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# Effect of Different Chemical Treatments of Bagasse on Water Metabolism in Sheep

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WATER requirement and metabolism were studied in sheep fed sugar cane bagasse (S.C.B) treated with different alkali NaOH, NaOH + Ca $(OH)_2$ and $NH_4OH$ or acid ($H_2SO_4$) reagents in order to improve its nutritive value. Total body water (TBW) and water turnover rate (WTR) were increased ($P< 0.01$) in the different alkali treatments. Acid treatment induced a marked increase in WTR ($P<0.01$) above the control. Biological half -life (t 1/2) of water was decreased ($P<0.01$) for both NaOH and NaOH + Ca $(OH)_2$ treatments compared with untreated bagasse. Total water intake (TWI) and total water loss (TWL) of animals fed NaOH or NaOH+ Ca $(OH)_2$ treated bagasse were higher ($P< 0.01$) than those of the control.Season of year had an obvious effect on water metabolism, where TBW, WTR, TWI and TWL were higher ($P< 0.01$) in summer than in winter.

**Key words** : Sheep, water metabolism, bagasse feeding

Water plays an important role in heat regulation particularly under hot condition in addition to its important role in carring out the biochemical reactions for all activities. Water metabolism was our tool to evaluate the physiological situation of animals. Daily water turnover, as one component of water metabolism, may reflect the range of the metabolic adaptation and can be used as index for estimation daily water requirement (Kamal and Elmasry, 1984;Abdelrazik. *et al.*, 1985).

The aim of this study was to determine water requirements and metabolism in Ossimi rams feed sugar cane bagasse treated with different alkali or acid reagents in order to improve its nutritive value. Variations between the effect of summer and winter seasons on the different water metabolism components were estimated .

## Material and Method

Eight Ossomi rams at 10 - 12 months of age and 30 - 40 kg body weight were

chosen from the sheep flock of the Experimental Farm, at the Faculty of Agriculture, El-Minia University. In summer season 4 Ossimi rams were fed untreated sugar cane bagasse (S.C.B) as a control group, 5% NaOH , 2.5 % NaOH + 2.5 % Ca $(OH)_2$ and 6% $NH_4$ OH treated S.C.B. in a 4 x 4 latin squar arrangement . In the winter season this experiment was repeated with an additional treatment of 2.4 % $H_2SO_4$. In this experiment five animals were offered the five treatments in a 5 x 5 latin squar arrangement. The untreated or treated bagasse represents 75% of the diet, while the rest 25% was the conventional concentrate mixture. Animals were confined in metabolic crates for a period of 22 days to facilitate total collection of feces and urine. The effect of the experimental diet on water metabolism was studied during the last 5 days .During this period feed intake, water intake and total excretion of feces and urine were recorded and data were used to calculate water balance.

At the end of day 17 of each treatment, animals were injected into the jugular vein with a single dose of 0.005 mCi of tritiated water (TOH) / kg body weight. Feeding and drinking were withheld overnight before and 6 hr after dosing to minimize TOH loss and to aviod TOH dilution before its equilibration with body water. Blood samples were collected from each animal before injection to determine the basel count, and at 6, 24, 48, 72 and 96 hr post injection. The plasma was stored at - 20 C until the radioactivity was counted using Liquied Scinitillation Spectrometer (Packard Tri - Carb 3255) for one minute. The counts obtained were used to calculate total body water (TBW), water turnover rate (WTR), water bilogical half time (t1/2) and total water loss as described by Kamal *et al* .(1984). Data were statistically analyzed according to Snedecor and Cochran (1980).

## Results

1- *Total body water (TBW)*

Data in Table 1 show a significant effect of bagasse treatment on TBW either expressed as ml /kg or % of body weight during summer and winter. The maximum value of TBW was observed for NaOH treatment, follwed by NaOH + Ca $(OH)_2$, $NH_4$ OH and the untreated groups, respectively. During summer, the NaOH treatment caused an increase ($P< 0.05$) in TBW % than the control or $NH_4OH$ treatment and than NaOH+ Ca $(OH)_2$ treatment . During winter, NaOH, and NaOH + Ca $(OH)_2$ treatments induced a marked increase ($P< 0.01$ ) in TBW % in comparison with the other 3 treatments. Treatment with acid in winter seems to have no effect on TBW % compared with the control diet . The overall mean TBW as ml/kg or % was significantly ($P< 0.01$) higher in summer than in winter.

