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WATER INTAKE OF SHEEP AS INFLUENCED BY FEED INTAKE AND ENVIRONMENTAL TEMPERATURE

T.M. El-Bedawy, H.M. Murad, M.M. Shafie and S.M. Salem

Department of Animal Production, Faculty of Agriculture, University of Cairo, Giza, Egypt

SUMMARY

Data of 750 daily observations obtained from 5 mature non-producing Ossimi x Rahmani sheep, in six metabolism trial, each lasted for 25 days under 18°C or 35°C environmental temperature were averaged for each experiment in 30 records were subjected to multiple regression analysis of variance to quantify the relationship between total water intake and environmental temperature °C, dry matter intake and body weight. Two models were calculated:

$Y = 2054.07 + 74.53 X_1 + 1.28 X_2 - 31.86 X_3$ ....(1)

$Y = 298.32 + 78.18 X_1 + 1.19 X_2$ .....(2)

where

Y = total water intake (ml/head/day)

X_1 = environmental temperature °C

X_2 = dry matter intake (g/head/day)

X_3 = body weight (Kg)

A model was suggested to predict total water intake (ml/Kg $W^{0.75}$) from environmental temperature °C and dry matter intake (g/Kg $W^{0.75}$) to avoid differences in body weight and dry matter intake

$Y = 14.19 + 4.18 X_1 + 1.14 X_2$ .....(3)

where

Y = Total water intake (ml/Kg $W^{0.75}$)

X_1 = environmental temperature °C

X_2 = dry matter intake (g/Kg $W^{0.75}$)

Total water intake could be taken as water requirement for maintenance as sheep were mature and non-producing.

Keywords: Water intake, environmental temperature, feed intake, sheep

INTRODUCTION

Intensive sheep management involving housing during non grazing season needs an accurate estimation of water requirements of sheep especially in dry tropical regions where water is a limiting factor in success of management. Water requirement is influenced by breed, environmental temperature, pregnancy, lactation, age, sex and feed intake (El-Nouty et al., 1988). The objective of this is to predict maintenance requirement of water by sheep by quantification the relationship between total water intake and environmental temperature and feed intake.

MATERIALS AND METHODS

Five mature Ossimi x Rahmani males were used in six experiments each lasted 25 days. In the first four experiments sheep were fed 720 g dry matter from rations composed of 75% barley grains and 25% berseem hay or 912 g dry matter from rations composed of 50 % barley grain and 25% berseem hay. Each treatment was carried out under 18 and 35 °C environmental temperature. In other two experiments, ad. libitum feeding of barley grains and berseem hay was applied. The daily ad libitum dry matter intake averaged 1809.4 g under 18°C and 2116.2 g under 35°C. Water was freely offered two time daily.

Data of body weight, environmental temperature , daily total water intake and dry matter intake are presented in Table 1. The obtained data (750 records) were averaged for each experiment in 30 records to be used in the regression analysis (REG procedure of SAS (1982) to predict total water intake in relation to dry matter intake, environmental temperature and body weight.

The regression model to predict water intake from environmental temperature °C, dry matter intake kg/head/day) and body weight (Kg) is :

$$Y = C + b_1x_1 + b_2x_2 + b_3x_3$$

Y = total water intake (ml/head/day)

C = constant

X_1 = environmental temperature °C

X_2 = dry matter intake (g/head/day) in model 1 and 2 being dry matter intake (g/Kg $W^{0.75}$) in model 3.

X_3 = body weight (Kg) and b_1, b_2, and b_3= regression coefficients of total water intake on X_1, X_2, and X_3, respectively.

