to maintain higher concentrations (43 to 60 mg NH_3N/l). The ability of goats to maintain higher rumen NH_3N with low N diets was associated with their lower water intake. The mean water intake of goats and sheep was 1884 and 2795 ml/kg DMI, respectively.

It is concluded that goats have a greater DOMI than do sheep particularly when offered forages with OMD <0.6 and of low N content partly because of their ability to maintain higher rumen NH_3N concentrations.

Keywords Sheep; goats; intake; digestibility; water; rumen ammonia-N.

INTRODUCTION

It is thought that goats can utilise low quality feed better than can sheep (El Hag, 1976; Wilson, 1977; Devendra, 1977; Gihad *et al.*, 1980; Sharma and Rajora, 1977; Doyle and Egan, 1980; Boer *et al.*, 1982; Watson and Norton, 1982; Schmid *et al.*, 1983; Alam *et al.*, 1983) but with high quality feed there appears to be little difference between the species (El Hag, 1976; Sharma and Murdia, 1974; Gamble and Mackintosh, 1982; Jones *et al.*, 1972; Watson and Norton, 1982; Schmid *et al.*, 1983; Alam *et al.*, 1983; Doyle *et al.*, 1984). The reasons for these differences have not been elucidated but Watson and Norton (1982) have drawn attention to the higher rumen NH_3N concentration in goats which they attributed to greater rumen protein degradation as a result of a longer retention time of digesta in the rumen.

Mousa *et al.* (1983) showed that water restriction in goats and sheep improved digestibility and N balance. Water restriction or infusion in cattle and sheep influences urinary N excretion (Goodall and Kay, 1968; Utley *et al.*, 1970) and rumen NH_3N concentration (Thornton, 1970). There is evidence that goats drink less water than sheep per unit of dry matter intake (Gihad, 1976; Gihad *et al.*, 1980; Owen and Ndosa, 1982; Alam *et al.*, 1983) and Alam *et al.* (1984) proposed that the lower water intake may be the cause of the higher rumen NH_3N concentration. In this paper the comparative intake and digestion of a range of diets of varying N content by sheep and goats are examined.

MATERIALS AND METHODS

Three trials were conducted using 7 forages, the chemical compositions of which are shown in Table 1. Details of animals, feeding procedure and management for meadow hay 1 were given by Alam *et al.* (1983) and only the data for DOMI and digestibility from week 16 of that trial are used here.

For the forage meadow hay 2, DOMI was determined over 10 d after feeding for 10 weeks to 6 goats and 6 sheep, approximately 4 months old and weighing 13.9 ± 0.89 and 25.0 ± 1.4 kg respectively. Rumen NH_3N and water intake were determined on an additional 2 goats and 2 sheep of the same age which were cannulated at the rumen, abomasum and ileum and fed at 2 h intervals from an automatic feeder.

The other 5 forages were offered to 5 goats and 5 sheep in two 5 x 5 latin square designs. The goats and sheep were approximately 10 months old, cannulated at the rumen and weighed 21 ± 1.4 and 32.3 ± 2.2 kg, respectively. Animals were fed *ad libitum* and offered, once a day, 20% more feed than they

TABLE 1 Chemical composition (g/kg DM) of forages used.

Trial	1	2	3				
	Meadow hay 1	Meadow hay 2	Prairie grass hay	Ryegrass hay	Ryegrass straw	Cocksfoot straw	Barley straw
OM	951	903	910	918	947	936	952
N	7.1	23.9	26.8	17.5	8.4	10.3	6.6
NDF	576	514	603	617	687	722	802

TABLE 2 Apparent OM and NDF digestibility and DOMI (g/kg $W^{0.75}$/d) by goats and sheep. Significance levels apply to sheep *v* goat comparisons.

Trial	1	2	3					
	Meadow hay 1	Meadow hay 2	Prairie grass hay	Ryegrass hay	Ryegrass straw	Cocksfoot straw	Barley straw	Mean
OMD								
Goats	0.68	0.77	0.67	0.58	0.53	0.46	0.50	0.55
Sheep	0.55**	0.73*	0.64	0.58	0.54	0.46	0.51	0.55
SED	0.013	0.021			0.022			0.009
NDFD								
Goats	0.61	0.80	0.70	0.64	0.52	0.46	0.56	0.57
Sheep	0.41**	0.78	0.67	0.65	0.54	0.48	0.59	0.59
SED	0.027	0.022			0.026			0.012
DOMI								
Goats	28.8	43.5	41.3	34.7	23.6	24.2	19.8	28.7
Sheep	23.4*	46.5	40.2	29.1	20.7	14.9*	16.5	24.3**
SED	3.96	2.49			3.72			1.52

consumed on the previous day. Any spillage was collected and given to the animal at approximately 1600 h. A 7 d preliminary period was followed by a 10 d collection period for estimation of digestibility.

