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# Effect of Ammonia Treated Straw with Supplements on Intake and Digestibility of Sheep

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**Abstract:** The effect of ammonia treatment of straw and of barley and lucern-unmolassed sugar beet pulp supplementation on intake, digestibility, nitrogen retention and metabolizable energy of barley straw was studied in sheep. A conventional balance trial was conducted in two periods with 12 sheep, six sheep receiving the same straw in each period, with two sheep on each diet. Chemical analysis of the straw showed a remarkable increase in crude protein content (2.90-8.75% DM) intake (744-939 g/day), dry matter digestibility (56.9-65.3%) nitrogen retention (-10.2-1.4 g/100g N intake) and ME (6.60-8.01 MJ/kgDM) after treatment with ammonia. Supplementation with barley and to lesser extent with lucern-sugar beet pulp, suppressed straw intake but increased total intake up to 600 g dry matter per day.

**Key words:** Intake, digestibility, ammonia, barley straw, sheep

## Introduction

Straw constitutes the major portion of the fibrous part of ruminant diets all over the world, especially, in the tropical and subtropical countries. Straw is the basal food of cattle in Bangladesh. In some areas and seasons it is fed alone or with a very little supplement like rice bran. Straw being a poor quality food, is low cost and easily available to farmers. Feeding straw alone can not maintain an animal and often resulted in the loss of live weight or milk yield. Shifting of soluble nutrients in plant cells to grain with maturity and lignification of cell wall materials resulted in low intake (max. 2% of live weight) and digestibility (40-45%) in cattle and imbalance in essential nutrient content such as digestible protein (almost zero in some of the available types) and minerals ( Staniforth, 1982). Treatment with urea/ammonia or alkali or supplementation of straw with easily digestible cell wall materials found to have increased intake and digestibility of straw (Huque, 1991). However, supplementation with cereals up to a level of 10-15% often avoids replacement of fiber intake (Huque, 1991) and helps to increase the production of animals but further increase of supplementary level of cereals lowers the fiber digestibility (Huque, 1991) and intake. The present work was thus undertaken with the following objectives:

(I) To determine the effect of ammonia ($NH_3^+$) treatment on the intake of barley straw by sheep.

(ii) To compare the effects of supplementation with lucern-unmolassed sugar beet pulp or barley grain pellets on intake and digestibility of untreated or ammonia treated straw.

## Materials and Methods

The experiment was conducted at Edinburgh School of Agriculture Farm at Easter Howgate, Edinburgh, with sheep in metabolism crates. Twelve Suffolk × half-bred weather lambs of about 16 months age having treated with anthelmintic drug were weighed (mean weight 42.8 kg) and divided into six groups each of two. The animals were put into individual metabolism crates. The intake and digestibility of straw and nitrogen retention in sheep fed untreated or ammonia treated straw alone or supplemented with barley or lucern-unmolassesed sugar beet pulp pellets were measured. The experiment was conducted in two periods with 12 animals having 6 diets (Table 1) in each period with 2 animals on each diet. The allocated lambs (1-12) diets are shown in (Table 1).

**Treatment of straw:** Barley straw was treated with 35g of ammonia per kg of fresh straw in the oven (capacity-3 large bales) in a 23 hour cycle. The temperature reaching a maximum of 90 °C after 6 hours and being maintained at that level for 10 hours followed by 7 hours cooling and 1 hour removal and refilling. Both treated and untreated straw were chopped.

**Digestibility trial:** Each animal was fitted with a harness before they were put into the metabolism crates. A canvas bag with a plastic liner was fitted to each animal to facilitate collection of faeces. The animals were adjusted to diets and for 10 days faeces and urine were collected. At least 15% of daily straw intake was offered in excess to determine the voluntary intake of the fed. Similar measurements were made again in the second period re-allocating the diets randomly to the animal groups. The adjustment period of the second period was 14 days to minimize the residual effects of the previous diet. The animals were fed twice daily (09.30 and 16.30 h) and meals were weighed for two days (4 meals) at a time. A 10% urea solution was given with the straw, required to satisfy the rumen degradable protein (RDP) requirements of the animals. Feed refusals were collected daily, put in the oven at 100 °C for 24 hours and the dry weight was recorded. Faeces bags were emptied twice daily to reduce the risk of infection of the animal and was deep frozen (-18 °C) in a plastic container. Urine was collected twice daily from an open bucket placed under the crate. Urine samples were bulked for each sheep in a big plastic bucket covered with a lid and the pH of the urine was maintained at 2-3 with 25% sulphuric acid to prevent the escape of ammonia and bacterial action.

**Methods of Analysis:** Each bulked sample was thoroughly mixed and representative samples of each were taken for analysis. Dry matter (DM), nitrogen, ash were determined following the procedure of AOAC (1985). The gross energy (GE) content of feeds was determined in a Bomb calorimeter. The results were subjected to analysis of variance in completely randomized design.