Percentage of total body solids (TBS) which was calculated by subtraction of 100 minus TBW%, had a trend oppesit that of TBW%.

**TABLE 1 . Means (± SE) of body weight (BW), total body water (TBW) and total body solids (TBS) in Ossimi rams fed sugar cane bagasse treated with different chemicals during summer and winter seasons.**

| Treatment | BW (kg) | TBW | | TBS (%) |
|---|---|---|---|---|
| | | (ml/kg) | (%) | |
| Summer : | N.S | * | * | * |
| Untreated | 31.5 ± 2.17 a | 592.8 ± 18.33 a | 59.3 ± 1.83 a | 40.7 ± 1.83 a |
| NaOH | 32.4 ± 2.59 a | 668.0 ± 16.25 b | 66.8 ± 1.62 b | 33.2 ± 1.62 b |
| NaOH + Ca $(OH)_2$ | 32.9 ± 2.24 a | 612.1 ± 10.93 a | 61.2 ± 1.09 a | 38.8 ± 1.09 a |
| $NH_4OH$ | 30.9 ± 1.69 a | 600.1 ± 17.16 a | 60.0 ± 1.71 a | 40.0 ± 1.71 a |
| Winter : | N.S | ** | ** | ** |
| Untreated | 31.7 ± 1.97 a | 480.5 ± 24.12 a | 48.1 ± 1.67 a | 51.9 ± 1.67 a |
| NaOH | 35.8 ± 1.52 a | 621.8 ± 36.06 b | 62.2 ± 3.61 b | 37.8 ± 3.61 b |
| NaOH + Ca $(OH)_2$ | 35.1 ± 1.30 a | 593.6 ± 21.03 b | 59.4 ± 2.10 b | 40.6 ± 2.10 b |
| $NH_4OH$ | 34.4 ± 1.27 a | 498.0 ± 12.02 a | 49.8 ± 1.20 a | 50.2 ± 1.20 a |
| $H_2SO_4$ | 32.1 ± 1.34 a | 498.9 ± 12.50 a | 49.5 ± 1.30 a | 50.5 ± 1.30 a |
| Overall means : | N.S | ** | ** | ** |
| Untreated | 31.6 ± 1.37 a | 530.0 ± 19.06 a | 53.0 ± 2.45 a | 47.0 ± 2.45 a |
| NaOH | 34.3 ± 1.46 a | 642.3 ± 21.71 b | 64.2 ± 2.17 b | 35.8 ± 2.17 b |
| NaOH + Ca $(OH)_2$ | 34.1 ± 1.20 a | 601.9 ± 12.38 c | 60.2 ± 1.24 c | 39.8 ± 1.24 c |
| $NH_4OH$ | 32.8 ± 1.13 a | 543.4 ± 20.26 a | 54.3 ± 2.03 a | 45.7 ± 2.03 a |
| Season : | N.S | ** | ** | ** |
| Summer | 31.9 ± 1.00 a | 618.2 ± 10.43 a | 61.8 ± 1.04 a | 38.2 ± 1.04 a |
| Winter | 34.2 ± 0.79 a | 548.5 ± 17.94 b | 54.9 ± 1.79 b | 45.2 ± 1.79 b |

Within columns, treatment means with different letters differ significantly (* : $P < 0.05$; ** : $P < 0.01$, NS : not significant).

2- *Water turnover rate (WTR) and biological half time (T 1/2)*

Water turnover rate (ml/kg/day or ml/kg $^{0.82}$ / day ) was significantly ($P<0.01$) affected by chemical treatment of bagasse during both seasons (Table 2) . The highest values were noted for NaOH treatment followed by NaOH + $Ca(OH)_2$ , $NH_4OH$ and the untreated bagasse , respectively . During winter , treatment of bagasse with acid induced an increase ($P<0.01$) in WTR expressed as ml/kg $^{0.82}$ / day over the control , and a decrease ($P<0.01$ ) than bagasse treated with NaOH + Ca (OH) 2 . No significant differences in WTR were observed when bagasse was treated with acid or $NH_4$ OH . The values of WTR were higher ($P<0.01$) in summer than in winter .