Intake and faecal output were monitored in all trials over a 7 to 10 d period and water intake monitored over the last 4 d of this period. All animals were weighed prior to feeding, at the start and end of each digestibility trial. Rumen fluid was obtained via the cannula prior to the morning feed and stored at −20°C until analysis.

All feed, refusals and faecal samples were subsampled and dried at 70°C for 24 to 48 h for DM determination. Samples were ground through a 1 mm sieve and analysed for organic matter (OM) and ash free NDF (Van Soest and Wine, 1967).

RESULTS

Forages ranged in N content from 6.6 to 26.8 g N/kg DM (Table 1) while the OM digestibility (OMD) ranged from 0.46 to 0.77 (Table 2).

The relationship between digestible organic matter intake (DOMI, g/kg$W^{0.75}$/d) of goats and sheep was

DOMI (goats) = 0.74 DOMI (sheep) + 10.6 ($r^2 = 0.94$)

Not all the individual differences between animal species in DOMI or OMD or cell wall digestibility for particular feeds reached significance (Table 2). The ratio DOMI goats/DOMI sheep indicated that differences greater than 15% began to occur at OMD <0.6 (Fig. 1).

The mean rumen NH_3N and voluntary water consumption are given in Table 3. Rumen NH_3N concentration was related to the N content of the feeds. Goats tended to maintain higher rumen NH_3N concentration on all feeds. Of the 5 forages where the ratio DOMI goats/DOMI sheep was greater than 1.15 only 3 of them resulted in a sheep rumen NH_3N concentration less than 50 mg NH_3N/l (Table 3) though values always tended to be lower in sheep than in goats. Water consumption by goats tended to be lower than that by sheep (Table 3).

TABLE 3 Rumen ammonia concentration (mg/*l*) and water intake (ml/kg DMI) by goats and sheep and the ratio goats:sheep DOMI. Significance levels apply to sheep *v* goat comparisons.

Trial	1	2	3					
	Meadow hay 1	Meadow hay 2	Prairie grass hay	Ryegrass hay	Ryegrass straw	Cocksfoot straw	Barley straw	Mean
NH_3-N								
Goats	54	191	234	106	60	78	43	104
Sheep	15	161	151*	91	41	65	37	77**
SED	29.5	33.3			20.6			7.2
Water intake								
Goats	1143	1529	2379	2005	2213	2206	1911	2103
Sheep	2281**	3025†	2756	2956	2911	2536	3099†	2852**
SED	205.3	137.5			599.0			132.2
Ratio goat: sheep								
DOMI	1.23	0.94	1.03	1.19	1.14	1.62	1.20	

† $P<0.1$

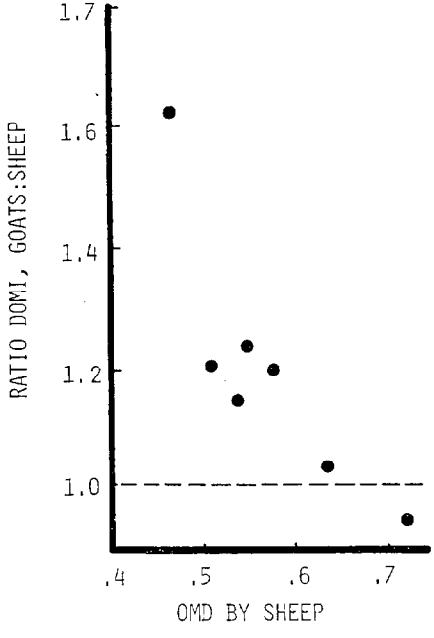

FIG. 1 Ratio (goats:sheep) of intake of digestible organic matter (DOMI) ($g/kgW^{0.75}/d$) and organic matter digestibility (OMD) by sheep.

