Performance of sheep fed NaOH-treated straw with browse compared with urea-treated straw

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ABSTRACT

Two experiments were carried out to study the relative intakes and performance of sheep fed NaOH-treated straw supplemented with browse or shrub compared with sheep fed urea-treated straw. The shrub or browse used were *Securinega virosa, Milletia thonningii*, and *Delonix regia*. The browse/shrub was fed together with NaOH-treated rice straw (STS) (44.2 g NaOH in 118 g water per kg straw) and compared with urea-treated straw (UTS) (75.5 g urea in 434.3 ml water per kg straw). In Experiment 1, significant differences ($P<0.05$) were observed in intake. Animals on *Delonix* had a lower intake (38 g/kg$^{0.75}$) compared to the others (42 to 44 g/kg$^{0.75}$). Straw intake was higher on UTS (43 g/kg$^{0.75}$) compared to the others (31 to 34 g/kg$^{0.75}$). Intake of browse was lower with *Delonix* (7.0 g/kg$^{0.75}$) compared to the others (10 g/kg$^{0.75}$). No significant differences ($P>0.05$) were observed among treatment groups in either rumen *p*H or ammonia levels. In Experiment 2, significant differences ($P<0.05$) were observed in intake, daily weight gains, and feed conversion efficiency. Total dry matter intake varied from 46 to 51 g/kg$^{0.75}$, straw intake ranged between 36 and 51 g/kg$^{0.75}$, and browse intake between 9 and 14 g/kg$^{0.75}$. Daily weight gain was between 44 and 62 g/d while feed conversion ratio ranged between 6 and 8 kg kg^{-1}.

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RÉSUMÉ

FLEISCHER, J. E., SOTTIE, E. T. & AMANING-KWARTENG, K. : *Le rendement de mouton nourri de paille traitée de NaOH avec un brout par comparaison avec la paille traitée d'urée.* Deux expériences se sont déroulées pour étudier les consommations et les rendements relatifs de mouton nourri de paille traitée de NaOH et avec le brout ou l'arbuste comme régime complémentaire par comparaison avec le mouton nourri de paille traitée d' urée. L' arbuste ou le brout utilisé étaient *Securinege virosa, Milletia thonningii* et *Delonix regia*. L' arbuste/le brout était donné à manger conjointement avec la paille de riz traitée de NaOH (PTS) (44.2 g NaOH en 118 g d'eau par kg de paille) par comparaison avec la paille traitée d' urée (PTU) (75.5g d' urée en 434.3 ml d'eau par kg de paille). En Expérience 1, des différences ($P < 0.05$) étaient observées dans la consommation. Les animaux nourris de *Delonix* avaient une consommation plus basse (38 g/kg$^{0.75}$) en comparaison des autres (42 à 44 g/kg$^{0.75}$). La consommation de paille était plus élevée avec PTU (43 g/kg$^{0.75}$) en comparaison des autres (31 à 34 g/kg$^{0.75}$). La consommation de brout était plus basse avec *Delonix* (7.0 g/kg$^{0.75}$) en comparaison des autres (10 g/kg$^{0.75}$). Aucune différence considérable ($P > 0.05$) n' était observée parmi les groupes de traitement soit en *p*H de rumen soit les niveaux d' ammoniaque. En Expérience 2, des différences considérables ($P<0.05$) étaient observées en consommation, gains quotidiens de poids et efficacité de conversion de ration. La consommation de matière sèche totale variait de 46 à 51 g/kg$^{0.75}$, la consommation de paille totale variait entre 36 et 51g/kg$^{0.75}$ et la consommation de brout total variait entre 9 et 14 g/kg$^{0.75}$. Le gain de poids quotidien était entre 44 et 62 g/j alors que la proportion de conversion de ration variait entre 6 et 8 kg kg^{-1}.

