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Effect of drinking high salt water from weaning to adulthood in Barbarine male lambs

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Abstract. Forty adult Barbarine male lambs were used to evaluate the effect of prolonged drinking of saline well waters on growth, ruminal and digestive performances after a period of 4 months of administration. At the weaning day, animals were randomly allocated high salt water (10 g NaCl / 1l of water) or control water (potable fresh water, 0.5g/l). Animals were adapted for experimental conditions before starting the 105-day growth trial. At the end of the growth trial, animals were housed in metabolic cages for total faecal collection during 10 consecutive days. Drinking high salt water did not affect the growth performance. Ony, caudal condition scores increase in S-lambs comparing to C-lambs ($P<0.001$). Moreover, S-lambs decreased their serum triglyceride, cholesterol, glucose, total protein, acid uric and creatinine concentrations ($P<0.01$). Urea and γ-GT concentrations were not affected by water salinity ($P>0.05$).The response of the weaned lambs in water and food intakes, in ruminal fermentation, in digestibility coefficients, in urinary excretions of total purine derivatives, allantoin, xanthine plus hypoxanthine and uric acid as well as in urine outputs and nitrogen balances were similar for both groups independently the water quality used ($P>0.05$).Utilization of such saline water could be used successfully and safely as good quality of water resources without compromising their feedlot performance.

Keywords: High salt water – Lambs – Ruminal fermentation – Digestibility – Nitrogen balance.

I – Introduction

Ram production in Tunisia is essentially carried on under grazing conditions. The use of concentrate supplements to reduce body weight losses during the dry season and to insure more accelerated gains during the rainy season is practically unknown. With the increased demand for meat and the establishment of price differentials for an improved product, ample justification exists to initiate research on the practice of supplementation for animals under grazing conditions and the regulation of concentrate consumption using high salt levels added to water or diet (Ru *et al.,* 2000).The incorporation of salt in the supplement to regulate intake has been demonstrated by some authors to be practical for beef cattle (Kroger and Carroll, 1964) and sheep (Weir and Miller, 1953; Kraidees *et al.,* 1998; Pearce *et al.,* 2008; Sun and Zhou, 2010), while others have observed limitations to this practice (Wilson, 1966; Henze *et al.,* 1994).

Therefore, the objectives of this experiment were to evaluate the effect of drinking 10% high salt water to Barbarine male lambs from weaning to adulthood on body weight gain, body condition scores, food and water intakes, ruminal fermentation, apparent digestibility and nitrogen balance.

II – Materials and methods

On the day of weaning, we randomly selected from the offspring born to ewes drinking a potable, normal salt (0.5% NaCl) water, twenty clinically healthy male lambs, 4-month-old, with an average body live weight 26kg ± 0.5 kg and the dorsal and caudal body scores were 1.5 ± 0.1 kg and 3 ± 0.5 kg respectively. They were randomly divided into two groups with the first group was contin-

ued to drink a potable water (0.5%, C- *lambs*) but the second group was received high-salt water (10% NaCl, S- *lambs*) from the weaning to the adulthood (8-month-old). Animals were individually offered weighed amount of 1 kg of hay daily at 8:00h plus concentrate feed mixture which consisted of 80% soybean, 17.5% triticale and 2.5% CMV. The experiment was approved by the Animal Ethics Committee of The National Institute of Agronomic Research in Tunisia.

Body live weight (BLW) was recorded weekly in order to calculate the body live change (BLC) and average daily gain (ADG). The daily feed intake (DMi and OMi) and water intake calculated for each animal.

Serum triglyceride, cholesterol, glucose, albumin, total protein, uric acid, urea, creatinine and Gamma glutantransferase (γ-GT) contents were determined according to the standard operating procedures.

At the 90th day of experiment (7-months-old), 50 ml of rumen fluid was sampled before feeding, 3 and 6 hours post feeding from each animal for measurement of pH and osmolarity values, ammoniac-N, Na and K ions concentrations and protozoa enumeration and identification.

At the 120th day of experiment (8-months-old), eight representative lambs averaging 29-kg body weight from each treatment group were selected for a metabolic experiment.The lambs were adapted to cages for 7 days, followed by 5 days when feces and urine were collected after excretion and bulked daily for total weight determination in order to assess the apparent digestibility of diets, nitrogen balance and microbial N synthesis as Allantoin, Xanthine plus Hypoxanthine, Acid uric and Purine.

All data were analysed by separately with the PROCMIXED procedure. The statistical model includes watering regimens (C vs S), age of weaned lambs and the interaction between these two fixed variables. All analyses were using the of the statistical analysis systems 9.0 version (SAS, 2004). Differences between means were considered significant when the P-value is below 0.05.

III – Results and discussion

BLW was not affected by water salinity ($P > 0.05$). Similar results were reported by Potter *et al.* (1972), Rasool *et al.* (1996) and Alhadrami *et al.* (2005). The same observation was proved in young sheep or cattle (Walkerden *et al.,* 1976), fattening sheep and cattle (Meyer *et al.,* 1955) and of weaned rats (Coelho *et al.* 2006). The ADG of weaned lambs were not affected by water salinity ($P>0.05$). Similar results were reported by Srivastavam and Sharma (1998) who shown no difference between adult lamb drinking high, low or normal level of salt.

