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Effect of Treating Wheat Straw with Urea on its Crude Protein Content

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Abstract: Wheat straw is one of the livestock feeds in Saudi Arabia. However its use as feed is rather limited because of its low crude protein content. This trial was undertaken to improve the protein content of wheat straw by urea treatment. Twenty-five wheat straw samples (each weighing 3 Kg) were sprayed with five different urea solutions at the rate of 40 mL of water/100 g of straw. The solutions were prepared by dissolving 1, 2, 3, 4 or 5 g of urea in 40 mL of water. The five treated samples at each urea level were kept in air tight containers and assigned at random to storage at 30°C for 2, 4, 6, 8 or 10 weeks. Subsequently, proximate chemical composition of treated and untreated straw was determined. Analysis of variance was used to examine the effect of urea treatment, ureolysis duration and their interaction on crude protein. All sources of variations affected ($p<0.001$) crude protein of treated straw. The highest crude protein content (ranging from 8-11% as compared with a mean of 6.67±1.9% for the control) was obtained on the 4 g of urea/100g straw dissolved in 40 mL of water for all storage periods. Different mathematical models were used to describe changes in crude protein content of treated straw with advancing storage period. The fifth polynomial level provided the best fit for that relationship. Lambs preferred ($p<0.001$) urea-treated to untreated straw and treated wheat straw was equally ($p>0.05$) preferred to Rhodes grass.

Key words: Wheat straw, urea-treatment level, ureolysis duration, crude protein, lambs, feed preference

INTRODUCTION

Wheat straw is the most abundant agricultural residue in Saudi Arabia. It is widely used as a cheap source of bulk feed to ruminants. The feed value of wheat straw, is however, limited by its low available energy content, low protein, minerals and vitamins. It is now established practice in some parts of the world to upgrade the protein content of low quality roughages by urea treatment[1-3]. Fortunately, large regular supplies of urea are produced in Saudi Arabia by Saudi Basic Industries Corporation (SABIC) that can be utilized to upgrade nitrogen content of straws.

Spraying layers of straw with urea solution of known: concentrations achieves the process of upgrading nitrogen content of poor roughages. Treated straw is subsequently stored under anaerobic conditions at temperatures between 30-60°C for variable durations. This promotes ureolysis and the release of ammonia gas. Some ammonia combines with the plant cell wall but most of it evaporates. There are conflicting reports about the optimal straw: water ratios (urea treatment level) and optimal ureolysis period that would give the highest crude protein content in treated straw[1].

The objectives of this study is to find out the urea treatment level of wheat straw and ureolysis duration that would yield best results in terms of crude protein content. A feed preference study will also be conducted to determine the acceptance of lambs to treated straw.

MATERIALS AND METHODS

Twenty-five wheat straw samples, weighing 3 Kg each, were used in 5x5 Latin square experiments. There were five urea solutions (obtained by dissolving 1, 2, 3, 4, or 5 g urea in 40 mL of water) and five ureolysis (reaction) periods (2, 4,6,8 and 10 weeks). To apply urea each sample was spread on a plastic sheet and sprayed evenly with the assigned urea solution. The samples were then placed in plastic bags that were pressed to remove air from them and sealed. The treated samples of each urea solution were assigned at random to five ureolysis (reaction) periods and stored under vacuum to allow ureolysis to take place. After the completion of the designated ureolysis period the samples were removed and allowed to dry before they were analyzed. Proximate chemical analysis of treated and treated straw samples was carried out in triplicates. All analyses followed the procedure s of the American Association of Official Analytical Chemists[4].

Analysis of variance was carried out to determine the effect of urea treatment, ureolysis duration and their interaction on crude protein content of wheat straw.

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Different mathematical models were used to describe changes in crude protein content with the advance in ureolysis duration.

A feed preference study was carried out to determine the acceptance of lambs to urea-treated wheat straw. For that purpose five four-month old Awassi lambs weighing 21±0.05 Kg were used. The lambs were kept in individual pens and offered a diet composed of equal parts of untreated straw, Rhodes grass and urea-treated straw (straw sprayed with 4 g urea/100 g of straw in 40 mL of water and stored under anaerobic conditions for eight weeks) for an adaptation period of one week. In the first day following the termination of the adaptation period each lamb was offered 200 g of each treated straw and Rhodes grass in two different containers. In the second day the preference of lambs to treated and treated wheat straw was likewise tested. In the third day Rhodes grass and untreated wheat straw were compared in a similar manner. Daily consumption from each of the tested feeds was recorded and added to obtain combined feed intake. The proportion of each feed from the combined total was computed to determine feed preference. Chi-square was used to test the significance of the difference of proportions from 0.5 (equal preference). All statistical analyses followed the procedures of the Statistical Analyses Systems Institute[5].

