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# EFFECT OF UREA AND LIME TREATMENTS ON FEEDING VALUE OF WHEAT STRAW USED IN GROWING LAMBS RATION.

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## ABSTRACT

Tow experiments were conducted to evaluate the effect of alkali treatment on the wheat straw. In experiment 1, chopped wheat straw (0.5 – 1.5 cm) was subjected to different alkali treatments involving 3 levels of urea ($T_1$) (1.5, 3 and 5 % w/w), 3 levels of lime ($T_2$) (4, 6 and 8 % w/w) and a combination of urea and lime ($T_3$) (5% urea plus 4 or 6 or 8% lime w/w). The moisture in all treatments was 50% and the treatment period was 4 weeks.

Cell wall constituents (CWC) solubilised significantly ($P<0.05$) due to synergistic effect of alkali treatment. Wheat straw was treated with 5% urea plus 8% lime has the lowest CF, NDF, ADF and ADL being 31.61, 53.54, 44.29 and 5.38%, respectively compared with untreated wheat straw (40.66, 76.14, 54.81 and 9.21%) in the same order. The average of crude protein increased in $T_1$ and $T_3$ by 114.5 and 163.1 %, respectively compared with untreated wheat straw. Data indicated that a combination of 5 % urea plus 8 % lime at 50 % moisture for 4 weeks reaction time was the most effective treatment for reducing the ADF, ADL and hence improving the chemical composition of wheat straw.

In experiment 2, growth trials for 90 days were conducted by using 12 growing Rahmany lambs (averaged 24.10 kg body weight and 7-8 months old). Animals were divided randomly into two groups and were fed at 3 % of live body weight on ration consisted of 75% concentrate mixture and 25 % roughage. In first group (control, R1), the roughage was berseem hay, while, in the other group (R2) it was alkali treated wheat straw, 5 % urea plus 8 % lime at 50 % moisture for 4 weeks reaction time. There was no significant ($P<0.05$) difference between R1 and R2 in the digestibility of OM (84.74 and 83.77 %) and NFE (88.35 and 87.66%), respectively. The digestibility of CF was higher in R2 (70.95%) than in R1 (67.80%). The nutritive values of the experimental rations as total digestible nutrient (TDN) and digestible crude protein (DCP) were 99.48 and 103.98% in R2 as a percent of R1.

There was no significant ($P<0.05$) difference in average daily body weight gain, total body weight gain and final body weight between the animals fed the experimental rations being (141.11 and 130.0 g), (12.7 and 11.7 kg) and (36.8 and 35.8 kg) in R1 and R2, respectively.

So, berseem hay can be replaced by wheat straw treated with 5 % urea plus 8 % lime at 50 % moisture for 4 weeks incubation period, without any adverse effects on growth performance of growing lambs.

**Keywords:** Wheat straw, urea and lime treatments, digestibility, growing lambs, growth performance, feed utilization.

## INTRODUCTION

Agricultural by-products have been used as livestock feeds since ancient times. In Egypt, large amounts of these agricultural by-products are produced annually. These by-products are poor in their nutritive value for ruminants owing to its low nitrogen content, high fiber content and hence low palatability. Mostly, they are source of environmental pollution, whereas they are used as a fuel to get energy.

It has been known that the alkali treatment can improve the nutritive value of these by-products (Ford, 1978 and Akin and Hartly, 1992). Numerous studies have demonstrated the effectiveness of sodium hydroxide ( NaOH) and ammonia treatments in improving the nutritive value of agricultural by-products (Wanapat *et al*., 1985; Mason *et al*., 1990 and Moss *et al*., 1990).

In many countries ammonia is not available for agricultural uses, whereas NaOH causes soil salinity problems and places a high Na load on the animal (Haddad *et al*., 1995). More over both NaOH and ammonia are costly and dangerous to handle, especially in the developing countries. On the other hand, comparing NaOH and ammonia with calcium hydroxide ($Ca(OH)_2$) and urea are cheaper and easy to handle (Waiss *et al*., 1972; Mason *et al*., 1990; Zaman *et al*., 1993; Zaman and Owen, 1995 and Granzin and Dryden, 2003). However, one problem identified by several researchers (Owen *et al*., 1984) is that $Ca(OH)_2$ – treated material becomes moldy with time. Ammonia treated material is generally mould free because ammonia inhibits mould growth. So, treatment of straw with urea is subsequently hydrolyzed to ammonia has been investigated in many countries (Haque *et al*., 1983 and Doyle, 1984) and it has been found that urea serves as a good preservative for treatment of straw besides improving its nutritive value.

