

EVALUATION OF TREATMENTS FOR FORTIFYING ROUND BALES
OF BARLEY STUBBLE USING A SPEAR TECHNIQUE

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SUMMARY

The recent advent of large round hay bales has renewed interest in pasture and stubble hay conservation. A simple technique for fortifying poor quality hay has been successfully developed using a spear (2 m x 1.2 cm pipe) for pumping solutions into round bales. Three 20 litre treatment solutions were used containing urea 2.2%, urea 1.5% + ammonia 0.9%, and urea 2.2% + molasses 0.6% w/w of hay. Increases in nitrogen content and dry matter digestion of all samples taken from treated bales were recorded suggesting that uniform fortification was achieved. The latter two treatments increased total dry matter digested by c. 47%. The practical and economic aspects of this method of fortification are highlighted in this study.

INTRODUCTION

The ready availability of cereal stubble has prompted many investigations into methods of improving its nutritive value for livestock (Jackson 1977; Kellaway et al. 1978). Economic and practical aspects of fortifying low quality stubble often preclude treatment which is capable of maximising intake and digestibility of dry matter. Dryden (1982) reported significant losses in ammonia nitrogen after airing of ammonia-treated barley stubble. Such losses result in a fortified fodder whose N content is still deficient for optimum rumen function (Weston and Hogan 1973). However, the advent of large round bales suggests that a suitable micro-environment for proliferation of bacteria and fungi could be created after the addition of appropriate ingredients (Seal and Kelley 1980). Microbial attack of organic matter could then break down leaf and stem structures and thereby increase cellulose availability for ruminant utilisation (Burrows et al. 1979). Cheap sources of ingredients together with a simple method of delivering a fortified solution into a round bale are necessary considerations for industry acceptance.

MATERIALS AND METHODS

In this experiment, barley stubble was conserved in round bales of approximately 150 kg. Treatments were imposed by pumping solutions into the bales through a spear. These solutions contained urea and/or ammonium hydroxide in isonitrogenous formulations which ensured a minimum total N of 1.4% w/w of fortified stubble. The addition of molasses to the urea treatment was examined in order to evaluate its possible effect on microbial growth. All treatments were designed to create an ammoniated micro-environment within the bale to enhance both caustic and microbial breakdown of the organic matter. Two experiments were carried out to evaluate the treatments in terms of dry matter digestibility. In the first study, the fortification technique was evaluated by assessing the rumen digestibility of treated stubble using rumen fistulated sheep. In the second study, the relative differences between treatments were compared in weaner sheep by measuring in vivo dry matter digestibilities.

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Evaluation of the spear technique

Four round bales (c. 150 kg) of barley stubble were randomly allocated to four treatments. Treatment 1 was an untreated control bale. Treatments 2, 3 and 4 consisted of additions of urea 2.2%; urea 1.5% + aqua ammonia 0.9%; urea 2.2% + molasses 0.6% respectively. All treatments were designed to add 1% N w/w of hay. A spear consisting of a 2 m x 1.2 cm pipe was connected to a small pump to deliver approximately 20 l/min of solution containing the fortification treatment. This spear was repeatedly driven (c. 25 times) into one end of each round bale, and by means of an on-off valve the solution was injected in a uniform pattern throughout the bale. Each bale received approximately 20 litres of the solution.

Twelve grab samples were obtained from each bale, bulked and hammermilled through a 2 mm screen. This process was repeated for each of the four bales. A corresponding number of samples were obtained after the round bales were chaffed, and these were prepared in a similar manner. Sub-samples of each bale before and after chaffing were randomly collected for nitrogen determination (Kjeldahl method) and rumen digestibility. In vivo procedures using the nylon bag technique described by Mehrez and Orskov (1977) were adopted using bags with 37 μ pore size. Values were obtained after incubation periods of 17 hours in rumen fistulated sheep.

In vivo disestion study

Twelve weaner sheep were used to evaluate the four treatments. This involved three sheep per treatment for two digestion periods. Initially during period 1 sheep were randomly allocated to one of the four treatments. Subsequently in period 2 the three sheep in each treatment during period 1 were randomly allocated to one of the other treatments.