DISCUSSION

These results confirm other reports where differences in intake and/or digestibility of feeds were recorded between sheep and goats (Devendra, 1977; Wilson, 1977; El Hag, 1976; Gihad, 1976; Gihad *et al.*, 1980; Boer *et al.*, 1982; Watson and Norton, 1982; Sharma and Rajora, 1977; Doyle and Egan, 1980; Alam *et al.*, 1983). The published trials were conducted with adult animals whereas the present results were obtained with animals less than 1 year old. Differences in DOMI occurred with forages having OMD less than 0.6 but were quite variable, the difference tending to be greater the lower the OMD of the forage (Fig. 1). This class of forage is suitable only for maintenance of stock so it would appear that only on maintenance and sub-maintenance forages have goats any advantage over sheep. This is particularly important where crop residues are an important forage source (Devendra, 1978; 1982).

Most studies have recorded differences in OMD or cell wall digestibility (Doyle and Egan, 1980; Watson and Norton, 1982; Boer *et al.*, 1982; Doyle *et al.*, 1984; Schmid *et al.*, 1983) but the only difference observed in this series of experiments occurred after the animals had been on the forage for at least 10 weeks (Alam *et al.*, 1983). This suggests that the extent of digestion was close to the potential digestibility for both species.

Only 3 of the 5 forages with OMD less than 0.6 resulted in a rumen NH_3N concentration in sheep of less than 50 mg NH_3N/l, considered the minimum concentration for optimal bacterial activity (Satter and Slyter, 1974). Goats had higher rumen NH_3N concentrations and this could partly explain the difference in DOMI. However, 2 forages produced much higher rumen NH_3N concentrations and yet the differences in DOMI in favour of goats ranged from 20 to 60%. It is probable that goats accomplished this higher intake through a larger rumen digesta load compared to sheep since there were no major differences in rate of passage of digesta as estimated

by an indigestible marker (Alam unpublished data). This may also have partly accounted for the differences observed with the other 3 forages. Watson and Norton (1982) have reported higher rumen water volumes in goats than in sheep consuming low quality forages which indicates a larger rumen digesta load in goats.

The mechanism by which goats maintain a higher rumen NH_3N concentration is not known. Watson and Norton (1982) have proposed that there is greater degradation of dietary protein in goats but data of Alam *et al.* (1984) have suggested that the lower water intake (ml/kg DMI) of goats observed by Gihad (1976); Gihad *et al.* (1980); Owen and Ndosa (1982) and Alam *et al.* (1983) would increase rumen NH_3N concentration. Alam *et al.* (1984) demonstrated that water infusion into goats depressed rumen NH_3N concentration. Moreover in situations of water deprivation, Mousa *et al.* (1983) observed greater N retention in both goats and sheep. Lower water intake in goats would therefore predispose them to greater N conservation. The relationship between comparative water intake, N conservation and forage utilisation should be investigated further.

With forages having an OMD greater than 0.6 there appeared to be little difference in DOMI and OMD between goats and sheep; a result in agreement with El Hag (1976), Sharma and Murdia (1974), Gamble and Mackintosh (1982), Jones *et al.* (1972), Watson and Norton (1982), Schmid *et al.* (1983), Alam *et al.* (1983) and Doyle *et al.* (1984). Thus in situations where high quality feed is used to promote high live-weight gain, the species are direct competitors in terms of feed utilisation and intake. Digestibility values obtained by sheep appear to be safe for use in goats for high quality feeds.

It is concluded that goats achieve a higher DOMI than sheep with forages of low digestibility (OMD<0.6) and low N content. This may be partly explained by their ability to maintain higher rumen NH_3N levels.

ACKNOWLEDGEMENTS

The skilled technical assistance of Mr G. Elmsly, Miss M. Heney, Mr N. Jay, Miss R. Maxwell and Mrs P. Wilson is gratefully acknowledged. We thank A. Familton for skilled surgery. MRA is grateful to the New Zealand Government for financial support under the Commonwealth Scholarship and Fellowship plan.

REFERENCES

Alam M.R.; Poppi D.P.; Sykes A.R. 1983. Intake, digestibility and retention time of 2 forages by kids and lambs. *Proceedings of the New Zealand Society of Animal Production* **43:** 119-121.

Alam M.R.; Borens F.; Poppi D.P.; Sykes A.R. 1984. Comparative digestion in sheep and goats. In *Ruminant physiology — concepts and consequences.* University of Western Australia (In press).