Table 1. Average environmental temperature, body weight, dry matter intake and water intake by sheep

Trait	Mean	SE	Minimum	Maximum
Body weight , Kg	53.7	0.8	47.0	60.0
Environmental temperature, °C	26.5	1.6	18.0	35.0
Dry matter intake,				
g/head/day	1214.3	101.2	770.0	2354.0
g/Kg0.75	60.92	4.67	36.63	113.48
Total water intake				
ml/head/day	3776.7	225.9	1753.0	5679.0
ml/Kg0.75	196.27	11.45	88.91	285.50

RESULTS AND DISCUSSION

Regression of total water intake,ml/head/day (Y) on environmental temperature °C (X_1), daily dry matter intake, g/head/day (X_2) and body weight, Kg (X_3) as well as their analysis of variance are presented in Table 2. The following model was calculated.

$$Y= 2054.07 + 74.53\ X_1 + 1.28\ X_2 - 31.86\ X_3 \quad .....(1)$$

Table 2. Regression of water intake (ml/ head/ day) on environmental temperature (°C), body weight, (Kg) and daily dry matter intake, (g/head/ day)

Variable	b	SE	t(df=26)	Prob.	R
Temperature, °C	74.5343	17.2101	4.331	.00020	0.6473
Body weight, Kg	-31.8586	36.8374	-0.865	.39503	0.1673
DMI, Kg	1.2825	0.2793	4.592	.00010	0.6693
Constant	2054.0721				

Multiple R= 0.8061

Analysis of variance of Table 2.

Source	df	Sum of squares	Mean sq.	F	Prob.
Regression	3	28852063.7722	9617354.57	16.08	4.10E-06
Residual	26	15361215.5175	598058.34		
Total	29	44401580.6667			

Regression coefficient of water intake on body weight (b_3= - 31.86) was not significant (t = -0.865; P=.39503) and their correlation coefficient was low (r=0.1673). Therefore, body weight as independent variable was removed from the model 1 to improve the accuracy of estimation in model 2.

The regression and the analysis of variance of model 2 based on environmental temperature and dry matter intake are shown in Table 3. The relationship between total water intake and environmental temperature and dry matter intake was quantified in the following model:

$$Y = 298.32 + 78.18\ X_1 + 1.19\ X_2 \quad ....(2)$$

It could be concluded from model 2 that an increase in environmental temperature by 1°C would increase water intake by 78 ml/head/day while unit increase in dry matter intake will increase water intake by 1.19 unit above 353 ml water intake as a constant.

Table 3. Regression of water intake (ml/head/day) on environmental temperature (°C) and daily dry matter intake (g/head/day)

Variable	b	SE	t(df=27)	Prob	R
Temperature, °C	78.1846	16.6064	4.708	.00007	0.6715
DMI, Kg/day	1.1949	0.2590	4.613	.00009	0.6639
Constant	298.3158				

Multiple R= 0.7998

Analysis of variance of Table 3.

Source	df	Sum of squares	Mean sq.	F	Prob.
Regression	2	28404741.7749	14202370.8875	23.97	1.03E-06
Residual	27	15996838.8917	592475.5145		
Total	29	44401580.6667			

Dry matter intake varied according to the body weight of sheep. Therefore a model based on environmental temperature and dry matter intake per metabolic body weight (Kg $W^{0.75}$) was suggested as follows:

$$Y = 14.19 + 4.18\ X_1 + 1.14\ X_2 \quad .....(3)$$

where

Y = Total water intake (ml/Kg $W^{0.75}$)

X_1 = environmental temperature °C

X_2 = dry matter intake (g/Kg $W^{0.75}$)

The regression coefficients and their analysis of variance were presented in Table 4.

Table 4. Regression of water intake on environmental temperature °C (Temp) and dry matter intake (g/Kg $W^{0.75}$)

Variable	b	SE	t(df=27)	Prob	R
Temp	4.1770	.8705	4.798	.00007	0.6715
DMI, g/Kg W0.75	1.1410	.2858	3.992	.00045	0.6093
Constant	14.1925				

Multiple R= 0.7797

Analysis of variance of Table 4.