**TABLE 2 . Means (± SE) of water turnover rate (WTR) and biological half - life (T1/2) of water in Ossimi rams fed sugar cane bagasse treated with different chemicals during summer and winter seasons .**

| Treatment | WTR | | t 1 / 2 |
|---|---|---|---|
| | ml / kg / day | ml / kg $^{0.82}$ / day | (days) |
| Summer : | ** | ** | * |
| Untreated | 55.3 ± 2.00 a | 101.9 ± 3.20 a | 7.5 ± 0.16 a |
| NaOH | 89.6 ± 10.15 b | 166.9 ± 19.82 b | 5.4 ± 0.61 b |
| NaOH + Ca $(OH)_2$ | 69.9 ± 5.23 a | 128.6 ± 10.13 a | 6.3 ± 0.43 bc |
| $NH_4$ OH | 65.5 ± 4.92 a | 121.7 ± 8.75 a | 6.4 ± 0.38 cd |
| Winter : | ** | ** | ** |
| Untreated | 33. 0 ± 5.64 a | 63.4 ± 10.92 a | 9.1 ± 0.41 a |
| NaOH | 67 .5 ± 8.56 b | 128.2 ± 15.72 b | 6.6 ± 0.45 b |
| NaOH + Ca $(OH)_2$ | 58.1 ± 1.89 bc | 108.6 ± 3.13 c | 7.0 ± 0.18 c |
| $NH_4OH$ | 42.8 ± 3.84 a | 80.5 ± 7.09 d | 8.3 ± 0.55 a |
| $H_2SO_4$ | 41.7 ± 2.04 a | 75.4 ± 5.59 d | 8.3 ± 0.35 a |
| Overall means : | ** | ** | ** |
| Untreated | 42.9 ± 4.99 a | 80.5 ± 8.98 a | 8.3 ± 0.34 a |
| NaOH | 77.3 ± 7.25 b | 145.4 ± 13.42 b | 6.1 ± 0.41 b |
| NaOH + Ca $(OH)_2$ | 62.9 ± 3.02 c | 117.5 ± 5.68 c | 6.7 ± 0.24 bc |
| $NH_4OH$ | 52.9 ± 4.91 ac | 98.8 ± 8.89 ac | 7.4 ± 0.46 c |
| Season : | ** | ** | ** |
| Summer | 69.8 ± 4.27 a | 129.8 ± 8.13 a | 6.4 ± 0.27 a |
| Winter | 50.4 ± 3.99 b | 95.2 ± 7.43 b | 7.7 ± 0.29 b |

Within columns, treatment means with different letters differ significantly (* : $P < 0.05$; ** : $P < 0.01$, N.S : not significant).

The results in Table 2 indicated a marked decrease in water t 1/2 in animals fed on bagasse treated with different chemicals in both seasons in comparison with control. NaOH treatment had the greatest effect in reducing water t 1/2 than other treatments. Acid or $NH_4OH$ treatments of bagasse during winter insignificantly reduced the t 1/2 than the control values. The overall mean value of water t 1/2 was significantly lower during summer than during winter.

3- *Water balance (WB)*

Total water intake (TWI) was calculated by adding water in feeds (FW). drinking water (DW) and metabolic water (MW). Generally, there were increases in TWI over the control values, particualalry when NaOH or NaOH + $Ca(OH)_2$ treated bagasse were fed . NaOH treatment increased the TWI in summer ($P < 0.05$) and in winter ( $p< 0.01$) while NaOH + Ca $(OH)_2$ increased ($P < 0.01$) the TWI only during winter. Acid treatment during winter had no significant effect on TWI or in its fractions above the control ration. The mean value of TWI was higher ($P< 0.01$) in summer than in winter (Table 3).