Dorsal condition scores was not affected by water salinity ($P>0.05$). However, caudal condition scores increase high statistically with treatment and age. S-lambs, 8-month-old, had high caudal note than C-lambs ($P<0.001$).

Table 1. Effect of drinking high salt water on Body condition scores of weaned Barbarine male lambs

Parameters	Water type	Post weaning (days) 0	30	60	90	Overall	S.E. Salinity	Age	Interaction
Dorsal Score	F	1.47	1.50	1.44	1.53	1.48	0.02	0.05	0.05
	HS	1.53	1.56	1.56	1.53	1.55			
Caudal Score	F	3.41	3.72	4.09	4.25	3.87	0.08***	0.05***	0.05
	HS	3.63	4.25	4.34	4.56	4.20			

F: fesh water (0.5% NaCl). HS: high salt water (10% NaCl). SE: standard error of means. ***P<0.001.

Serum biochemical indices are illustrated in Table 2. Drinking high salt water decreased the concentration of serum triglycerides, cholesterol glucose, total protein and uric Acid (P<0.05) and increased the concentration of serum Creatinine (P<0.01). Urea and γ-GT concentrations were not affected by water salinity (P>0.05). With increased salt intake from drinking water, the body is exposed to a metabolic stress, resulting in increased energy requirements to maintain the sodium/potassium gradient, which decreased the concentration of glucose (Ahmed *et al.,* 2001) and in increased passage of fluids into the interstitial tissue which decreased the concentration of total protein (Ahmed *et al.,* 2001). However, high salt level did not damage on kidney function and liver enzymes.

Table 2. Effect of drinking high salt water on metabolites blood profiles of weaned Barbarine male lambs

Parameters	Water type	Post weaning (days) 30	60	90	120	Overall	S.E. Salinity	Age	Interaction
Triglyceride	F	18.72	25.90	24.85	26.25	31.43	1.55*	3.13*	4.50*
(mg/dL)	HS	14.62	21.71	21.09	27.71	26.28			
Cholesterol	F	77.48	68.67	54.55	68.85	67.39	4.21*	6.81*	9.31
(mg/dL)	HS	42.86	74.17	40.76	66.64	56.11			
Glucose	F	53.64	43.42	33.98	17.83	42.22	7.13*	11.85***	17.14
(mg/dL)	HS	46.00	42.78	43.75	14.70	36.81			
Total protein (g/l)	F	46.55	52.96	41.04	32.13	43.17	0.98*	1.66***	2.7
(g/l)	HS	41.43	50.34	39.05	28.12	39.73			
Uric Acid	F	0.91	0.94	0.56	0.69	2.02	0.11*	0.19***	0.3
(mg/dL)	HS	0.55	0.69	0.54	0.73	1.45			
Urea (mg/dL)	F	25.00	24.19	24.52	23.45	29.29	1.55	2.75	1.51
	HS	23.12	20.44	20.38	24.14	29.52			
Creatinine	F	22.71	26.06	22.91	31.62	29.70	0.06**	0.14***	0.12
(mg/dL)	HS	25.79	26.89	31.07	38.95	26.80			
γ-glutantransferase	F	0.85	1.64	1.77	0.58	1.21	1.24	2.62***	1.68
(U/L)	HS	1.54	1.81	1.54	0.70	1.40			

F: fesh water (0.5% NaCl). HS: high salt water (10% NaCl). SE: standard error of means. *P<0.05; ***P<0.001.

Average daily food intake, DM intake and MO intake and daily food intake/kg body weight. (Table 3) were similar in the lambs drinking high salt water or potable water (P>0.05) during all the experiment period. Similarly, average daily water intake of S-lambs was similar compared to C-lambs (P>0.05). Also, average daily water intake/kg body weight no affected by drinking high salt water (P>0.05) (Table 3). Kraidees *et al.* (1998) found a linearly increase in water intake with the increase for Na ingested and the increase of kg OM intake.

RumenpH and osmolarity decreased with drinking high salt water (P<0.05). Elam and David (1962) found added sodium chloride tended to decrease the pH. However, ammoniac-N, sodium and potassium concentrations, protozoa quantification and generic composition were not affected by salinity water (P>0.05). The same observations were proved by Kattnig *et al.* (1992) in Holstein steers drinking saline water (2.300 ppm TDS).

The salinity of water did not affect the entire digestibility's parameter. This finding was in accord to the bibliography. The both group treated similarly under the salt stress without any problem for the sheep's health, if clean, soft water is provided at all times. These results indicated that adult lambs accept drinking high salt level (Weir and Miller, 1953).

Concerning nitrogen retention, there were insignificant (P>0.05) variations among treatments where all lambs were in positive nitrogen balance and retained insignificant various amounts of nitrogen. The results are in harmony with those obtained by El- Shaer *et al.* (2001).