This study included two experiments, Exp.1 was to determine the effectiveness of different levels of urea and lime on the chemical composition of wheat straw. Based on results of the Exp.1, growing lambs were fed a fixed percentage of treated wheat straw in growth trials (Exp.2).

## MATERIALS AND METHODS

The present study was carried out at the experimental station, Department of animal production, Faculty of Agriculture, Cairo University.

Experiment 1, chopped wheat straw (0.5 – 1.5-cm) was treated with urea (1.5, 3 and 5% w/w), lime (4, 6 and 8% w/w) or with a combination of 5% urea and 4, 6 and 8% lime w/w. Both urea and lime powder (unslacked) were dissolved in required amount of water then sprayed on 200 gm lots of straw in triplicate and the moisture was maintained at 50%. The corresponding concentration of available lime for reaction was 1.32, 1.98 and 2.54% at 4, 6 and 8%, respectively as lime powder (unslacked) which is 33% soluble in water. The treated straw was sealed on double polyethylene bags and kept at room temperature for 4 weeks. . At the end of reaction period, samples were dried and ground to pass through 1-mm sieve size. Chemical composition and cell wall constituents, CWC, were determined according to (AOAC, 1990) and (Goering and Van Soest, 1970), respectively.

Experiment 2, Wheat straw was treated with a mixture solution of urea (5%) and lime (8%) at 50 % moisture for 4 weeks. Adaptation period on tested rations was carried out for three weeks, then a growth trial for 90 days was carried out, 12 intact growing Rahmany lambs were divided into two equal groups according to body weight (averaged 24.10-kg body weight, 7-8 months old). Animals were assigned randomly to receive one of two experimental rations. In control ration (R1), lambs were fed on 25% berssem hay and 75% concentrate mixture (20% soybean meal, 20% wheat bran, 56.8% yellow corn, 1% salt, 2% lime stone and 0.2% mixture of minerals and vitamins). While, in the other ration, lambs were fed on 75% concentrate mixture (20% soybean, 20% wheat bran, 58.8% yellow corn, 1% salt and 0.2% mixture of minerals and vitamins and 25% treated wheat straw (R2). All animals were fed at 3 % of their live body weights. In R2 treated wheat straw was placed in air before feeding to animals. Drinking water was available all the time. The body weight was recorded biweekly and feed intake was recorded daily, meanwhile, daily body weight gain and feed conversion were calculated. At the end of the growth trial, three animals of each group were used to evaluate the nutrient digestibility, nutritive value and nitrogen balance of the experimental rations through metabolism trials. Feces and urine were daily collected for seven days and samples were taken for analysis. Samples of feeds and feces were analyzed according to (AOAC, 1990). Data were statistically analyzed using the general linear model procedure, SAS (1986).

## RESULTS AND DISCUSSION

**Experiment 1:**

Data in Table (1) indicated that there was no difference in the average of OM content between the untreated wheat straw (UWS) and urea treated straw ($T_1$) being 86.14 and 85.71 %, respectively. While, there was a decrease in the average of OM of wheat straw by 4.63 and 5.22 % with lime treatment ($T_2$) and urea plus lime treatment ($T_3$), respectively compared with UWS. This reduction might be due to the increase in ash content by 28.79 and 32.47 %. These results agree with those obtained by Das and Kundu (1994), Sirohi and Rai (1995), Abdul-Aziz *et al.* (2001) and Granzin and Dryden (2003). The content of CP as average didn't affected in $T_2$ compared with UWS being 4.40 and 4.63 %, respectively. Zaman and Owen (1995) obtained similar data. On the other hand $T_1$ and $T_3$ increased CP content by 114.5 and 163.1 %, respectively compared with UWS. This increase might be due to urea addition as was indicated by Wanapat *et al.* (1985), Haddad *et al.* (1995) and Sirohi and Rai (1995). All treatments decreased the average of EE content being 2.00, 1.47 and 1.51% in $T_1$, $T_2$ and $T_3$, respectively compared to 2.20 % in the UWS. These results were confirmed with those obtained by Dan and Kundu (1984) who suggested that the decreases in EE content might be due to that the alkali treatment breakdown EE into fatty acids. The averages of contents of CF, NDF, ADF and ADL were decreased in all treatments by 6.10, 2.15, 3.67 and 15.53% in $T_1$; 14.41, 16.34, 13.37 and 34.31% in $T_2$ and 17.41, 21.03, 15.58 and 34.64% in $T_3$, respectively compared with UWS.

These decreases might be due to that the alkali treatments reduces the strength of intermolecular hydrogen bonds, which may be physically restrained from swelling. Similar data were obtained by Whistler and Teng (1970), Letham *et al.* (1979), Rai and Mudgal (1987), Oliveros *et al.* (1993), Sirohi and Rai (1994 and 1995), Abdul-Aziz *et al.* (2001) and Granzin and Dryden (2003).

