AMMONIA TREATED WHEAT STRAW AS A SUBSTITUTE FOR MAIZE SILAGE FOR GROWING LAMBS

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Two trials were carried out to evaluate the ensilation of wheat straw with ammonia and and its feed value to lambs. In the first experiment the straw was treated with levels of ammonia (g/100 g straw) from 0-8%. At 2% ammonia and 30% water total N was increased from 0.74 to 1.11% (g/100 8 M and digestibility from 37.7 - 41.8% This treatment was used in the preparation of dicta for a feeding trial with lambs, in which maize silage was substituted by levels of treated straw and untreated straw from 0-75%. In addition all animal. received 331 g/d of concentrate (50% cottonseed meal and 50X molasses). liveweight gain was not affected by the substitution of 75% of the maize silage with treated straw al. though DM intake increased and feed conversion efficiency decreased. When the maize silage was replaced by untreated straw liveweight gains were substantially worse at all levels. Although digestibility of maize silage and treated straw appeared to be similar the former gave better feed conversion. It is suggested that this may be due to a larger proportion of its nutrients being digested post ruminally.

Key Words: Sheep, wheat straw, ammonia, growth, feed intake conversion

During the dry season the feeds available for ruminants in the central and western plateau of Guatemala are reduced by the scarce amount of pasture and agricultural by-products. One of these latter is wheat straw which in recent years has been submitted to various treatments to improve its digestibility specifically by acid and alkali hydrolysis. The objective of the present experiment was to evaluate the effect of ammonia on the nutritive value of wheat straw.

Materials and Methods

Two experiments were carried out. In the first experiment wheat straw was ensiled with different concentrations of anhydrous ammonia and water for 30 or 45 days and the effects measured on uptake of N and in vitro DM digestibility. The second experiment was a feeding trial with growing lambs to study the effect of substituting maize silage with ammoniated straw.

Experiment 1:

The wheat straw was cut with a forage chopper in pieces approximately 2.5 cm long. The treatment with ammonia was carried out in polythene bags. The concentrations of ammonia were 2, 4, 6 and 8g of anhydrous NH3/100g of straw. The experimental design was a 4 X 2 X 2 factorial with 2 repetitions. The treatments were the 4 concentrations of ammonia, 2 levels of water (30 and 60%) and 2 durations of ensiling (30 or 45 d). The polythene bags were 50 cm wide, 70 cm. long and 0.6mm thick. In each bag was placed 500g of chopped straw. The appropriate quantity of water was added and mixed thoroughly with the straw. The bags were then partially closed and gaseous ammonia injected under pressure from a cylinder. During the ammoniation process the bag containing the straw was placed on a balance in order to quantify the amount of ammonia added. At the appropriate moment the bags were sealed and stored at ambient temperature for 30 to 45 d.

Table 1 :
Effect of ammonia concentration on total N content and in vitro DM digestibility of wheat straw[1]

	Level of NH3, g/100 g straw					
	0	2	4	6	8	SEx (P)[2]
Total N, g/100 g DM	0.74	1.11	1.39	1.26	1.36	+ .0088(.001)
In vitro digest. of DM, %	37.7	41.8	42.9	43.4	45.2	+ .92 (.13)

[1]Statistical analysis relates only to NH_3 concentrations of 2 to 8%
[2]Probability level according to F test

After the ensiling period the bags were opened and the ammoniated straw exposed to the air until all excess ammonia had been volatilized and the straw no longer smelled of ammonia. Duplicate samples were taken of the ensiled material and analysed for total N and for in vitro DM digestibility by the method of Tilley and Terry (1963).

Experiment 2:

The most appropriate treatment according to experiment 1 was used to treat the wheat straw in this experiment. This was 2% of anhydrous ammonia,30% of water for 30 d. The silage was prepared in a tower silo on the farm Palo Blanco which is situated at an elevation of 1850 m above sea level with ambient temperatures between 12 and 23!C, and an average rainfall of 2,400 '/year. The tower silo was 7m high and 2.5 m in diameter. The silo was impermeable with a cement lining. However for additional security the floor and the sides were lined with black polythene 6.6mm thick before the straw was introduced.

Table 2: Effect of moisture revel on in vitro digestibility of wheat straw

	Moisture content, %		
	30	60	SEx (P)
In vitro DM digestibility, %	44.9	41.8	+ .92 (.005)

The wheat straw was put in the silo without chopping in successive layers incorporating water between each layer to give a total of 775 kg of straw and 233 lifers of water. The water and the straw were mixed thoroughly with a fork. Finally the straw was covered completely with polythene using adhesive tape to provide airtight conditions. Bales of wheat straw were put on top of the ensiled straw so as to prevent the pressure of the gaseous ;ammonia lifting the polythene.

Four holes were make in the polythene and through these 15.5kg of gaseous ammonia was injected to give a proportion of 2% of ammonia in the straw. The weight of ammonia introduced was determined by putting the gas cylinder on a balance during the injection process, After the 30 d ensiling period the silo was opened for 7 d to allow the excess ammonia to volatilize. Subsequently the treated straw was taken from the silo dried in the open air for one day and then made into small bales of about 10 kg weight. The maize silage control was made when the grain was in the milk stage. A tower silo was used similar to that described for the ammoniated straw. The ensiling period was two months.

