Effect of Naturally High Sulfur Water Intake on the Growth Performance of Lambs

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ABSTRACT

Twelve cross-bred lambs, 4 months of age averaging 20 kg body weight were used. Lambs were divided randomly into 2 groups of 6 animals. Each group consisted of 3 lambs of each sex. The control group received normal drinking water (2252.80 ppm total dissolved solids containing, 254.4 ppm sulfur), and the treatment group received naturally high sulfur water (3174.0 ppm total dissolved solids containing 1027.2 ppm sulfur). The experiment lasted 10 weeks with water intake being recorded daily for the first 7 weeks and body weight recorded each week of the experiment. Mixed hay was provided *ad libitum* and a supplement concentrate diet of about 600 grams/ head/ day was provided throughout the experimental period. The results showed no significant effect of water treatment on either water consumption or on body growth performance. Male lambs gained more weight than females ($p < 0.5$). Meat quality testing and histological examinations of the caracasses of both sexes showed no significant treatment effects.

The results indicated no apparent effects of using naturally high sulfur water for sheep drinking. However, further investigation is needed to study the effects of sulfur and other dissolved solids in water on physiological performance of ruminants.

INTRODUCTION

Naturally high sulfur water is found in different regions of Libya. It has higher total dissolved solids than normal drinking water and a temperature of about 55°C as it comes out of the ground (Table. 1). Often this is the most readily available or sometimes the only source of livestock water in dry areas where normal underground water is lacking. Several studies on the tolerance of livestock for saline waters have been reported (1). It has been suggested that sulfates are more harmful to livestock (3, 8) with cattle and sheep being more resistant to the effect of saline water than other species.

Experimental data on the effect of drinking naturally high sulfur water on ruminants are not available in the literature. However, it is well documented that ruminant

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microorganisms can utilize inorganic as well as organic forms of sulfur to synthesize sulfur containing amino acids (4). Lambs fed sulfate, calcium sulfate or elemental sulfur gained weight faster, consumed more dry matter, digested and retained greater weights of N and S than lambs on a sulfur deficient diet (5). The naturally high sulfur water contains an elemental inogranic source of sulfur. Thus, its use for ruminant drinking in dry areas where protein is deficient in many feeds may improve feed utilization. This experiment, therefore, was conducted as an attempt to investigate the effect of drinking naturally high sulfur water on growth performance of growing lambs.

Table: 1 — Chemical composition of normal drinking water and naturally high sulfur water (ppm)*

Item	Normal water	High sulfur water
pH	7.6	7.8
Total dissolved solids	2252.8	3174.0
Ca	160.0	326.4
Mg	97.9	96.0
Na	465.6	621.0
K	66.3	122.1
HCO_3^-	248.5	482.8
Cl	940.8	979.8
S	254.4	1027.2
Water temperature °C	10.0	55.0

* The analysis was performed in the Soil and Water Department, Faculty of Agriculture, University of Al-Fateh. Tripoli

MATERIALS AND METHODS

Twelve crossbred lambs, 6 of each sex, averaging 20 kg body weight and 4 months of age were assigned randomly to 2 groups of 6 lambs (3 of each sex) and maintained individually in digestibility boxes. The control group received normal drinking water containing 2252.80 ppm total dissolved solids (TDS) including 254.4 ppm sulfur and the treatment group received the naturally high sulfur water which contained 3174.00 ppm TDS including 1027.2 ppm sulfur. Normal water (tap water) was supplied via municipal water line. The naturally high sulfur water because of its high temperature (55°C) as it comes out of the ground was cooled in a big concrete reservoir and was carried to the experimental station in 20 liter containers. The chemical composition of both waters is presented in Table 1. The feed provided was composed of mixed hay and concentrates (12% protein). The hay was provided *ad libitum* throughout the experiment and the concentrates were given at a rate of 600g/ head/ day. All lambs were in good health and under same management conditions during the experimental period which lasted 10 weeks. Water consumption was recorded daily for the first 7 weeks and body weight was taken weekly for 10 weeks. Venipuncture blood samples were also taken weekly and plasma was stored for future hormonal analysis. The experiment was also designed to measure digestibility and water balance, but was difficult to assess due to continuous movement of lambs inside the boxes.

At the end of the experiment one lamb of each sex of each group was slaughtered. Meat quality testing, histological and anatomical visual examinations were performed on the caracasses.

Data collected through the first 7 weeks were exposed to 2×2 factorial analysis as described by Snedecor and Cochran (6). Growth patterns for the ten week experiment are presented graphically.

RESULTS AND DISCUSSION

The mean effects of water treatment and type of sex on daily water consumption and body weight of lambs are presented in Table 2. Daily water consumption was not significantly influenced by type of water or by sex. This was similar to early reports (3, 8) which showed that sheep were more resistant to the effect of saline water, and was in contrast to the results obtained by Anderson and Stothers (1) who showed higher water consumption for animals that received saline water treatment containing 6000 ppm, and also, to Carrigus *et al.*, (2) who found that water consumption was greater for animals that received water containing 300 ppm more sulfates, than the control.