Introduction

Small ruminant production is very widespread in Ghana, as many of the rural farmers consider it a convenient investment, unlike cattle. However, the animals are left to roam around the homestead, depending on the natural grasslands and household refuse for their sustenance. Thus, feeding is a major limiting factor in production, as the available feeds are relatively poor in quality. Animals, therefore, lose weight during the dry season (Otchere *et al.*, 1977). Much work has been done to stave off this weight loss problem by using crop residues (Addae, 1988). Crop residues are roughage that become available to livestock after crops have been harvested. They are generally high in fibre and lignin but low in protein, and digestibility is poor. Consequently, intake and animal response to its feeding are low. A lot of chemical treatments have been carried out to improve the nutritive quality and intake. Sodium hydroxide and urea have been the most widely used. Urea has the advantage of improving digestibility and nitrogen content, and is also simpler in application (Egyir, 1994). Sodium hydroxide also improves digestibility but not nitrogen content, and it poses technical difficulties in its use. Unfortunately, these efforts have not caught on well with farmers. On their own initiative, however, many farmers coppice browse for their animals. Browse not only provides the needed protein and energy (Rose Innes & Mabey, 1964; Le-Houerou, 1980), but also vitamins and minerals that are lacking in the natural grassland in the dry season (Le-Houerou, 1980; Norton, 1994). The provision of browse, however, is rarely balanced with adequate roughage. Consequently, the full benefits are not realized.

The objective of this work, therefore, was to study the relative intake and performance of sheep fed either NaOH-treated straw supplemented with browse or shrubs, and how they compare with sheep fed urea-treated straw.

Materials and methods

Two experiments were conducted at the University of Ghana Agricultural Research Station, Legon. In both experiments, Nungua Black Head × Djallonke crossbreds were used. The shrubs and browse used in both trials were *Securinega virosa* (Roxb ex Wild) (Euphorbiaceae), *Milletia thonningii* (Schum and Thonn) Baker (Papillionaceae), and *Delonix regia* Raf (Leguminosae). These were fed together with NaOH-treated rice straw (STS) (44.2 g NaOH in 118 g water per kg straw). There was also urea-treated rice straw (UTS) (75.5 g urea in 434.3 ml water per kg straw (Quarshie, 1993). Water and mineral salt lick (Mg 2500, Fe 1800, Mn 380, Zn 280, Co 110, and Se 3 mg/kg) were made available at all times. Crude protein was determined by the method of AOAC (1990), cell wall constituents by the method of Goering & Van Soest (1970), and *in vitro* digestibility by the method of Minson & Mcleod (1972), all on the browse/shrubs and straw.

Experiment 1

Eight wethers averaging 23.3 ± 0.78 kg liveweight and fitted with permanent rumen cannulae (6.4 cm diameter) were used. Two weeks before the commencement of the experiment, animals were treated for ectoparasites with Bayticol (Bayer, Leverkusen) and endoparasites with Abendazol (Dapharma, Raamsdonskever, Holland). Four animals per treatment were housed in individual metabolic crates. Each of the four groups was assigned to one browse treatment at a time as follows: *Delonix* (T_1), *Securinega* (T_2), *Milletia* (T_3), and urea-treated straw (T_4). The animals were placed on one particular browse for 4 weeks and then switched over to another. During the 4th week, rumen samples were taken for *p*H and NH_3 determinations at 0, 4, 8, 12, 16, 20, and 24 h after feeding for 3 successive days. Ammonia was determined by using the method of Markham (1942). The design used was a 4 × 4 Latin square.

Experiment 2

Twenty-four gimmers with an average liveweight of 14.2 ± 1.86 kg were randomly distributed into four groups with six animals per treatment. The treatment groups were those on *Delonix* (T_1), *Securinega* (T_2), *Milletia* (T_3), and urea-treated straw (T_4). The animals were paired and placed in pens with concrete floors and asbestos roofing. The sides of the pens had wooden rails.

The animals were treated for ecto- and endoparasites as indicated (Experiment 1). They were allowed 2 weeks to adapt to the diet. The feeding trial lasted 10 weeks during which period feed intake was recorded. They were weighed once every 2 weeks after a 12-h starvation period. The completely randomised design was used.