All sheep were individually fed ad libitum for 4 weeks (period 1). Dry matter intake (DMI) and digestibility measurements were made during the last 7 days. Treatments were changed for period 2 which lasted a further 4 weeks. Measurements were made during the last week as in period 1. Sub-samples of the hay offered in each treatment and of the feed residues were oven dried to determine daily DMI. Faecal dry matter was determined from daily faecal collections to calculate digestible dry matter.

RESULTS

Evaluation of the spear technique

The results of nitrogen and digestibility measurements are presented in Table 1. Nitrogen content in all samples from the treated bales was higher than from the control bale. The mean incremental change averaged 94% above the value of 0.85% N for the control bale. This value was c. 11% less than the calculated theoretical value of 1.86% N w/w DM for the fortified treatments. There were significant differences in rumen digestibility between each of the four treatments both before and after chaffing. Digestibility increased in the following order: control, urea, urea + ammonia, urea + molasses.

In vivo digestion study

Significant differences in DMI occurred between each of the four treatments. DMI increased in the following order: control, urea, urea + ammonia, urea + molasses. The percentage increases above the DMI of the control bale value were 8.7, 26.6 and 35.8 respectively. Digestibility of DM in both the

urea + ammonia, and urea + molasses treatments was significantly greater ($P \leq 0.01$) than in the control and urea treatments (Table 2).

TABLE 1 Nitrogen content and rumen dry matter digestibility of samples from bales fortified using the spear technique

Samples	Treatment				SEM
	Control	Urea	Urea + ammonia	Urea + molasses	
Grab					
Nitrogen (%)	0.78	2.19	1.60	1.70	-
Digestibility (%)	35.1 ^a	36.5 ^b	39.3 ^c	44.4 ^d	1.64
Chaffed					
Nitrogen (%)	0.85	1.71	1.81	1.44	-
Digestibility (%)	34.9 ^a	37.7 ^b	40.7 ^c	43.2 ^d	1.59
Parameters within rows with different superscripts differ significantly (a-b-c-d $P \leq 0.01$)					

TABLE 2 Dry matter intake (DMI) and digestibility of barley stubble treatments fed to weaner sheep

	Treatment				SEM
	Control	Urea	Urea + ammonia	Urea + molasses	
Dry matter intake (g/d)	346 ^a	376 ^b	438 ^c	470 ^d	7.3
Digestibility (%)	50.4 ^a	48.7 ^a	56.3 ^c	56.5 ^c	0.88
Parameters within rows with different superscripts differ significantly (a-b, c-d $P \leq 0.05$; a-c, a-d $P \leq 0.01$)					

DISCUSSION

The relative differences in DM digestibility obtained in the two experiments were similar. This result suggests that the nylon bag technique would be a useful research aid in screening treatments to improve nutrient quality of cereal stubbles. The uniformity of increases in nitrogen and digestibility between the grab and chaffed samples indicates that the spear technique can be an effective method of fortifying round bales. Although further studies are required to examine other solutions, this study does highlight the practicality of fortifying round bales of cereal stubble.

The in vivo results of the ammonia and molasses treatments indicate an increase of c. 47% in total digested DM. The reason that the addition of small amounts of molasses apparently increased digestibility has not been explained in this study. However, the minerals in molasses have increased (c. 41%) DM intakes at this level of supplementation (Hoey et al. 1976). In addition, some unpublished observations revealed an additional fungus (*Aspergillus glaucus*) cultured from hay treated with urea + molasses. This suggests that some microbiological changes may have occurred which also contributed to the increase in digestibility. In contrast to this result, the urea only treatment increased total digested DM by 5.2%. The small increase (8.7%) in DMI is similar to that of

other studies (Weston 1967) and highlights the need for the addition of minerals to obtain an animal response (Coombe et al. 1971).

Fodder conservation in round bales of hay is a practical method of supplementing sheep in pastoral and farming areas where abundant native pastures or cereal stubbles are available for harvesting. Fortification of this hay using a spear to pump nitrogen and minerals in a solution into the bale would increase nutrient quality sufficiently to ensure liveweight maintenance. This, together with the economic aspect of the technique which involves little capital outlay and \$10 per tonne for ingredients, offers industry a husbandry option for use during dry seasons.

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