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RELATION BETWEEN CLIMATIC CONDITION AND NITROGEN METABOLISM IN FARAFRA EGYPTIAN SHEEP.

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ABSTRACT

Four Egyptian Frafra rams aged 36 months of average body weight 42.5 kg were used to study the relation between environmental condition and nitrogen metabolism. The rams were fed four isocaloric rations with different levels of crude protein (CP) (6.13, 7.93, 9.70 and 15.07 %) during summer and winter seasons. The experimental design was 4 x 4 Latin square. Dry matter intake, nutrient digestibility, nitrogen balance, adaptation parameters and nitrogen metabolites in blood were measured.

The dry matter intake, CP and EE digestibilities and DCP%, SE% and DE (kcal/100g) during winter season were significantly (P< 0.05) higher than those of summer season. The crude protein and CF digestibility and DCP% for ration containing 15.07 % CP were (P<0.05) higher than those in other rations. The N balance of Frafra sheep in summer season was higher (P<0.05) than that in winter season. Moreover, the N balance for ration containing 15.07 % CP was higher (P<0.05) than those in other rations. Skin temperature (ST), Ear temperature (ET), Wool temperature (WT) and Respiration rate (RR) of Frafra sheep were significantly (P<0.05) higher in summer season than winter season, while, no significant effect for level of protein in rations and environmental condition on blood nitrogen metabolites.

Key words: *Egyptian Frafra sheep, nitrogen metabolism, environmental condition*

INTRODUCTION

Protein is the most expensive nutrient in livestock feeding; therefore it is often a limiting factor for livestock production. A minimum of 7 percent crude protein in the dry matter diet is required for normal rumen function. Protein deficiencies will reduce feed intake, rumen function and retard fetal development, as stated by **Singh and Sengar (1970)**. The requirements of crude protein for maintenance is influenced by many factors, i.e. animal (age, species, breed, physiological status and activity), diets (composition, energy-protein ratio, level of degradable protein and essential amino acid content), climatic conditions (ambient temperature and relative humidity) and methodology by which protein requirements are determined **(El-Bedawy *et al.*, 1998; El-Bedawy *et al.*, 2004 and El-Shafie *et al.*, 2005)**.

The general inverse relationship between ambient temperature and intake is influenced by a number of factors, including environmental humidity, genotype, physiological state, thermal susceptibility, acclimation and diet **(Colditz and Kellaway, 1972; Young, 1987)**. On the other hand, animals have complex physiological mechanism which enables them to interact with the environment in various ways to fulfill the successful maintenance and activities **(Shafie, 1989 and 1999)**. Meanwhile, the decline in ruminants productivity often happened when high ambient temperature and humidity lead to heat stress, primarily due to reducing voluntary feed intake and metabolizable energy (ME) (**Bianca, 1965; NRC, 1981; Beede and Collier, 1986**). Changes in temperature lead to alteration of water consumption and urine production in ruminants and there is evidence that they also affect nutrient digestibilities (**Balley *et al.*, 1962**).

The object of the present study was to determine the effect of environmental condition on nitrogen metabolism in Farafra Egyptian sheep.

MATERIALS AND METHODS

This study was carried out at the animal house of Animal Production Research Institute, Ministry of Agriculture. The experimental period extended through summer 2005 to winter 2006. The experiment included two metabolic trials in 4 x 4 Latin Squares design to evaluate two different environmental conditions (summer and winter) and four levels of protein in the rations with the same level of energy. First level, control ration (R1), consisted of 50% yellow corn (YC) + 50% rice straw (RS). The second ration (R2) consisted of 45% YC + 5% soybean meal (SBM) + 50% RS. The third ration (R3) contained 40% YC + 10% SBM + 50% RS and the fourth ration (R4) contained 25% YC + 25% SBM +50% RS.

Four Egyptian Farafra rams aged 36 months and of averaged body weight 42.5 kg were used in this study. The rams were fed the above four isocaloric rations with crude protein levels of 6.13, 7.93, 9.70 and 15.07 % for R1, R2, R3 and R4, respectively. Ingredients and chemical composition of experimental rations are presented in Tables 1 and 2. The rams were fed individually in metabolic cages for 15 days as preliminary period followed by seven days for total collection of feces and urine. The feeds offered at 09:00 am and residues, if any, were daily collected and weighed to determined daily feed intake. Drinking water was available all the time.