## Results and Discussion

**Chemical composition of feed ingredient:** The chemical composition of feed ingredients used in the diets is shown in Table 2. Ammonia treatment improved the average crude protein content from 29.4 g $kg^{-1}$ to 86.9 g $kg^{-1}$. These result are similar to those of Saadullah *et al.* (1981). Straw is extremely fibrous, rich in lignin and of extremely low nutritive

Table 1: The composition of diet

| Diets | Composition (g $kg^{-1}$) | Animal on each diet | |
|---|---|---|---|
| | | First period | Second period |
| Untreated straw alone | 1000 | 11, 12 | 8, 9 |
| Untreated straw+barley pellets | 520+480 | 9, 10 | 7, 12 |
| Untreated straw+Lucern and sugar-beet pulp | 520+480 | 7, 8 | 10, 11 |
| Ammonia treated straw alone | 1000 | 5, 6 | 1, 4 |
| Ammonia treated straw+barley pellets | 520+480 | 3, 4 | 2, 6 |
| Ammonia treated straw+lucern and sugar-beet pulp | 520+480 | 1, 2 | 3, 5 |

Table 2: Average composition of feed ingredients

| Periods | Ingredients | DM (g $kg^{-1}$) | OM (g $kg^{-1}$DM) | CP (g $kg^{-1}$DM) | GE MJ/$kg^{-1}$DM |
|---|---|---|---|---|---|
| 1 | Untreated barley straw | 873 | 950 | 29.0 | 18.64 |
| | $NH_3$ treated barley straw | 892 | 951 | 87.5 | 18.79 |
| | Barley pellets | 858 | 947 | 106.0 | 17.63 |
| | Lucern-sugar beet Pulp | 873 | 912 | 122.0 | 16.64 |
| 2 | Untreated barley straw | 892 | 975 | 29.7 | 18.72 |
| | $NH_3$ treated barley straw | 884 | 960 | 86.3 | 18.75 |
| | Barley pellets | 860 | 945 | 108.4 | 17.52 |
| | Lucern-sugar beet Pulp | 873 | 908 | 130.0 | 17.44 |

Table 3: Intake of total dry matter and straw dry matter (mean for 4 animals on each diet)

| Parameter | Treated group | | | Untreated group | | |
|---|---|---|---|---|---|---|
| | straw | straw + barley | straw + lucern -sugar beet pulp | straw | straw+ barley | straw + lucern -sugar beet pulp |
| Total dry mater intake (g/day) | 939$^a$ | 1425 | 1550 | 744$^b$ | 910 | 1238 |
| Straw dry mater intake (g/day) | 925$^a$ | 657$^c$ | 710$^b$ | 721$^b$ | 516$^e$ | 583$^d$ |

Mean with different superscript in the same raw differ significant variation at P<0.05

Table 4: Intake, digestibility, ME value and N - retention of diets (mean of 4 results)

| Diets | DMI (g/kgw$^{0.75}$) | DMD (%) | OMD (%) | DOM (% in DM) | CP Dig (%) | DCP (% in DM) | E Dig. (%) | DE (MJ/ KgDM) | NR (g/100g N Intake) | ME (MJ/kg/ DM) |
|---|---|---|---|---|---|---|---|---|---|---|
| Treated straw (TS) | 58.80 | 56.90 | 57.70 | 54.12 | 40.02 | 3.47 | 52.73 | 9.76 | 1.4 | 8.01 |
| TS+ barley | 81.50 | 65.27 | 66.88 | 62.87 | 58.72 | 7.38 | 62.45 | 11.09 | 40.8 | 9.37 |
| TS+ Lu - sugar beet pulp | 83.20 | 60.23 | 62.22 | 57.47 | 47.77 | 4.95 | 57.32 | 10.13 | 17.4 | 8.36 |
| Untreated straw (UTS | 44.20 | 49.84 | 51.25 | 48.29 | 53.42 | 4.15 | 45.98 | 8.32 | - 10.2 | 6.60 |
| UTS+ barley | 50.90 | 58.63 | 60.52 | 56.89 | 57.43 | 5.83 | 55.72 | 9.85 | 10.2 | 8.09 |
| UTS+ Lu - sugar beet pulp | 76.40 | 58.51 | 60.33 | 55.84 | 57.28 | 5.92 | 55.70 | 9.73 | 33.0 | 8.03 |
| * SED - | 8.510 | 1.675 | 1.890 | 1.742 | 3.021 | 0.366 | 1.871 | 0.318 | 11.70 | 0.317 |

* SED - Standard errors of differences of means. DMI= Dry mater intake DMD = Dry mater digestibility
OMD= Organic mater digestibility DOM= Digestible organic mater. CP Dig.= Crude protein digestibility
DCP = Digestible crude protein E Dig = Energy digestibility DE = Digestible energy
NR = Nitrogen retention ME= Metabolizable energy.

value (McDonald *et al.*, 1981). Treatment of barley straw with ammonia increased the intake and digestibility of the straw.