From data in the same table, it could be concluded that 5% urea plus 8% lime was the best level for improving the chemical composition of wheat straw through decreasing the CF, NDF, ADF and ADL contents being 31.61, 53.54, 44.29 and 5.38%, respectively. While they were (32.06, 66.78, 48.23 and 6.44%) with 5% urea plus 4% lime and (31.78, 60.07, 46.29 and 6.25%) with 5% urea plus 6% lime, in the same order.

**Experiment 2: -**

The chemical composition of the feed ingredients and the experimental rations are presented in Table (2). Data concerning digestibility and feeding values (Table, 3) indicated that the digestibility of DM

in R1 was the best 82.09% compared to 77.98% in R2. This result might be due to the increasing of ash content in R2 by 8.65 % compared with R1. This result was confirmed with those obtained by Mohamed *et al.* (1987) and Abdul – Aziz *et al.* (2001). On the other hand, the digestibility of crude protein was significantly (P<0.05) increased in R2 (83.65%) compared with R1 (77.25%).

**Table (2): Ingredients, formulation and the chemical composition of tested rations (DM basis)**

| Item | Rations | |
|---|---|---|
| | Control (R1) | R2 |
| **Ingredients, % (DM basis)** | | |
| Soybean meal | 15.00 | 15.00 |
| Wheat bran | 15.00 | 15.00 |
| Yellow corn | 42.60 | 44.10 |
| Salt | 0.75 | 0.75 |
| Lime stone | 1.50 | ------ |
| Min. & Vit. Mixture | 0.15 | 0.15 |
| Berseem hay | 25 | ------ |
| Treated wheat straw | ------ | 25 |
| ***Chemical composition,% (DM basis)** | | |
| OM | 92.60 | 91.96 |
| CP | 14.52 | 14.42 |
| CF | 11.67 | 12.28 |
| EE | 3.19 | 3.13 |
| NFE | 63.22 | 62.13 |
| Ash | 7.40 | 8.04 |

***Determined**

This increase might be due to the effect of urea treatment as suggested by Herrera *et al.* (1983). There was a significant (P<0.05) difference in the digestibility of crude fiber between the tested rations being 67.80 and 70.95% in R1 and R2, respectively. This variation in the digestibility of crude fiber might be due to the variation in fiber fractions of rations (Sirohi and Rai 1995 and Abdul-Aziz *et al*., 2001). While, There was no significant (P<0.05) difference in the digestibilities of OM, EE and NFE between R1 and R2 being (84.74, 84.14 and 88.35 %) and (83.77, 84.02 and 87.66 %), respectively. Data in the same table, indicated that there no significant (P<0.05) difference between R1 and R2 in the nutritive value as TDN or DCP being (80.00 and 79.58%) and (11.56, 12.02%).

**Table (3): Digestion coefficients and nutritive value of rations (DM basis).**

| Item | Rations | |
|---|---|---|
| | R1 | R2 |
| **A pparent digestibility, %** | | |
| DM | 82.09[a] | 77.98[b] |
| OM | 84.74 | 83.77 |
| CP | 77.25[b] | 83.65[a] |
| EE | 84.14 | 84.02 |
| CF | 67.80[b] | 70.95[a] |
| NFE | 88.35 | 87.66 |
| **Nutritive value, %** | | |
| Total digestible nutrients (TDN) | 80.00 | 79.58 |
| Digestible crude protein (DCP) | 11.56 | 12.02 |

[a,b,c] **Means on the same row with different superscripts are significantly different (P<0.05)**

Data in Table (4) showed that there was no significant (P<0.05) difference between animals fed R1 and R2 in average daily body weight gain (141.11 and 130.0g), total body weight gain (12.7 and 11.7kg) and final body weight (36.8 and 35.8 kg). These results might be due to presence of insignificant (P<0.05) difference between R1 and R2 in the total dry matter intake (0.914 and 0.899kg), nitrogen balance (4.69 and 4.45gm) and feed conversion as g DMI /g gain (6.48 and 6.92) or g TDN/g gain (5.18 and 5.5).
Data for economical evaluation of feeding growing lambs on rations were summarized in Table,5. It was noticed that R2 was cheaper than R1 by 4.84%.

In view of the obtained results, it could be concluded that berseem hay can be replaced by wheat straw treated with 5 % urea plus 8 % lime at 50 % moisture for 4 weeks incubation period in the growing lambs rations.