Table 2 — Mean effect (± SE) of water treatment and sex on daily water consumption and body weight.

Item	Water		Sex	
	Normal	Sulfur	Male	Female
Water cosumption l/day	3.3 ∓ 0.3	3.1 ∓ 0.7	3.2 ∓ 0.1	2.9 ∓ 0.1
Body Wt., (Kg)	28.0 ∓ 1.0	27.3 ∓ 1.1	28.9 ∓ 1.3	26.4 ∓ 1.0*

* $p < 0.05$

The body weight was not significantly affected by water treatment. However, it was significantly ($p < 0.05$) influenced by sex, since males gained more weight than females. This was generally expected due to high efficiency of feed conversion. The efficiency of utilizing supplemental sulfur by ruminant's microorganisms is dependent on the form and source of the sulfur added. Kohlan *et al.*, (4) found that sulfur from methionine resulted in greatest microbial protein synthesis with 100% efficiency, whereas sulfur from other supplemental sulfur sources such as sodium sulfate and elemental sulfur were only 55% and 35.8% as effective, respectively. The sulfur in the treatment water used in this study was in an elemental inorganic form. The water was also higher in other elements such as bicarbonates, Ca and K which might somehow affect the *homeostasis* of the animal. The role of sulfur in improving feed utilization by ruminants cannot be ruled out especially when the diet is deficient in sulfur. Garrigus *et al.*, (2) stated that the addition of elemental sulfur to a ration low in sulfur increased feed utilization of lambs. Kohlan *et al.*, (5) showed that lambs fed various sulfur sources including elemental sulfur had gained faster, and consumed more dry matter than lambs feeding on sulfur-deficient diets.

The growth pattern of lambs for the entire experiment period (10 weeks) is illustrated in Figure 1. Although there were no significant effects due to water treatment, lambs under normal water showed slightly better growth performance than those