**Intake:** The daily intake of total dry matter and straw are shown in Table 3. Treatment of straw with ammonia significantly increased the total dry matter intake (P<0.01). Supplementation of straw with lucern-sugar beet pulp significantly (P<0.01) increased the total dry matter intake but the increase with barley supplement was just below the significant level (P<0.05). The difference in total dry matter intake with the two supplements was not statistically significant (P>0.05, Table 3). The dry matter intake was increased by about 28% for ammonia treatment which was less than 41 % as reported by Horton (1978). The dry matter intakes were found to be 44.9 and 58.8 g/kgw$^{0.75}$, respectively for untreated and treated straw (Table 4). These results are in agreement with those of Mira *et al.* (1983; 44.8 & 58.1 g/kg w$^{0.75}$) . The intake of straw and the total dry matter intake was higher with the lucern-sugar beet pulp than that with the barley supplement (Table 3). Barley supplement depressed the intake of both types of straw. Nutrient intake from untreated straw alone (+urea) was below the maintenance level for a 42 kg weather lambs. But ammonia treatment increased the dry matter intake that contained energy higher than that, required to maintain the animals.

**Digestibility:** The results of the digestibility trial along with the statistical analysis are shown in Table 4. Non-significant differences (P>0.05) were found for any of the parameters between the two periods. Digestibilities of dry matter, organic matter and energy were significantly increased due to ammonia treatment of straw (P<0.05) but the digestibility of the crude protein was significantly higher for untreated straw with added urea (P<0.01). Supplementation with barely significantly (P<0.01) increased the digestibilities of dry matter, organic matter, crude protein and energy in the diets. The increase with lucern-sugar beet pulp in digestibility was just below the significant level (P>0.05). With untreated straw the effects of the supplements were similar. With ammonia treated straw, crude protein and energy digestibilities were significantly higher and dry matter and organic matter digestibilities were higher, but just below the significance level (P<0.05) with barley than with lucern-sugar beet pulp. Barley supplementation with ammonia treated straw was found to be the best diet in this experiment. The barley supplementation improved the digestibilities of the dry matter, organic matter, crude protein and energy in the ammonia treated straw to a greater extent than the lucern and sugar beet pulp supplement. For example, the digestibility of dry matter was 65.30% with barely supplement whereas this was 60.30% with lucern-sugar beet pulp supplement (Table 4). These results differed from those of the experiment of Fahmy, 1984 (cited by Ørskov, 1985). He reported that the digestibility of barley straw (30%) with 70% of beet pulp supplement and 70% of rolled barley supplement was 70% and 65% respectively and digestibility of straw alone was 40% and 22% respectively, calculated by difference. He found a better effect from beet pulp.

**Nitrogen retention (NR):** Supplementation with both barely and lucern-sugar beet pulp significantly increased the nitrogen retention ($P<0.01$). As the untreated straw alone was supplemented with urea there was no significant difference ($P>0.05$) in N-retention with ammonia treatment although treated straw values were higher. Supplementation of treated straw with barely gave a significantly higher N-retention than supplementation of untreated straw ($P<0.05$) but the difference was not significant ($P<0.05$). Untreated straw was supplemented with urea solution to provide the rumen degradable protein. A negative nitrogen balance was observed for 3 out of total 4 animals having untreated straw (+urea) diets. The reason may be excessive loss of urea with the refusals. Urea with untreated straw was found to have a better effect on crude protein digestibility and DCP value (53.42% and 4.15) than that of added nitrogen in the treated straw (40.02% and 3.47). Higher degradation of urea in the rumen may have increased it (Table 4). Urea supplementation could have increased the nitrogen supply to microbes and improved the digestibility of untreated straw.

**Metabolizable energy (ME):** The gross energy values of the untreated and the treated straw was similar but ME value of the treated straw was higher due to higher digestibility of energy. Thus, treatment of straw may offer a better production of the ruminant. The ME of the straw diets was significantly increased due to ammonia treatment ($P<0.05$). The ME value of treated straw was significantly higher ($P<0.01$) than that of untreated straw (+ urea). The ME value of treated straw+barley was significantly higher than that of the untreated straw+barley ($P<0.01$) but there was no significant difference ($P>0.05$) between the ME values of the straws supplemented with lucern-sugar beet pulp. Energy from barley helped to capture the ammonia in the rumen and nitrogen balance was improved significantly ($P<0.05$) by barley supplementation in this study.

Barley supplementation of ammonia treated straw was found to be the best diet for sheep. Where a high level of production is desired and where use of barely grain or other grains is economically feasible, barely or other high energy grain supplements will give good results. For moderate production lucern-unmolassed sugar beet pulp or any similar quality products (ground-nut tops, cowpea, *Lathyrus sativum* etc.) will be appropriate with untreated straw. In context of the developing countries for example in Bangladesh, where barely or other cereal grains are in great demand of human consumption and where only a moderate production from the animals in the goal, feeding of high quality legumes along with an alternative energy supplement with untreated straw seems to be worthwhile.

For feeding low productive animals there may be little advantage in treatment when economics are considered. To provide low cost concentrate and high quality legumes or other byproducts as supplements for untreated straw may cost less than the ammonia treatment. As urine treatment of straw has been proven experimentally to be beneficial this can be practiced at farm level and can be cost effective.

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