The results were statistically analyzed according to methods outlined by Snedecor & Cochran (1976).

Results

Table 1 shows the chemical composition and *in vitro* digestibility (IVD) values of the browse/shrubs in the experiment. *Milletia* was significantly different ($P<0.05$) from *Securinega* in all the chemical composition and IVD values except in lignin. It was, however, similar ($P>0.05$) to *Delonix* in all the parameters. *Delonix* was similar ($P>0.05$) to *Securinega* in all the parameters except in lignin and IVD values. All the browse/shrubs had a crude protein content of at least 18.8 per cent and a wide range of IVD values (41 to 75 per cent).

Table 2 shows the chemical composition of the untreated and treated rice straw. Urea significantly increased ($P<0.05$) the crude protein content. Both treatments also increased ($P<0.05$) the ADF and IVD values.

Experiment 1

Table 3 shows the relative intake of straw and browse by sheep, values for *p*H, and rumen NH_3. Intake of straw alone was higher ($P<0.05$) for animals on UTS than for those on the other groups. Animals on *Delonix* had about 29 to 32 per cent significantly lower ($P<0.05$) intake than animals on the other browses for total dry matter intake (TDMI) of straw and browse. Animals on *Delonix* had significantly lower ($P<0.05$) intake of

TABLE 1

Chemical Composition and In Vitro *Digestibility of the Browse and Shrubs Used in the Experiment (Percent Dry Matter)*

Sample	*Dry matter*	*Crude protein*	*Neutral detergent fibre*	*Acid detergent fibre*	*Cellulose*	*Acid detergent lignin*	In vitro *dry matter digestibility*
D. regia	34.27[a]	19.91[ab]	56.45[b]	34.63[b]	12.10[a]	22.02[a]	52.86[a]
M. thonningii	31.54[a]	21.88[b]	63.23[b]	37.99[b]	25.61[b]	11.85[ab]	40.70[a]
S. virosa	44.33[b]	18.82[a]	26.52[a]	14.15[a]	10.15[a]	3.32[b]	75.05[b]
SE	3.37	0.78	9.77	6.45	4.21	4.68	8.71

SE = Standard error of mean. Figures in the same column with different letters are significant ($P<0.05$)

TABLE 2

Chemical Composition and In Vitro *Digestibility of the Untreated and Treated Rice Straws Used in the Experiment (Percent Dry Matter)*

Sample	*Dry matter*	*Crude protein*	*Neutral detergent fibre*	*Acid detergent fibre*	*Cellulose*	*Acid detergent lignin*	In vitro *dry matter digestibility*
Untreated rice straw	86.06[a]	5.34[a]	80.20[a]	50.35[a]	32.00[a]	9.55[a]	40.86[a]
NaOH-treated rice straw	79.17[b]	7.08[a]	73.05[a]	54.55[b]	33.40[a]	9.02[a]	50.98[b]
Urea-treated rice straw	84.7[a]	10.45[b]	62.40[b]	56.80[b]	34.12[a]	8.98[a]	52.98[b]
SE	3.65	2.69	8.96	3.27	1.08	0.32	6.17

SE = Standard error of mean. Figures in the same column with different letters are significant ($P<0.05$)

TABLE 3

Relative Intake of NaOH-treated Straw and Browse Rumen pH *and* NH_3 *Compared to Urea-treated Straw*

Sample	*No. of animals*	*Average liveweight (kg)*	*Straw intake g/kg*	*Browse intake g/kg*	*Total dry matter intake g/kg*	*Browse: straw ratio*	*Relative total dry matter to UTS (%)*	*Rumen pH*	*Rumen NH_3 mg/100 ml*
D. regia (T_1)	8	22.8	31.13^{a}	7.19^{a}	38.32^{a}	1:4.3	85	6.72^{a}	10.88^{a}
S. virosa (T_2)	8	22.8	31.34^{a}	10.59^{b}	42.91^{b}	1:3.0	92	6.52^{a}	12.25^{a}
M. thonningii (T_3)	8	23.3	34.08^{a}	10.44^{b}	44.22^{b}	1:3.4	103	6.66^{a}	12.16^{a}
Urea-treated straw (T_4)	8	24.4	43.05^{b}	-	43.05^{b}	-	100	6.71^{a}	11.08^{a}
SE		0.78	5.01	1.84	2.55	-	-	0.27	2.44