Boer M.; Milton J.T.B.; Ternouth J.H. 1982. The utilisation of three roughage diets by sheep and goats. *Proceedings of the Australian Society of Animal Production* **14:** 653.

Devendra C. 1977. Studies in the intake and digestibility of two varieties (Serdang and Coloniao) of Guinea grass (*Panicum maximum*) by goats and sheep. *MARDI Research Bulletin* **5:** 91-109.

Devendra C. 1978. The digestive efficiency of goats. *World review of animal production* **14:** 9-22.

Devendra C. 1982. The socio-economic significance of goat production in the ASEAN region. In *Proceedings of the Third International Conference on Goat Production and Disease.* Tucson, Arizona, pp. 201-208.

Doyle P.T.; Egan J.K. 1980. Intake and digestion of herbage diets by Angora goats and Merino sheep. *Proceedings of the Australian Society of Animal Production* **13:** 521.

Doyle P.T.; Egan J.K.; Jhalen A.J. 1984. Intake, digestion and nitrogen and sulphur retention in Angora goats and Merino sheep fed herbage diets. *Australian journal of experimental agriculture and animal husbandry* **24:** 165-169.

El Hag G.A. 1976. A comparative study between desert goat and sheep efficiency of feed utilisation. *World review of animal production* **12(3):** 43-48.

Gamble A.W.; Mackintosh J.B. 1982. A comparison of digestion in goats and sheep of similar live weights. *Proceedings of the Australian Society of Animal Production* **14:** 652.

Gihad E.A. 1976. Intake, digestion and nitrogen utilisation of tropical natural grass hay by goats and sheep. *Journal of animal science* **43:** 879-883.

Gihad E.A.; El-Bedawy T.M.; Mehrez A.Z. 1980. Fibre digestibility by goats and sheep. *Journal of dairy science* **63:** 1701-1706.

Goodall E.D.; Kay R.N.B. 1968. Water intake and the cycling of nitrogen to the stomach in sheep. *Journal of physiology, London* **194:** 38-39P.

Jones G.M.; Larsen R.E.; Jared A.H.; Donefer E; Gaudreau J.M. 1972. Voluntary intake and nutrient digestibility of forages by goats and sheep. *Journal of animal science* **34:** 830-838.

Mousa H.M.; Ali K.E.; Hume I.D. 1983. Effects of water restriction on urea metabolism in camels, desert sheep and desert goats fed dry desert grass. *Comparative biochemistry and physiology* **74:** 715-720.

Owen E.; Ndosa J.E.M. 1982. Goats versus sheep: Roughage utilisation capacity. *Proceedings of the Third International Conference on Goat Production and Disease.* Tucson, Arizona, p. 362.

Satter L.D.; Slyter L.L. 1974. Effect of ammonia concentration on rumen microbial protein production *in-vitro*. *British journal of nutrition* **32:** 199-208.

Schmid L.G.; Swingle R.S.; Brown W.H. 1983. Comparative digestibility of different quality roughages by sheep and goats. *Proceedings of the American Society of Animal Science, Western Section* **34:** 332-334.

Sharma V.V.; Murdia P.C. 1974. Utilisation of berseem hay by ruminants. *Journal of agricultural science,*

Cambridge **83:** 289-293.

Sharma V.V.; Rajora N.K. 1977. Voluntary intake and digestibility of low grade roughage by ruminants. *Journal of agricultural science, Cambridge* **88:** 79-88.

Thornton R.F. 1970. Factors affecting the urinary excretion of urea nitrogen in cattle 1. Sodium chloride and water loads. *Australian journal of agricultural research* **21:** 131-144.

Utley P.R.; Bradley N.W.; Boling J.A. 1970. Effect of restricted water intake on feed intake, nutrient digestibility and nitrogen metabolism in steer. *Journal of animal science* **31:** 130-135.

Van Soest P.J.; Wine R.H. 1967. Use of detergents in the analysis of fibrous feeds. IV. Determination of plant cell wall constituents. *Journal of the Association of Official Agricultural Chemists* **50:** 50-55.

Watson C.; Norton B.W. 1982. The utilisation of pangola grass hay by sheep and Angora goats. *Proceedings of the Australian Society of Animal Production* **14:** 467-470.

Wilson A.D. 1977. The digestibility and voluntary intake of the leaves of trees and shrubs by sheep and goats. *Australian journal of agricultural research* **28:** 501-508.