Feces and urine were collected; a sample of 10 % of the collected feces was sprayed with solution of 10 % sulfuric acid and 10 % formaldehyde then oven dried at 60 °C for 24 hours. A composite sample of dry feces for each rams was ground and kept at room temperature for nitrogen determination. Urine was collected in clean stopper plastic bottles, each containing 50 ml of 10 % sulfuric acid and used for nitrogen determination.

Chemical composition of feeds, feces and nitrogen contents of the urine were determined according to the standard methods of **A.O.A.C. (1984)**

In both trials the physiological parameters (Adaptation parameters) were daily measured at morning and at noon (08:00 and 14:00). Rectal temperature (RT) was measured using a standard clinical thermometer. Skin temperature (ST), wool temperature (WT) and ear temperature (ET) were measured by using infrared thermometer. Respiration rate (RR) was recorded by counting the blank movements for a minute (breaths/min) where all possible precautions were taken into consideration to avoid disturbing the animal during counting. The respiration rate was counted before measuring the body temperature.

Table 1. Ingredients content (%) in the experimental rations

Ingredients	IFN	R1	R2	R3	R4
Yellow corn	4-02-931	50	45	40	25
Soybean meal	5-04-604	0	5	10	25
Rice straw	1-04-077	50	50	50	50

Table 2. Calculated chemical composition of tested ration.

Feed stuff	DM	OM	CP	CF	EE	NFE	ASH
R 1	90.50	91.10	6.13	17.49	2.47	65.01	8.90
R 2	90.34	90.80	7.93	17.69	2.55	62.63	9.20
R 3	90.18	90.51	9.70	17.88	2.63	60.30	9.49
R 4	89.70	89.62	15.07	18.49	2.87	52.19	10.38

Ambient temperature (AT) and relative humidity (RH%) were recorded. Measuring the physiological responses using the method described by (**Herting 1968**). Blood samples were collected from the jugular vein in heparenized tubes. Determination of plasma total protein (TP) using a colorimetric method as described by **Armstrong and Carr 1964)**, plasma albumin (ALB) was carried out according to the method of (**Doumas *et al.*, 1971)**, plasma globulin (GLB) by the difference between total protein and albumin. Plasma, plasma creatinine (CR) is determined by quantitating the red pigment alkaline creatinine picrate (Joffe reaction) according to **Schirmeister (1964)**.

SE and TDN were calculated by using Morrison's factor. Digestible energy (DE) of tested ration for sheep was calculated according to the equation of **Abou Raya *et al.* (1972).** The equation was: DE (kcal / 100g DM = 34.81+3.71 (TDN).

Data of the experiment were statistically analyzed using (**SPSS 1988)** system .the differences between means were tested using Duncan's New Multiple Rang TEST (**Duncan 1955**).

RESULTS AND DISCUSSIONS

Digestion coefficient and nutritive value:

Effect of season:

The data in Table 3 showed that, the DM intake as g/h/d in winter season was significantly (p<0.05) higher than that in summer season. This result agreed with **(Bhattacharya and Hussein 1974)** who found that heat stress decreased dry matter intake in summer season. The CP and EE digestibilities with sheep in winter season were significantly (p<0.05) higher than that in summer season. On the other hand **Christopherson (1976)**; **Mcdowell *et al.* (1969) and Warren *et al.* (1974)** reported that, all digestibility values in cattle were increased as the temperature increased. **Ames (1983)** reported that, most data tend to support the hypothesis that nutrient digestibilities were increased during heat stress. Moreover **Davis and Melvilen (1960)** explained that, increasing nutrient digestibilities values with higher temperature, probably due to depressed intake, which resulted in slower rate of passage.

The nutritive values as DCP%, SE% and DE (kcal/100g) of rations fed in winter season were significantly (p<0.05) higher when compared with those fed in summer season this might be due to increase DM intake and digestibilities for most nutrients.

Effect of ration (levels of CP):

The data in Table 3 showed that, the CP digestibility for animals fed ration 4 (15.07 % CP) were significantly (P<0.01) higher than other rations, also CF digestibility for animals fed ration 4 (15.07 % CP) were significantly (P<0.05) higher than other rations, which might be attributed to increasing the level of soybean meal as it rich in amino acids. **Mlay *et al.* (1971)** reported that, N supplementation of poor quality feed had greatly improved the intake and digestibility of DM, OM. Moreover **Leng (1990), Goodchild and Mcmeniman, (1994) and Wilson and Kennedy (1996)** found that, voluntary feed intake associated with the deficiency of essential nutrients. Also the nutritive value as DCP of R4 was significantly (P<0.05) higher than those of R3, R2 and R1 while R1 showed the lowest one.