**Table (4): Effect of rations feeding on , feed intake, live body weightfeed conversion and nitrogen balance of lambs.**

| Item | Rations | |
|---|---|---|
| | R1 | R2 |
| **Live body weight:-** | | |
| **Initial live body weight, kg** | 24.10 | 24.10 |
| **Final live body weight, kg** | 36.80 | 35.80 |
| **Total body weight gain, kg** | 12.7 | 11.70 |
| **Daily body weight gain, g** | 141.11 | 130.0 |
| **Feed intake, g DMI/ day:-** | | |
| **Concentrate** | 0.685 | 0.674 |
| **Roughage** | 0.229 | 0.225 |
| **Total DMI** | 0.914 | 0.899 |
| **TDN intake, g** | 731.2 | 715.4 |
| **TDN, kg / kg (w)$^{0.75}$** | 0.056 | 0.056 |
| **Feed conversion efficiency:** | | |
| **g DMI / g gain** | 6.48 | 6.92 |
| **g TDN / g gain** | 5.18 | 5.50 |
| **Nitrogen balance:-** | | |
| **Nitrogen intake, g/h/d.** | 21.23 | 20.74 |
| **Feces nitrogen, g/h/d.** | 5.73 | 5.68 |
| **Urine nitrogen, g/h/d.** | 10.81 | 10.61 |
| **Nitrogen balance, g** | +4.69 | +4.45 |

**Table (5): Economical evaluation of rations fed to growing lambs.**

| Item | Rations | |
|---|---|---|
| | R1 | R2 |
| **Price of feed intake, L. E.** | | |
| Concentrate | **0.58** | **0.57** |
| Berseem hay | **0.15** | **-----** |
| Treated wheat straw | **-----** | **0.07** |
| **Feed cost/daily gain L. E.** | **0.73** | **0.64** |
| **Feed cost /kg gain L. E.** | **5.17** | **4.92** |
| **Economic efficiency** | **2.32** | **2.44** |

**Economic efficiency expressed as the ratio between the price of total live weight gain and the price of feeds consumed.**
**Based on market prices at the beginning of experiment, the prices (LE/Ton) were, concentrate, 800; berseem hay, 600 and treated wheat straw, 300.**
**The price of one kg body weight on selling was 12.**

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## تأثير المعاملة باليوريا والجير على القيمة الغذائية لتبن القمح المستخدم فى عليقة الأغنام النامية

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تم إجراء تجربتين لتقييم المعاملة بالقلويات على تبن القمح.
فى التجربة الأولى: تم معاملة تبن القمح المقطع (٠,٥ – ١.٥سم) بالمعاملات التالية، المعاملة باليوريا بتركيز ١,٥، ٣، ٥% و/و (المعاملة الأولى)، المعاملة بالجير بتركيز ٤، ٦، ٨% و/و (المعاملة الثانية)، المعاملة باليوريا ٥% + الجير ٨% و/و (المعاملة الثالثة). وكانت نسبة الرطوبة فى جميع المعاملات ٥٠% وتم التحضين على درجة حرارة الغرفة لمدة أربع أسابيع.
لوحظ حدوث زيادة فى درجة ذوبان مكونات جدر الخلايا عند المعاملة بالقلوى . المعاملة الثالثة حققت أفضل تاثير على خفض الألياف الخام (٣١,٦١%)، NDF (٥٣,٥٤%)، ADF (٤٤,٥٤%)، ADL (٥,٣٨%) وذلك مقارنة بالتبن غير المعامل (٤٠,٦٦، ٧٦,١٤، ٥٤,٨١، ٩,٢١%) بنفس الترتيب.
التجربة الثانية: تم استخدام ١٢ ذكر رحمانى نامى (متوسط وزن ١٤,١ كجم ، وعمر ٧-٨ شهور) فى تجربة نمو استمرت ٩٠ يوم. وغذيت الحيوانات على مادة جافة بما يعادل ٣% من وزنها (٧٥ % علف مركز + ٢٥ % مادة خشنة) وبناء على نوعية المادة الخشنة تم توزيع الحيوانات عشوائياً على مجموعتين هى:

المجموعة الأولى (الكنترول): علف مركز + دريس برسيم.
المجموعة الثانية : علف مركز + تبن قمح معامل بالمعاملة الثالثة.