RESULTS AND DISCUSSION

Proximate chemical analysis of untreated wheat straw (Table 1) shows that it contained a crude protein content of 6.67 g/100g dry matter. This value is higher than the crude protein value reported for wheat straw (3.8%) by Abdouli and Kraiem[6], comparable to that of Barley straw (6. g/100 g straw) reported by Hadjipanayiotou and Economides[7] but is considerably lower than that reported for rice straw by Gao Tengyun[8]. These variations in crude protein of straws might be ascribed to differences between cereal species, varieties and degree of soil fertilization with urea. High levels of soil fertilization with urea are achieved in Saudi Arabia because urea is readily available for farmers at affordable prices. In many other places where similar cereals are grown the cost of nitrogen supplementation is high and far beyond the financial capabilities of the farmers.

Treatment of wheat straw with urea turned its colour from yellow to dark brown. Ammonia gas was smelt in all treated samples but the strongest smell of ammonia was noticed in straw samples to which 100:40:5 straws: water: urea ratio was applied.

Assessment of various treatment conditions affecting ammoniation of wheat straw with urea revealed significant ($p<0.001$) treatment effect for all sources of variations viz., urea treatment and ureolysis duration and urea treatment by ureolysis duration interaction. For the latter reason the mean crude protein content of treated wheat straw was presented in Table 2 for the interaction effect together with mean crude protein of untreated straw.

Table 1: Chemical analysis of feed during experiments

	Concentrates	Straw	Rhoda's
Dry matter (%)	91.8	73.0	64.2
Fibers (%)	7.02	30.02	24.2
Protein (%)	14.8	6.8	9.5
Fat (%)	3.64	0.84	2.84
Ash (%)	6.76	15.86	14.76

Table 2: Comparative straw urea treatment and without of sheep feeding

Comparative	% of feed consume	P-value
Straw treatment+(Rhoads)	0.08±0.511	>0.05
Straw treatment+Straw non treated	0.05±0.761	< 0.001
Rhoads+Straw non treated	14.8	6.8

Table 3: The preference of lambs to urea-treated wheat straw

Comparative	Treated straw	Rhoads	St.Dev
Initial weight/kg	25.67	25.79	2.37
Final weight/kg	34.85	33.64	1.25
Increased total weight/kg	9.178	7.846	0.35
Increased daily weight/g	136.3	130.9	7.7
Feed consumed/kg	18.2	16.8	-
Concentrate consumed/kg	32.4	32.4	--
Dry matter consumed/kg	5.6	6.27	--
Food conversion	50.6	49.2	-
Average cost feed for 2 month/head/SR	26,32	34,44	-
% comparative cost of straw treated + Rhoads	0.76	1	-

The crude protein of urea-treated straw (Table 2) is exceptionally greater than that of untreated wheat straw (Table 1) in this study. This is in agreement with the findings of many workers[2,9,10]. [11]reported 3.29 folds increase in crude protein for Barley straw (from 37 g/Kg to 122 g/Kg) as a result of urea treatment. In this study there was 1.4-1.8 times increase in crude protein content of treated wheat straw as a result of ammoniation. The discrepancy between theses studies in the magnitude of response to ammoniation of straw may be ascribed partly to genetic causes, differences in the degree of soil fertilization and the conditions of urea treatment.

It is acknowledged that the effectiveness of straw treatment with urea is influenced by many factors including urea level, reaction period, quantity of water and physical form[12]. Nevertheless there is need to examine these factors under local conditions as ideal conditions in one place may prove unsuitable in a different place. Table 2 further shows that the crude protein of treated straw increased with advancing ureolysis duration. However, this increase was not linear throughout. In most levels of urea treatment maximum crude protein content was achieved at the eighth week of ureolysis after which it declined. The fifth polynomial level provided the best fit for describing, at each level of urea treatment, changes in

crude protein with advancing ureolysis period. The maximum (11.28%) crude protein content was obtained after treating wheat straw at the rate of 4 g urea /100 g straw dissolved in 40 mL water for eight weeks.

The preference of lambs to urea-treated wheat straw was examined and the results are given in Table 3. Voluntary intake from treated wheat straw was significantly ($p<0.001$) greater than that from untreated wheat straw and was equally preferred ($p>0.05$) to Rhodes grass. Thus in addition to improving crude protein content urea treatment of wheat straw also increased voluntary feed intake. Reported an increase voluntary intake of treated rice straw by cattle, camels and small ruminants and ascribed it to acceleration of organic matter degradation by ruminal microbes because treatment of straw with urea satisfied their nitrogen requirements.

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