Interaction between season (summer and winter) and ration:

No significant difference for interaction between summer season and winter season for all digestibility and nutritive value. While the CP digestibility and DCP were significant.

Feed units intake and N- balance:

Effect of season:

The data in Table 4 show that, feed units intake (g/h/d) as TDN and DCP fed during winter season were significantly (P<0.05) higher than those during summer season. The data showed that urinary nitrogen and total nitrogen

Table 3. Effect of Season and crude protein content of diet on digestion coefficient and nutritive values of tested ration.

Effects of	DM Intake (g/h/d)	Digestion coefficient %						Nutritive values %			DE (Kcal/100g)
		DM	OM	CP	CF	EE	NFE	TDN	DCP	SE	
season											
1. Summer	740.2^{b} ±9.60	74.16 ±2.79	77.78 ±2.43	59.19^{b} ±12.89	57.51 ±6.40	81.03^{b} ± 3.95	85.02± 2.75	72.21± 2.43	6.02^{b} ±0.23	56.41^{b} ±3.09	302.7^{b} ±9.01
2. Winter	794.3^{a} ±7.13	74.12 ±7.43	77.53 ±6.28	61.87^{a} ±13.91	57.43 ±8.38	83.04^{a} ± 4.57	85.39± 6.85	72.88 ±5.55	7.82^{a} ±0.14	65.91^{a} ±2.27	308.5^{a} ±26.44
Sig.	*	NS	NS	*	NS	*	NS	NS	*	*	*
(CP) content:											
R 1	769.3 ±8.55	72.87 ±8.55	76.19 ±3.04	45.10^{d} ±3.90	55.45^{b} ±3.30	79.55 ±2.38	84.73± 3.53	71.99 ±2.84	3.01^{c} ±0.18	64.69 ±1.57	309.4 ±5.65
R 2	785.4 ±7.85	73.43 ±3.25	76.50 ±2.65	56.27^{c} ±3.28	59.31^{ab} ±3.05	81.45 ±2.06	85.17± 3.05	72.06 ±2.75	4.40^{b} ±0.93	65.49 ±3.89	302.1 ±8.56
R 3	766.2 ±7.01	73.95 ±3.09	77.27 ±2.71	63.44^{b} ±3.29	56.75^{b}± 3.01	82.79 ±2.11	85.72± 3.72	72.29 ±3.43	6.12^{a} ±0.71	65.98 ±4.00	303.0 ±9.62
R 4	743.6 ±7.81	76.32 ±3.31	74.30 ±3.14	77.48^{a} ±3.05	63.96^{a} ±3.29	84.69 ±2.09	85.12± 3.09	74.01 ±2.46	6.65^{a} ±0.55	66.54 ±3.77	309.4 ±10.60
	NS	NS	NS	**	*	NS	NS	NS	*	NS	NS
Interaction: Season * CP. content	NS	NS	NS	*	NS	NS	NS	NS	*	NS	NS

a b, c and d means in the same columns within each trait having different superscripts differ ($P<0.05$ or $P<0.01$) . and * = significant at 0.05 and ** = significant at 0.01.

Table 4. Effect of Season and crude protein content of diet on Nitrogen balance.