Source	df	Sum of squares	Mean sq.	F	Prob.
Regression	2	69378.3413	34689.1707	20.930	3.24E-06
Residual	27	44748.7073	1657.3595		
Total	29	114127.0486			

The accuracy of the three models was tested using the averages in Table 1. The actual daily water intake was 3776.67 ml/head/day or 196.27 ml/Kg $W^{0.75}$. While the corresponding predicted water intake was 3872.5 (ml/head/day) using model 1. and 3815 ml/head/day using model 2 or 194.4 ml/Kg $W^{0.75}$ using model 3. it is clear that the differences between the actual and predicted values did not exceed 3 percent of the total water intake.

As sheep in the present study were mature and non-producing being fed dry ration (above 90% DM), total water intake could give an indication to total water requirement for maintenance. However, water in feed should be considered when sheep are fed forages.

Forbes (1968) suggested a relationships to calculate the total water intake (TWI) from dry matter intake (DMI) using seven non-pregnant Scottish Halfbred (Border Leicester x Cheviot fed wilted grass silage as follows:

$$TWI = 3.86\ DMI - 0.99$$

where TWI was total water intake and DMI was dry matter intake, both expressed as Kg per head per day.

Forbes (1968) also expressed water intake in terms of Kg total water intake per Kg dry matter intake in order to exclude as far as possible the effect of dry matter intake on the relationship between other factors and total water intake, The suggested model was:

$$TWI/DMI = 0.18\ T + 1.25$$

where TWI/ DMI was the mean total water intake per unit dry matter intake (Kg/Kg) for six ewes and T °C was the mean of daily maximum and minimum temperature for each week.

From the present study, it could be concluded that the following model:

Total water intake (ml/Kg $W^{0.75}$) = 14.19 + 4.18 environmental temperature (°C) + 1.14 dry matter intake (g/Kg $W^{0.75}$) might be suggested to predict the water maintenance requirement of sheep. However, further investigations are needed to determine water requirements of farm animals in various physiological condition under different environmental conditions.

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إستهلاك الأغنام للماء وتأثره بالمأكول من الغذاء ودرجة حرارة الجو

طـه محمـد البـداوى - حمدى محمد مراد - محمد محمود الشافعى - سالم محمد سالم

أستخدم ثلاثين بيان ناتجة من متوسطات ٧٥٠ ملاحظة يومية على خمسة كباش خليطة (أوسيمى X رحمانى) فى ستة تجارب هضم متتالية أستغرقت كل تجربة ٢٥ يوما تحت درجة حرارة ١٨°م أو ٣٥°م فى تحليل إنحدار مركب لتقييم العلاقة بين الأستهلاك اليومى من الماء مع درجة حرارة الجو والمأكول اليومى من المادة الجافة ووزن الجسم. وقد حسبت المعادلتين الآتيتين :

المستهلك اليومى من الماء للرأس = ٢٠٥٤,٠٧+٧٤,٥٣ درجة حرارة الجو (م°) +١,٢٨ المادة الجافة المأكولة (جم/ رأس / يوم) -٣١,٨٦ وزن الجسم (كجم).

المستهلك اليومى من الماء للرأس = ٢٩٨,٣٢ + ٧٨,١٨ درجة حرارة الجو (م°) + ١,١٩ المادة الجافة المأكولة (جم / رأس /يوم)

ثم أقترحت معادلة عامة لحساب المستهلك اليومى من الماء للأغنام (مل/ كجم و^{٠,٧٥}) كعلاقة من درجة حرارة الجو (م°) والمادة الجافة المأكولة (جم/ كجم و^{٠,٧٥}) وذلك لتفادى الأختلافات الناتجة من اختلاف وزن الجسم كما يلى :

المستهلك اليومى من الماء (مل /كجم و^{٠,٧٥}) = ١٧,١٩ + ٤,١٣ درجة حرارة الجو (م°) + ١,١٤ المادة الجافة المأكولة يوميا (جم /كجم و^{٠,٧٥}) وحيث أن الأغنام المستخدمة فى هذه الدراسات لم تكن فى أي حالة إنتاجية والعلائق المستخدمة كانت علائق جافة (أكثر من ٩٠٪مادة جافة) فإن المستهلك اليومى من الماء قد يمثل الإحتياجات الحافظة من الماء للأغنام .