TABLE. 3 . Means (±SE) of water in feed (FW), drinking water (DW), metablolic water (MW), total water intake (TWI), water in urine (WU), water in feces excreted (WFE), and evaporative water (EW), total water loss (TWI), and water balance (WB), in Ossimi rams fed sugar cane bagasse treated with different chemicals during summer and winter seasons.

| Treatment | Water intake | | | | Water loss | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | FW L/day | DW L/day | MW L/day | TWI L/day | WU L/day | WFE L/day | EW L/day | TWL L/day | WB L/day |
| Sumer: | * | * | * | * | * | N.S | N.S | * | N.S |
| Untreated | 0.02 a | 2.3 a | 0.1 a | 2.4 a | 1.0 a | 0.1 a | 0.6 a | 1.7 a | 0.7 a |
| | ±0.003 | ±0.14 | ±0.01 | ±0.14 | ±0.08 | ±0.01 | +0.09 | ±0.04 | ±0.13 |
| NaOH | 0.04 b | 3.3 b | 0.2 b | 3.5 b | 1.1 a | 0.4 a | 1.1 a | 2.6 b | 0.9 a |
| | ±0.009 | ±0.26 | ±0.003 | ±0.30 | ±0.17 | ±0.05 | +0.36 | ±0.45 | ±0.11 |
| NaOH +Ca (OH)2 | 0.04 b | 2.5 a | 0.2 b | 2.8 a | 0.4 b | 0.05 | 1.2 a | 2.0 ab | 0.8 a |
| | ±0.005 | ±0.15 | ±0.02 | ±0.17 | ±0.10 | ±0.08 | +0.02 | ±0.24 | ±0.15 |
| NH4 OH | 0.05 c | 2.5 ab | 0.2 b | 2.8 ab | 1.0 a | 0.2 a | 0.9 a | 2.1 a | 0.7 a |
| | ±0.005 | ±0.11 | ±0.02 | ±0.02 | ±0.16 | ±0.03 | +0.11 | ±0.17 | ±0.20 |
| Winter : | ** | ** | ** | ** | N.S | ** | N.S | ** | N.S |
| Untreated | 0.03 a | 1.6 a | 6.2 a | 1.8 a | 0.7 a | 0.3a | 0.3 a | 1.3 a | 0.5 a |
| | ±0.004 | ±0.13 | ±0.02 | ±0.14 | ±0.15 | +0.06 | +0.16 | ±0.13 | ±0.09 |
| NaOH | 0.07 b | 2.7 b | 0.3 b | 3.1 b | 1.3 a | 0.7 b | 0.4 a | 2.4 b | 0.7 a |
| | ±0.007 | ±0.16 | ±0.03 | ±0.17 | ±0.14 | +0.11 | +0.03 | ±0.26 | ±0.11 |
| NaOH + Ca (OH)2 | 0.08 c | 2.3 b | 0.3 b | 2.7 b | 0.7 a | 0.8 b | 0.6 a | 2.0 b | 0.7 a |
| | ±0.009 | ±0.14 | ±0.04 | ±1.02 | ±0.12 | +0.16 | +0.04 | ±0.12 | ±0.06 |
| NH4 OH | 0.07 b | 1.5 a | 0.3 b | 1.9 a | 0.6 a | 0.4 a | 0.4 a | 1.4 a | 0.5 a |
| | ±0.005 | ±0.15 | ±0.03 | ±0.15 | ±0.06 | +0.04 | +0.10 | ±0.12 | ±0.08 |
| H2 SO4 | 0.40 a | 1.7 a | 0.2 a | 1.9 a | 0.9 a | 0.3 a | 0.2 a | 1.4 a | 0.5 a |
| | ±0.002 | ±0.20 | ±0.09 | ±0.21 | ±0.20 | +0.02 | +0.11 | ±0.11 | ±0.03 |
| Overall means : | ** | ** | ** | ** | ** | ** | * | ** | N.S |
| Untreated | 0.03 a | 1.9 a | 0.1 a | 2.0 a | 0.8 a | 0.2 a | 0.4 a | 1.4 a | 0.6 a |
| | ±0.003 | ±0.15 | ±0.01 | ±0.14 | ±0.09 | +0.05 | +0.10 | ±0.11 | ±0.07 |
| NaOH | 0.06 b | 2.9 b | 0.3 b | 3.2 b | 1.2 b | 0.6 b | 0.7ab | 2.5 b | 0.8 a |
| | ±0.008 | ±0.17 | ±0.03 | ±0.17 | ±0.11 | +0.09 | +0.18 | ±0.24 | ±0.08 |
| NaOH + Ca (OH)2 | 0.60 c | 2.4 c | 0.3 b | 2.7 c | 0.6 c | 0.6 b | 0.8 b | 2.0 c | 0.7 a |
| | ±0.008 | ±0.18 | ±0.03 | ±0.10 | ±0.07 | +0.12 | +0.12 | ±0.12 | ±0.08 |
| NH4 OH | 0.06 bc | 1.9 a | 0.3 b | 2.3 a | 0.8 ac | 0.3 a | 0.6 ab | 1.7 d | 0.6 a |
| | ±0.005 | ±0.21 | ±0.02 | ±0.19 | ±0.10 | +0.04 | +0.15 | ±0.14 | ±0.10 |
| Season : | ** | ** | ** | ** | N.S | ** | ** | ** | N.S |
| Summer | 0.04 a | 2.7 a | 0.2 a | 0.9 a | 0.9 a | 0.3 a | 1.0 a | 2.2 a | 0.7 a |
| | ±0.004 | ±0.13 | ±0.01 | ±0.13 | ±0.09 | +0.04 | ±0.11 | ±0.16 | ±0.07 |
| Winter | 0.60 b | 2.1 b | 0.3 b | 2.4 b | 0.9 a | 0.5 b | 0.4 b | 1.7 b | 0.6 a |
| | ±0.005 | ±0.14 | ±0.02 | ±0.15 | ±0.09 | +0.06 | ±0.05 | ±0.13 | ±0.04 |