Effects of	Feed units intake (g/h/d)			Nitrogen balance					
	TDN	SE	DCP	N intake	Fecal N	Urinary N	Total	N-Absorbed	N-balance
season									
1. Summer	395.7^{b} ±53.70	362.2 ±47.52	42.89^{b} ±2.00	11.46 ±3.98	4.43 ±0.52	5.53^{b} ±1.70	9.96^{b} ±1.80	7.03 ±0.99	1.50^{a} ±0.67
2. Winter	426.4^{a} ±49.78	366.6 ±45.01	48.30^{a} ±3.89	11.82 ±3.38	4.29 ±0.49	6.73^{a} ±1.65	11.02^{a} ±1.91	7.53 ±0.78	0.80^{b} ±0.52
	*	NS	*	NS	NS	*	*	NS	**
(CP) content									
R 1	405.8 ±37.19	329.3^{b} ±40.82	23.06^{c} ±1.18	7.54^{b} ±3.31	4.15 ±0.61	2.94 ^{c}±1.38	7.09^{b} ±1.73	3.39^{c} ±1.8	0.45^{c} ±0.80
R 2	415.2 ±42.71	378.4 ^{a}±39.08	34.97^{b} ±1.97	9.90^{b} ±3.50	4.38 ±0.51	4.07^{b} ±1.66	8.45^{b} ±1.69	5.52^{b} ±0.98	1.45^{b} ±0.78
R 3	411.9 ±40.08	376.1 ^{a}±38.88	47.42^{b} ±1.78	11.93^{b} ±3.10	4.35 ±0.69	5.24^{b} ±1.01	9.59 ^{ab}±1.39	7.58^{b} ±1.00	2.34^{b} ±1.01
R 4	409.2 ±39.85	374.7 ^{a}±35.26	80.93 ^{a}±1.38	17.94^{a} ±3.05	4.61 ±0.72	8.51 ^{a}±1.83	13.12^{a} ±1.99	13.33^{a} ±1.01	4.82^{a} ±0.98
	NS	*	**	*	NS	*	*	**	*
Interaction Season*CP content	NS	NS	**	*	NS	**	NS	*	NS

a b, c means in the same columns within each trait having different superscripts differ (P<0.05 or P<0.01)
* = significant at 0.05 and ** = significant at 0.01.

Effect of ration (levels of CP):

The feed intake as SE (g/h/d) of R2 was significantly ($p<0.05$) higher than those in other rations while, the DCP (g/h/d) of R4 was significantly ($p<0.01$) higher than those in other rations. On the other side, the data showed that N-balance of R4 were significantly ($p<0.05$) higher than those of other rations.

Interaction between season (summer and winter) and ration:

The interaction between season and rations was insignificant during summer while became significant during winter season for DCP, N–intake, urinary nitrogen and N-absorbed for sheep.

Physiological measurements and blood parameters:

Effect of season:

Animals have complex Physiological mechanism which enables them to interact with their environment in various ways to fulfill the most successful maintenance and activities **Shafie, (1989)** and **(1999).** The data in Table 5 show that estimates of ambient temperature (AT), skin temperature (ST), ear temperature (ET), wool temperature (WT) and respiration rate (RR) in summer season were significantly ($P<0.01$) higher than that in winter. On the other hand, the Relative humidity (RH) in winter season was significantly ($P<0.01$) higher than that in summer season. Several studies demonstrated that RT increased with increase of ambient temp. (AT). Also had highly effect on ST.ET and WT. It is well known that skin temperature (ST) is regulated by blood flow to the skin and both evaporation and radiation from the skin. At low peripheral blood flow (vasoconstriction), ST is low and heat loss to the environment is reduced. AT high peripheral blood flow (vasoconstriction), ST approaches the core temp and heat loss to the environment is increased **(Folk, 1974 and Yousef, 1985).** These results were in agreement with those obtained by **Eyal (1963b); Singh *et al.* (1980); Abd El Bary (1982); Shalaby (1985); Ibrahim (1994); Shalaby and Shehatata (1995); Abd El Hafez (1997) and Soloma (1999).**

The effect of season (summer and winter) on blood parameters such as total protein (TP), albumin (ALB), globulin (GLB), urea (UR) and creatinine (CR) were not significant.

Effect of ration (levels of CP):

No significant differences of ration on physiological measurements and blood parameters for sheep.

Interaction between season (summer and winter) and ration:

No significant difference for interaction between summer season and winter season on physiological measurements and blood parameters for sheep. While, RR and AT were significantly ($p<0.05$) higher in the rams.

Table 5. Effect of environmental condition on adaptive response and nitrogen metabolites in blood.