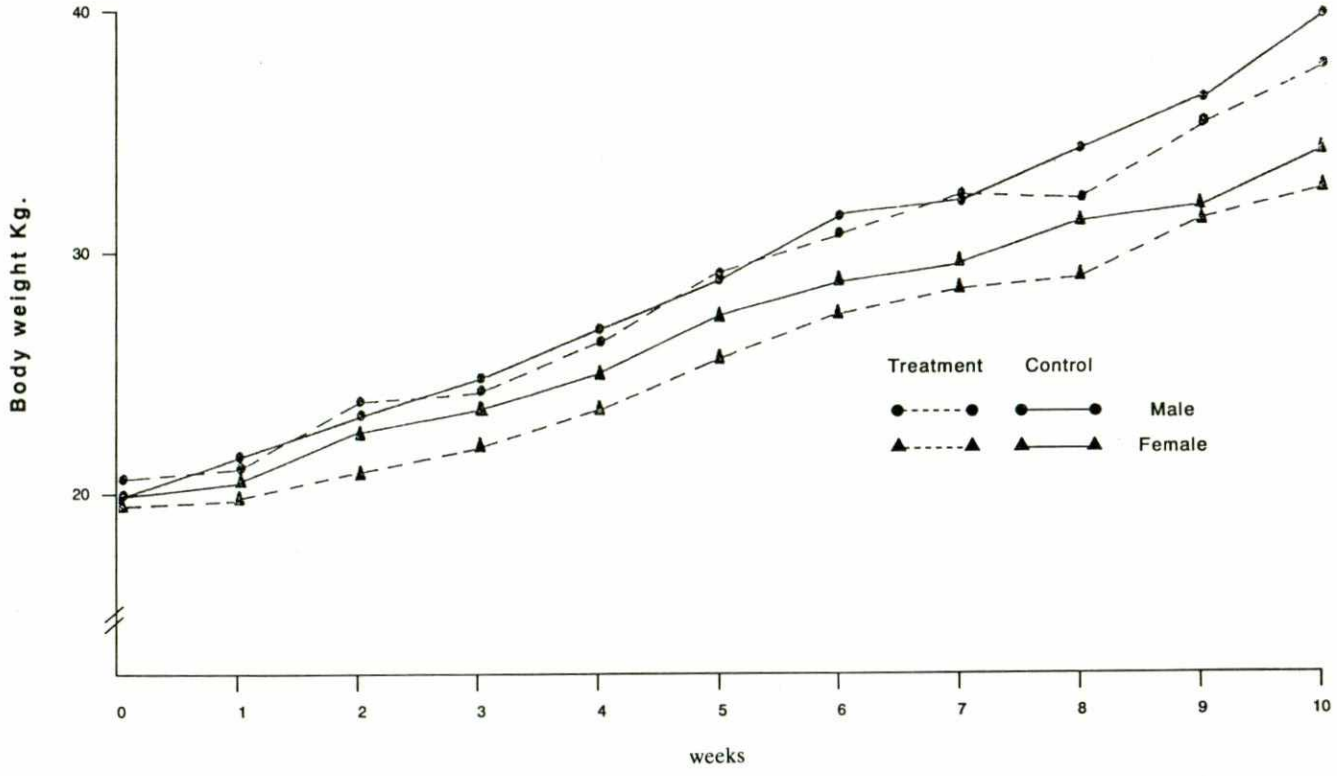

Figure 1: Effect of sulfur water on growth performance of lambs

under naturally high sulfur water. Also males in both groups performed better than the females. The net weight gain and daily rate of growth during the whole period are presented in Table 3. The control group appears to have slightly higher rate of gain than the treated group. Kohlan *et al.*, (5) found no significant differences among weight gains or dry matter consumption of lambs fed various forms of sulfur for the first entire 60 day period of the experiment. Carrigus *et al.*, (2) also found no treatment effect from adding sulfates to the water up to 3320 ppm on average daily gain. Anderson and Stothers (1) study showed no significant treatment differences in the average daily gain between animals receiving control water lower in total dissolved solids (125 ppm) and animals receiving water high in TDS (6000 ppm). In addition, they showed that control animals consumed more feed, gained faster and had a better feed/ gain ratio than the treatments

Table 3 — The effect of water treatment on growth performance of male and female lambs during 10 weeks.

Item	-Normal water-		-Sulfur water-	
	Male	Female	Male	Female
Initial body weight, Kg	20.2	20.0	20.7	19.5
Final body weight, Kg.	40.2	34.5	38.2	33.0
Net weight gain, kg	20.0	14.5	17.5	13.5
% Increase	99.0	71.0	85.0	69.0
Daily rate gain, g	247.0	175.0	216.0	167.0

At the end of the experiment, 2 lambs (one of each sex) from each group were slaughtered to determine treatment effects on caracass weight, dressing %, meat quality and occurrence of any abnormalities or diseases. Because of the small number of animals slaughtered data were not statistically analysed. However, the results indicate that lambs under normal water had slightly higher dressing % than treated lambs (Table 4). No apparent treatment differences were observed in the general appearance, color, texture, fat distribution or in the conformation of the caracasses. Histological and anatomical sectioning of the heart, liver, kidneys and lungs did not show any abnormalities or signs of disease due to treatment effects. These observations were similar to those of Anderson and Stothers (1) who reported no treatment effects on

Table 4 — Effect of water treatment on dressing % of male and female lambs slaughtered after 10 weeks experiment*.

Item	Normal water		sulfur water	
	Male	Female	Male	Female
Final weight, kg	42.5	39.0	35.0	41.5
Caracass weight, kg	21.3	18.5	18.5	22.0
Dressing %	50.0	53.0	47.0	47.0

* n = 1 lamb of each sex from each group.

liver, kidney weights or kidney histological structure in the sacrified animals.

The present study did not allow us to determine the broad significant effects of using this kind of water for ruminant drinking since the presence of other dissolved solids such as Ca, K and bicarbonates which may play a part in changing the internal homeostatic functions of the animal should also be considered. However, the results support the suggestion of Heller (3) and Weeth (8), in that sheep are resistant to high saline waters and also confirm the recomendations of the committee on water quality criteria (7), that water containing 5000 ppm TDS is not harmful, even when it contains 3320 ppm sulfates.

The results of this experiment indicated no harmful effects of using naturally high sulfur water for ruminant drinking although its effects on the physiological functions of body and reproductive performances of ruminants require further investigation.

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أثر المياه الكبريتية على معدل نمو الحملان

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المستخلص

استخدم في هذه التجربة 12 خروفاً ستة ذكور وستة إناث تتراوح أعمارها 4 شهور ومتوسط وزن الجسم 20 كجم. قسمت عشوائياً الى مجموعتين 6 حيوانات في كل مجموعة 3 إناث و 3 ذكور. تناولت مجموعة التحكيم مياه عذبة (مجموع المواد الصلبة الذائبة 2252.80 جزيء في المليون منها 254.4 جزيئاً في المليون من الكبريت)، وتناولت المجموعة المعاملة مياهاً كبريتية (مجموع المواد الصلبة الذائبة 3174 جزيئاً في المليون منها 1027.2 جزيئاً في المليون كبريت). استغرقت التجربة 10 أسابيع سجلت خلالها كمية الماء المستهلكة يومياً خلال السبعة أسابيع الأولى ووزن الجسم مع نهاية كل أسبوع لمدة 10 أسابيع. أوضحت النتائج أن الماء الكبريتي لم يؤثر معنوياً على كمية الماء المستهلكة ولا على معدل النمو، بالرغم من أن الحيوانات المعاملة كان معدل النمو فيها يتناقص مقارنة بالحيوانات التحكيم. لم يوضّح الفحص التشريحي البيطري أي أثر للمعاملة على نوعية وجودة الذبيحة، ولا على ظهور أي علامات مرضية عليها. بالرغم من الحصول على هذه النتائج المبدئية إلّا أن عدداً من البحوث يجب أن يجري للتأكد من أثر المواد الصلبة الذائبة في المياه الكبريتية على معدل الأيض في المجترات.