Straw consumed with browse/shrubs was NaOH-treated rice straw. SE = Standard error of mean
Figures in the same column with different letters are significant (P<0.05). UTS - Urea-treated straw.

browse compared to those on either *Securinega* or *Milletia*. The latter two had similar (P>0.05) browse intake. Browse intake varied between 17 and 25 per cent of the TDMI. Intake of browse to straw ratio ranged between 1:3.0 and 1:4.3. Total dry matter intake of straw and browse ranged between 85 and 102 per cent of that of urea-treated straw.

No significant differences (P>0.05) were observed in rumen *p*H among the four treatment groups. The lowest *p*H point (data not shown) was reached at 12 h after feeding in animals on *Delonix* (T_1) and urea-treated straw (T_4), but at 24 h after feeding on *Milletia* (T_3) and *Securinega* (T_2).

No significant differences (P>0.05) were observed in rumen NH_3 concentration of the various treatment groups. Rumen NH_3 concentration in all groups reached a peak 8 h after feeding (data not shown). Animals on *Securinega* and urea-treated straw maintained the peak NH_3 concentration for a considerable length of time compared with the others. In all groups at all times, the concentration was above 70 mg/100 ml of rumen fluid.

Experiment 2

Table 4 shows the relative intake and growth

TABLE 4

Relative Intake and Growth Response to NaOH-treated Straw and Browse Compared to Urea-treated Rice Straw

Sample	*No. of animals*	*Average daily straw intake g/kg*	*Average daily browse intake g/kg*	*Average total dry matter intake g/kg*	*Total dry matter intake relative to UTS intake (%)*	*Average initial liveweight (kg)*	*Average final liveweight (kg)*	*Change in weight (kg)*	*Average daily weight gain (g/d)*	*FCR kg/kg*
D. regia (T_1)	6	36.47^{a}	9.08^{a}	45.55^{a}	88.70	14.83	17.92	3.09^{a}	44.05^{a}	8.37^{b}
S. virosa (T_2)	6	35.91^{a}	13.52^{b}	49.44^{b}	96.30	12.83	17.25	4.42^{b}	61.91^{b}	6.01^{a}
M. thonningii (T_3)	6	36.20^{a}	12.78^{b}	49.07^{b}	95.58	14.08	17.90	3.82^{ab}	52.38^{ab}	7.23^{b}
Urea-treated straw (T_4)	6	51.34^{b}	-	51.34^{b}	100.00	15.10	19.30	4.20^{ab}	55.96^{ab}	7.79^{b}
SE		7.56	2.38	2.41	-	1.36	0.82	1.01	7.47	1.01

Straw consumed with browse/shrubs was NaOH-treated rice straw. SE = Standard error of mean
Figures in the same column with different letters are significant (P<0.05). UTS - Urea-treated straw.

response of animals in feeding trials. The trends were similar to those observed in Experiment 1, except for a slightly higher intake of straw and browse in Experiment 2. Animals on urea-treated straw had about 30 per cent higher intake of straw than animals on browse ($P<0.05$). Animals on *Delonix* had about 29 to 33 per cent significantly lower intake ($P<0.05$) than those on other browses. Animals on *Delonix* had about 4 to 11 per cent lower TDMI compared to the others.

All animals in various groups gained weight during the experiment. Animals on *Securinega* had the highest weight gain, and this was significantly different ($P<0.05$) only from those on *Delonix,* but not those on *Milletia* and UTS. Animals on *Milletia* and UTS had weight gains similar ($P>0.05$) to those on *Delonix*.