	Adaptive response							nitrogen metabolites				
Item	**AT**	**RH**	**RT**	**ST**	**ET**	**WT**	**RR**	**TP**	**ALB**	**GLB**	**UR**	**CR**
Effect of season:												
1. Summer	32.85^{a} ±0.48	40.83^{b} ±3.24	39.29 ±0.23	37.44^{a} ±0.60	36.73^{a} ±0.59	34.48^{a} ±0.63	40.69^{a} ±7.88	7.19 ±0.04	4.73 ±0.65	2.46 ±0.19	26.63 ±1.75	1.15 ±0.21
2. Winter	18.08^{b}± 1.26	51.14^{a} ±9.14	38.90 ±0.23	32.97^{b} ± 1.98	29.25^{b} ±2.6	27.29^{b} ±1.65	26.42^{b} ±3.49	6.85 ±0.82	4.16 ±0.45	2.64 ±0.13	28.35 ±0.01	1.46 ±0.01
Sig.	**	**	NS	**	**	**	***	NS	NS	NS	NS	NS
Effect of (CP) content:												
R 1			39.03 ±0.14	38.86 ± 0.54	32.25 ±1.29	27.31 ±0.84	32.03 ±3.37	6.64 ±0.59	4.12 ±0.53	2.52 ±0.15	30.67 ±1.29	1.36 ±0.32
R 2			39.03 ±0.12	34.94 ± 0.52	32.46 ±1.12	27.66 ±0.73	33.94 ±3.09	7.21 ±0.62	4.77 ±0.52	2.42 ±0.10	25.89 ±1.08	1.29 ±0.31
R 3			39.13 ±0.11	35.19 ± 0.49	32.91 ±1.19	28.51 ±0.68	34.54 ±3.05	7.48 ±0.78	4.94 ±0.59	2.48 ±0.17	28.01 ±1.00	1.28 ±0.29
R 4			39.10 ±0.13	34.97 ± 0.51	32.07 ±1.25	27.42 ±0.54	30.52 ±3.01	6.74 ±0.41	3.90 ±0.72	2.80 ±0.14	24.98 ±1.15	1.25 ±0.17
Sig.			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction: Season * CP. content	*		NS	NS	NS	NS	*	NS	NS	NS	NS	

a, b and c means in the same columns within each trait having different superscripts differ ($P<0.05$ or $P<0.01$)
* = significant at 0.05, ** = significant at 0.01 and *** = significant at 0.001

CONCLUSION

In conclusion, the nitrogen balance in summer season was noticeably positive (3.68) while in winter it was close to be neutral (0.83). This result might be attributed to, that in summer animal reduced the heat load by reducing feed intake and most protein source in the diet used in the physiological function of the animal body (enzymes, hormones, regeneration of the cells, etc). Subsequently nitrogen execration in the urine was reduced and nitrogen balance increased, while, in the winter season animal increased feed intake especially from energy sources. If the energy content of the animal diet is not enough to covering their energy requirements the animal used the available protein in the diet as energy source by deamination of amino acid and execrate the nitrogen in the urine. Subsequently urinary nitrogen was increased and nitrogen balance was reduced.

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العلاقة بين الظروف المناخية و التمثيل الغذائي للنيتروجين في أغنام الفرافرة المصرية

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معهد بحوث الإنتاج الحيواني

استخدم في هذه الدراسة عدد اربعة كباش فرافرة عمر 36 شهر بمتوسط وزن 42.5 كجم لدراسة العلاقة بين الظروف المناخية و التمثيل الغذائي للنيتروجين. غذيت الكباش على اربعة علائق متساوية في الطاقة و متدرجة في نسبة البروتين 6.13، 7.93، 9.70 و 15.07 % خلال فصلي الصيف و الشتاء. صممت التجربة على أساس مربع لاتيني 4x4 . و تم تقدير كل من كمية الغذاء المأكول، معاملات هضم المركبات الغذائية، ميزان الأزوت، المقاييس الفسيولوجية و كذلك بعض مكونات الدم المرتبطة بتمثيل النيتروجين. و كانت أهم النتائج كما يلي:

ارتفع معنويا خلال فصل الشتاء كل من المادة الجافة المأكولة، معامل هضم البروتين الخام و مستخلص الأثير، نسبة البروتين الخام المهضوم، نسبة الطاقة المهضومة و كذلك نسبة مكافئ النشا عنهم في فصل الصيف.

كذلك ارتفع كل من معمل هضم البروتين الخام و الألياف الخام و البروتين الخام المهضوم في العليقة المحتوية على 15.07 % بروتين خام مقارنة ببقية العلائق.

ميزان الأزوت في فصل الصيف كان أعلى معنويا عنه في فصل الشتاء كذلك كان ميزان الأزوت أعلى في العليقة المحتوية على 15.07 % بروتين خام مقارنة ببقية العلائق. درجات حرارة الجلد و الأذن و الصوف و معدل التنفس كانت أعلى في فصل الصيف عن فصل الشتاء. في حين لم يكن هناك تأثير لمستوى البروتين في العليقة ولفصل السنة على مكونات الدم المرتبطة بتمثيل النيتروجين.