Within columns , treatment means with different letters differ significantly (* : P < 0.05;** : P < 0.01, N.S : not significant ).

Total water loss included water in the urine (WU), feces water excretion (WFE) and evaporative water (EW). There were significant increases in total water loss for the different chemical treatments over that of the untreated bagesse (Table 3). NaOH treatment raised significantly the TWL values during summer and wintar in comparison with control. During winter, treatment with NaOH + Ca(OH)2 caused an increase ($P< 0.01$) in TWL value. $NH_4$ OH had no significant effect in TWL in both seasons. Treatment with $H_2$ $SO_4$ during winter was also without significant effect. The value of TWL was greater ($P < 0.01$) in summer than in winter. The major source of variation was the evaporative water (1.0 L/day in summer vs 0.4 L/day in winter). On the other hand, water in feces was higher ($P < 0.01$) in winter than in summer, while the water excreted in urine was similar during the two seasons.

Results of the calculated water balance (TWI - TWL/day) revealed no significant variation due to different chemical treatments either in summer or in winter, altough the values of water balance tended to be higher when NaOH or NaOH+Ca $(OH)_2$ treated bagasse were fed (Table 3). The mean values of water balance were 0.7 and 0.6 L/during summer and winter, respectively, but these differences were insignificant.

## Discussion

Results of the present study indicated that both TBW and WTR were significantly affected by chemical treatments of bagasse either in winter or in summer. The greatest effect was noted with NaOH followed by NaOH + $Ca(OH)_2$ then by $NH_4$ OH treatment. Treatment with acid during winter also increased TBW and WTR above that of the control, but the effects were lower than those of the alkali treatments. The present results agree with several studies indicating an increase in TBW and WTR by increasing salt or mineral ingestion through feed and /or drinking water. Macfarlane and Howard (1969) showed that TBW and WTR were increased during grazing of sheep on saltbush. kamal *et al.* (1984) also found that drinking of sea water significantly increased the WTR in goats, but TBW was slightly affected. The increases in TBW and WTR during feeding on bagasse treated with alkali or acid are mainly due to an increase in TWI through feed and drinking water (Table 3).