Table 3. Effect of drinking high salt water on food and water intakes of weaned Barbarine male lambs

Parameters	Water type	Post weaning (days) 15	30	45	60	75	90	105	Overall	S.E. Salinity	Age	Interaction
g per day	F	847.5	915.1	1039.7	1059.4	1214.6	1351.0	1349.2	1110.9	1.11	2.94***	3.1
	HS	841.9	912.0	1047.7	1058.0	1213.5	1354.0	1351.4	1111.2			
DM intake	F	75.8	87.6	91.9	101.1	117.2	128.0	134.0	105.1	1.31	3.47 ***	3.1
(% DM)	HS	70.0	90.9	92.4	96.5	121.5	120.7	129.8	103.1			
OM intake	F	59.7	47.3	63.0	58.7	59.7	88.6	74.6	64.5	1.66	4.41***	4.26
(% DM)	HS	46.9	48.7	63.9	48.6	51.1	87.8	77.2	60.6			
g per kg W 0.75	F	69	71.3	81.2	81.9	90.5	100.1	97.5	84.5	1.14	3.01***	1.4
	HS	67.8	72.3	82.3	80.8	87.5	97.0	96.5	83.5			
l per day	F	5.63	5.64	5.53	5.88	6.3	6.69	7.94	6.23	0.014	0.04***	0.045
	HS	5.75	5.67	5.57	5.86	6.27	6.67	8.02	6.26			
l per kg W 0.75	F	0.47	0.44	0.43	0.46	0.47	0.5	0.57	0.48	0.006	0.016***	0.009
	HS	0.46	0.45	0.44	0.45	0.45	0.48	0.57	0.47			
l per kg DM	F	6.07	6.17	5.31	5.55	5.19	4.95	5.88	5.59	0.001	0.003***	0.002
intake	HS	0.08	6.22	5.32	5.54	5.17	4.93	5.93	4.74			

F: fesh water (0.5% NaCl). HS: high salt water (10% NaCl). SE: standard error of means. *P<0.05; ***P<0.001.

Table 4. Effect of drinking high salt water on rumen fermentation of adult Barbarine male lambs

Parameters	Water type	Time post feeding (hour) 0	3	6	Overall	S.E. Salinity	time	Interaction
pH	F	5.91	5.78	6.02	5.90	0.50*	0.07	0.10
	HS	5.54	5.78	5.80	5.70			
Osmolarity	F	673.40	448.60	364.60	495.53	19.37**	26.93	31.29
(mosm/kg H2O)	HS	279.20	313.40	272.20	288.26			
NH3-N2+ (mg/dl)	F	8.99	16.08	16.07	13.71	1.93	1.47***	0.73
	HS	7.27	15.40	15.39	12.68			
Na+ (mg/100g)	F	34.44	30.78	27.24	30.82	1.05	1.55	2.36
	HS	33.48	31.20	30.66	31.78			
K+ (mg/100g)	F	34.86	34.68	44.28	37.94	2.82	2.90***	3.02
	HS	31.62	44.94	49.38	41.98			
Protozoa (10^5/ml)	F	34.00	44.00	70.40	49.46	10.67	11.55	9.74
	HS	29.6	35.6	42.00	35.73			
Endiplodium (10^5/ml)	F	25.2	22.00	41.60	29.00	5.71	6.40	6.64
	HS	19.60	21.60	24.80	22.00			
Epidimium (10^5/ml)	F	8.40	20.40	28.40	19.06	5.14	5.65	5.88
	HS	10.00	14.00	17.20	13.73			
Polyplastium (10^5/ml)	F	0.40	1.60	0.40	0.80	0.17***	0.32	0.52
	HS	0.00	0.00	0.00	0.00			

F: fesh water (0.5% NaCl). HS: high salt water (10% NaCl). SE: standard error of means. *P<0.05; **P<0.01; ***P<0.001.

The urine output increased insignificantly (*P*>0.05) in S-lambs comparing to C-lambs. This result was contrary to previous observations (Pierce, 1968; Wilson, 1966) which explicated that the increase of urine output is part of the normal response of the animal in dealing with excessive loads of Na in the body. Nitrogen intake g per day was similar (*P*>0.05) in the two groups without any affect in nitrogen balance in both groups.

Urinary excretions of allantoin, uric acid, xanthine plus hypoxanthine and total purine derivatives were not significantly affected (*P*>0.05) by drinking high salt water. When expressed as proportions

of total purine derivatives, allantoin proportion was increased and xanthine plus hypoxanthine proportion was reduced.

Lambs excreted three times as much as allantoin as xanthine plus hypoxanthine or uric acid. Drinking high salt water decreased slightly the allantoin, xanthine plus hypoxanthine, uric acid and purine excretion but this changes were not significantly different (P>0.05). The lower uric acid excretion of animal compensated quantitatively for the higher allantoin excretion (Liang *et al.*, 1994).

IV – Conclusion

The present results shows that *Barbarine male lambs* can subsist drinking saline water containing 10 g/l of NaCl for a relatively long period (105 days) without exhibiting harmful effects on health or any changes in digestibility, nitrogen balance or microbial system. Adult lambs were adapted to high salt level by some increasing serum concentration and ruminal osmolarity. Further study is required to investigate their responses to other ionic substances dissolved in their drinking water.

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