وفى نهاية تجربة النمو تم إجراء تجارب هضم . ولم يكن هناك اختلاف معنوى بين حيوانات المجموعتين الأولى والثانية فى هضم المادة العضوية والمستخلص الخالى من الأزوت (٨٤,٣٥، ٨٣,٧٧%)، (٨٨,٣٥، ٨٧,٦٦%) على التوالى. حققت الحيوانات فى المجموعة الثانية افضل هضم للألياف الخام (٧٠,٩٥%) مقارنة بحيوانات المجاميع الأولى (٦٧,٨٠%) على التوالى. القيمة الغذائية فى صورة مركبات مهضومة كلية وبروتين خام مهضوم كانت (٩٩,٤٨، ١٠٣,٩٨%) على التوالى فى المجموعة الثانية كنسبة مئوية من القيمة الغذائية للمجموعة الأولى.لم يكن هناك اختلافات معنوية بين حيوانات المجموعتين فى الزيادة اليومية فى الوزن (١٤١.١١، ١٣٠,٠جم)، الزيادة الكلية فى الوزن (١٢,٧، ١١,٧كجم)، الوزن النهائى (٣٦,٨، ٣٥,٨كجم) فى المجاميع الأولى والثانية على التوالى.

لذا فيمكن إحلال تبن القمح المعامل كيماوياً (٥% يوريا + ٨% جير بنسبة رطوبة ٥٠% والتحضين على درجة حرارة الغرفة لمدة ٤ أسابيع) محل دريس البرسيم المصرى دون حدوث أى أثار سيئة على كفاءة النمو للحملان النامية.

**Table (1): Effect of urea and lime treatments on the chemical composition of wheat straw (% DM).**

| Treatment combination Urea + Lime % | | Chemical composition, % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Moisture | OM | CP | EE | CF | NFE | Ash | NDF | ADF | ADL |
| UWS | 0 + 0 | 7.91 | 86.14 [a] | 4.63 [g] | 2.20 [a] | 40.66 [a] | 38.65 [c] | 13.86 [h] | 76.14 [a] | 54.81 [a] | 9.21[a] |
| | 1.5 + 0 | 6.66 | 85.81 [b] | 6.87 [f] | 2.00 [b] | 39.42 [b] | 37.52 [d] | 14.19 [g] | 75.23 [a] | 54.27 [a] | 8.12 [b] |
| T1 | 3.0 + 0 | 7.71 | 85.66 [c] | 9.88 [e] | 2.00 [b] | 38.36 [c] | 35.42 [e] | 14.34 [g] | 75.00 [a] | 52.41 [b] | 7.95[b] |
| | 5.0 + 0 | 7.03 | 85.66 [c] | 13.04 [a] | 2.00 [b] | 36.79 [d] | 33.83 [g] | 14.34 [g] | 73.28 [b] | 51.72 [b] | 7.28[c] |
| | average | 7.13 | 85.71 | 9.93 | 2.00 | 38.19 | 35.59 | 14.29 | 74.50 | 52.80 | 7.78 |
| | 0 + 4 | 7.28 | 83.40 [d] | 4.50 [h] | 1.58 [d] | 35.99 [e] | 41.33 [b] | 16.60 [f] | 68.00 [c] | 49.03 [c] | 6.60[d] |
| T2 | 0 + 6 | 7.69 | 82.18 [f] | 4.40 [l] | 1.52 [d] | 35.16 [f] | 41.10 [b] | 17.82 [d] | 64.86 [e] | 47.84 [d] | 6.18[d] |
| | 0 + 8 | 8.10 | 80.86 [g] | 4.30 [j] | 1.33[e] | 33.24 [g] | 41.99 [a] | 19.14 [b] | 58.25 [g] | 45.56 [e] | 5.36[e] |
| | average | 7.69 | 82.15 | 4.40 | 1.47 | 34.80 | 41.47 | 17.85 | 63.70 | 47.48 | 6.05 |
| | 5.0 + 4 | 6.53 | 82.91 [e] | 12.44 [b] | 1.72 [c] | 35.75 [e] | 33.00 [h] | 17.09 [e] | 66.78 [d] | 48.23 [cd] | 6.44[d] |
| T3 | 5.0 + 6 | 6.73 | 81.62 [h] | 12.21 [c] | 1.55 [d] | 33.38 [g] | 34.48 [f] | 18.38 [c] | 60.07 [f] | 46.29 [e] | 6.25[d] |
| | 5.0 + 8 | 6.38 | 80.40 [l] | 11.89 [d] | 1.26 [e] | 31.61 [h] | 35.64 [e] | 19.60 [a] | 53.54 [h] | 44.29 [f] | 5.38[e] |
| | average | 6.55 | 81.64 | 12.18 | 1.51 | 33.58 | 34.37 | 18.36 | 60.13 | 46.27 | 6.02 |

**[a,b,c] Means on the same row with different superscripts are significantly different (P<0.05).**

**UWS: untreated wheat straw. T1: urea treatment T2: lime treatment T3: urea + lime treatment**