Discussion

The chemical composition of browse plants falls within the range of values reported by other workers (Rose Innes & Mabey, 1964; Le-Houerou, 1980). The crude protein content of browse plants (19 to 22 per cent DM) and that of urea-treated straw (10 per cent) were higher than that obtained in the natural grassland in mid-dry season (Lansbury, Rose Innes & Mabey, 1965). Milford & Minson (1965) reported that when crude protein content of a feed is less than 7 per cent of the dry matter, intake decreases. Minson (1990) has also indicated that feed must contain at least 6 per cent crude protein to meet the requirements of microbes. Thus, it seems the intake of these browse plants may satisfy this requirement.

The IVD values of the browse plants and those of the treated straws were all above 50 per cent, except those of *Milletia* and untreated straw. These variations had been observed earlier (Sottie *et al.*, unpublished). Addo-Kwafo (1996), using only leaves from 6 to 8 months of *Milletia,* reported that the IVD value was 54 per cent, a value higher than that in this study. The samples used in this study were from a combination of leaves and twigs in varying physiological states collected in the dry season. *Delonix* and *Milletia* are semi-deciduous, and hence during the dry season shed most of their leaves. That notwithstanding, the IVD values for *Milletia* and *Delonix* contrast with the observations by Bamualim *et al.* (1984) that the lignin content was negatively correlated with feed digestibility. Other factors such as tannin which *Milletia* contains (Watts & Breyer-Brandwijk, 1962) can influence the value.

The *p*H values of the treatment groups fall within the range considered normal for grazing animals, and did not inhibit bacterial growth (Orskov, 1982). The non-significant difference observed suggests that the rates of fermentation were similar in all groups.

Rumen NH_3 contents in all groups were higher than the minimum value of 5.0 mg/100 ml of rumen fluid suggested as the optimum level needed to ensure increased microbial yield (Preston & Leng, 1987). It was, however, still below the level of 23.1 mg/100 ml which is considered the level needed for optimum fermentation (Orskov, 1982).

Wide variation in browse intake has also been reported by other workers (Norton, 1994). For instance, Mtenga, Komwihangilo & Koforo (1994), studying the relative performance of four browses, *Leucaena leucocephala, Albizia lebbek, Tamarindus indica* and *Gliricidia sepium,* reported that intakes were 40.2, 26.9, 21.3 and 1.7 $g/kgW^{0.75}$. Palmer & Schlink (1992), working with *Caliandra calothyrus,* noted that variations in intake of browse are influenced by such factors as species, plant fractions, stage of maturity, chemical composition, and the form (fresh, wilted or dry) in which it is presented.

The low intake of *Delonix* compared to *Securinega* and *Milletia* is partly attributed to the high lignin content and partly to the anti-nutritional factor it contains. Watts & Breyer-Brandwijk (1962) have reported that *Delonix* contains a quaternary ammonium compound. This may be an anti-nutritive component exacerbating the reduction in intake. On the contrary, the slight increase in intake of *Delonix* in Experiment 2, as was with the others, would suggest that when the animal is free to exercise, intake is increased.

Apart from the group on *Delonix* which had lower weight gains as a result of the low total dry matter intake, performance was the same or even better with browse intake compared to the urea-treated straw. This is due to the improved nutrient quality such as vitamins and minerals (L-Houerou, 1980), in addition to the rumen undegradable protein (Fleischer *et al.*, unpublished) that are provided the animals by the browse. Bamualim (1985) found that feeding leucaena to sheep increased the nitrogen intake of the animals and the post-ruminal digestible protein available to the animals. A similar situation occurred in this experiment. Thus, the higher digestibility of the browse, especially *Securinega,* coupled with the higher intake of the NaOH-treated rice straw improved the weight gains.

It is clear from the study that feeding these browses as supplements to treated rice straw would not only maintain the animal's weight, but also improve weight gains during the dry season.

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