The overall mean of TWI was increased by 60% abd 35% above control for NaOH and NaOH + $Ca(OH)_2$ treatments, respectively. Several investigators observed an increase in water consumption owing to feeding on alkali treated crop residues (Lamm *et al.*, 1979; El-Badawy, 1981; Varma and Jaiswal, 1981; Fahmy, 1985) Increases of water consumption was attributed to higher PH and/or osomatic pressure of rumen fluid. This was accompanied with a faster rate of passage of digesta through the rumen and the gastrointestinal tract leading to higher amount of water intake. In addition, greater

amounts of water are needed to excrete the larger amounts of minerals, particularly sodium which was ingested through feed.

Animals fed bagasse treated with alkali had a positive water balance that was greater than animals fed untreated bagasse (Table 3). Acid treatment had no effect on water balance and, consequently on TBW. The increase in water retention (positive water balance), which was noticed when alkali treated bagasse was fed, elevated the percentage of total body water, i.e. decreased total body solids percentage. Total body solids were decreased by 24, 16 and 3% when NaOH, NaOH + $Ca(OH)_2$ and $NH_4$ OH treated bagasse were fed, respectively (Table 1).

Sheep fed on bagasse either treated or untreated with chemical reagents showed greater TBW and WTR during summer than during winter. Thus TBS was lower in summer than in winter. This can be attributed to greater amount of TWI during the summer season, particularly the drinking water since the amounts of water taken from feed or metabolism were lower in summer than in winter (Table 3). The rise in WTR during summer is largely the result of the elevated air temperature during this season. These finding are in agreement with reports by several investigation on sheep and goats (Macfarlane and Howard, 1972; Khan, 1983; Taher, 1985) It was pointed out that high environmental temperature as such stimulates the site of drinking (Grace and Stevenson, 1971) and this might contribute to the increase in WTR observed during summer. Ruminants exposed to heat increase thier TBW and their extracellular fluid volume (Dagen and Young, 1981; Khan, 1983). This rise in TBW can be attributed to increased capacity for water retention upon exposure to heat in order to provide water for intense evaporative heat loss (El-Nouty *et al.*, 1988).

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# تأثير المعاملة بمواد كيمائية مختلفة للمصاصة علي تمثيل الماء في الأغنام

عبد المعطي خيري ابراهيم عبد المعطى (١) فرحات الدسوقي النوتى (٢)
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تم دراسة الإحتياجات من الماء وكذلك تمثيل الماء في الأغنام المغذاه علي مصاصة قصب السكر المعاملة بالقلويات المختلفة وهي أيدروكسيد الصوديوم أو أيدروكسيد الصوديوم + أيدروكسيد الكالسيوم أو أيدروكسيد الأمونيا وكذلك المعاملة بواسطة حمض الكبريتيك وذلك بغرض رفع قيمتها الغذائية . وقد ارتفع معنويا (١٪) كل من المحتوي الكلي لماء الجسم ومعدل إستخدام الماء نتيجة المعاملة بالقلويات . المعاملة بالحامض أدي الي زيادة معنوية (١٪) في معدل استخدام الماء. نصف العمر البيولوجي حدث له نقص معنوي (١٪) في المعاملة الخاصة بأيدروكسيد الصوديوم أو أيدروكسيد الصوديوم + أيدروكسيد الكالسيوم عند مقارنتها بالمعاملة القياسية. الماء الكلي الماخوذ والماء الكلي المفقود للحيوانات المغذاه علي المصاصة المعاملة بأيدروكسيد الصوديوم أو أيدروكسيد الصوديوم + أيدروكسيد الكالسيوم سجلت أرقاما مرتفعة معنويا (١٪) بالمقارنة بالمعاملة القياسية. فصل السنة كان له تاثير علي كل من الماء الممثل حيث كان المحتوي الكلي لماء الجسم ومعدل إستخدام الماء والماء الكلي الماخوذ والماء الكلي المفقودمرتفعا معنويا في فصل الصيف مقارنة بفصل الشتاء.