Before feeding/both the treated and untreated straw were processed in a forage chopper to give particles of about 2.5 cm . The maize had been harvested with a forage harvester which produced approximately the same size of particle. The mixtures of forages were put in the feeder each morning on a free choice basis. The concentrate supplement was placed on the forages and this was consumed completely such that any residues could be assumed to represent the mixed forages. The residues were weighed before giving the new feed for the day. The animals were weighed at 14 d intervals.

Five Dorset-Down cross bred lambs of 7-9 months of age and average weight 18.5 kg were used. They were distributed in seven treatments with two repetitions of each. Each treatment group was composed of two males and two females. The experiment lasted 59 d. The treatments were different combinations of maize silage and ammonia-treated straw or untreated straw, (see table 3) plus a concentrate mixture (50% cottonseed meal, 50% molasses) which was constant for all the treatments (341g/d). The forage mixtures were given ad libitum. Each group of animals was kept in a pen 3.5 X 1.5 m in a covered shed with earth floor; sawdust was used for litter.

Table 3:
Composition of feed ingredients used in growth trial with sheep

	Dry matter	Nitrogen[4]	pH	Cell contents[3,4]	Cell wall[4]	In vitro DM digest.
Maize silage[1]	17.2	1.09	4.2	30.5	69.5	49.4
Treated straw[2]	89.7	2.25	8.1	27.5	72.6	41.8
Untreated straw	96.1	0.59	7.1	21.4	78.6	35.9
Concentrate	87.8	2.93	--	70.8	29.2	72.9

[1]Contained 2.9% lactic acid in DM
[2]2% NH3 + 30% water, ensiled for 30 days
[3]By difference
[4]DM basis

Results

Experiment I: The physical characteristics of the straw were changed on ensiling. The colour changed from dark yellow to a clear coffee colour and the texture became more friable. There was no insect or mould infestation from any treatment. Table 1 shows that total N and in vitro digestibility both increased with ammonia concentration.

Ensilation time had no effect on N content but table 2 shows that increasing the % moisture reduces the digestibility,

Experiment 2: Tables 3 and 4 show the analyses of the feed ingredients used in this experiment. The DM matter content of the treated straw is much higher than that of maize silage, but the nitrogen content and digestibility compare favorably on a dry matter basis.

Table 4:
Fractionation of cell wall material in the ingredients used in the sheep growth trial (DM basis)

	Insoluble ash	Ligno cellulose	Hemi-cellulose	Cellulose	Lignin
Maize silage	2.60	49.0	20.5	37.2	9.25
Treated straw	5.35	62.1	10.5	45.9	10.9
Untreated straw	4.75	61.2	17.4	42.8	13.7
Concentrate	0.20	20.2	9 .0	14 . 1	5 .90

Table 5:
Composition of diets fed in sheep growth trial (% fresh basis)

Maize silage	100	75	50	25	75	50	25
Treated straw	---	23	50	75	--	--	--
Untreated straw	--	--	--	--	25	50	75
pH	4.1	4.5	5.0	6.5	4.2	4.6	5.8
Dry matter, %	19.2	38.7	57.1	75.3	39.0	56.7	73.0
Nitrogen, %[1]	1.16	1.75	1.84	2.56	.89	.79	.76
Cell wall. %[1]	63.7	63.5	63.0	64.1	72.9	72.5	74 5
In vitro DM digest.,%	53.9	52.7	54.8	53.0	38.4	38.5	36 2

[1]DM basis

Results of daily gains from combinations of maize silage, treated and untreated straw are presented in table 6, Replacement of maize silage with treated straw did not affect daily gain but did lead to an increase in DM intake which is reflect ted in a poorer feed conversion efficiency for the feeds containing higher percentages of treated straw. Substitution of maize silage with untreated straw led to substantially decreased performance despite increased dry matter intake.

The increased DM intake with increasing levels of treated or untreated straw and the pH of the feed mixture have an apparent relationship (r = .97)

Table 6:
Performance of sheep fed combination of maize silage, and treated and untreated straw

	Maize silage	Treated straw[1], %			Untreated straw[1], %			SEx (P)
		25	50	75	25	50	75	
Initial weight, kg	18.8	18.8	17.9	18.7	18.0	18.6	18.5	--
Daily gain, g	125	116	128	130	92	74	56	±9.6(.001)
DM intake, g/d 2	411	485	579	673	496	579	595	±20
Feed conversion	3.28	4.18	4.52	5.18	5.39	7.82	10.6	--

[1]The rest of the forage component was maize silage. The animals also received 341 g/d of concentrate.
[2] DM intake /gain in LW

Discussion

The increase in in vitro digestibility of the straw due to ammonia treatment is in agreement with data reported by Weiss et al (1972). The improvement appears to be due to solubilization of the hemicellulose component. Although the digestibility of the treated straw appeared to be similar to that of maize silage the straw was less efficient at supporting growth, This may be due to more of the maize energy being digested post-ruminally for this is known to be associated with more efficient use of metabolizable energy for growth (Thompson 1978; Preston and Leng 1979)

The relationship between pH and voluntary intake is not considered important as the increase in intake with increased percentages of straw was more likely to have been due to an attempt on the part of the animal to meet its necessary energy requirements for growth by eating more of the lower quality feed. It should be born in mind that the contribution of the protein concentrate to the diet was considerable and the Cottonseed meal is known to be an effective source of by-pass protein (Meyreles et al 1979).

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