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PROTEIN AND ENERGY REQUIREMENTS FOR MAINTENANCE OF DROMEDARY CAMELS

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ABSTRACT

Results from feeding and nitrogen balance trials were utilized to investigate the energy and protein that are required for maintenance of the dromedary camel. Sixteen animals where used in this experiment. The animals weight ranged from 467 to 600 kg, energy intake from 19.08 to 91.41g TDN/kg $W^{0.73}$, and protein intake from 136.36 to 563.07 mg DN/kg $W^{0.73}$. Animal performance varied between a weight loss of - 0.83 to gain of + 0.83 g/day /kg while nitrogen retention ranged from loss (-68.60 to retained + 286.75 mg DN/day/kg $W^{0.73}$. Appropriate regression models for the estimation of maintenance requirements and also for energy and protein interaction were done. The factorial procedure was used to estimating nitrogen requirements. The estimated requirements for the maintenance of live body weight were 31.12g TDN and 368 mg DN per kg $W^{0.73}$ daily. Allowing for energy and protein interaction, recommended 'allowances' for maintenance would be 32.68 g TDN and 387.2 mg DN per kg $W^{0.73}$ daily including the DN for hair growth and losses in sweat and scurf. These values are less than the recommended allowances for cattle (36.52 g TDN/Kg $W^{0.73}$ and 3.22 g DCP/Kg $W^{0.73}$), buffaloes (39.00 g TDN/Kg $W^{0.73}$ and 2.87 g DCP/Kg $W^{0.73}$) and goats (31.12 g TDN/Kg $W^{0.73}$ and 3.25 g DCP/Kg $W^{0.73}$). However, practically, there are no differences between them and those for sheep (27.78 g TDN/Kg $W^{0.73}$ and 2.43 g DCP/Kg $W^{0.73}$) in developing countries. There are many hopes that the future experiments may determine the energy and protein requirements for camel during its growth, lactation and pregnancy taking boy composition into consideration.

Keywords: Camels, protein, energy and maintenance requirements)

INTRODUCTION

Camels are considered as animals that their maintenance requirements for protein and energy had not been determined experimentally, except those values determined by Farid *et al.* (1990) and Farid (1995) for the requirements for protein and energy. In addition, Guerouali and Zine Filali (1992) determined only the requirements for energy under certain conditions. Camels have been considered as a "desert ship" that can sail in desert without feed or water intake for one month during drought periods. Although, it can take large amounts of water and feed if it presents in a short period of time without any side effects. Moreover, camels not only survive such droughts but also it can continue its production and reproduction. Camels can adapt for any external changes (temperature, humidity.... etc) by changing its internal body environment according to the surrounding sources. A Bedouin looks to his camel as his source of life as it gives him milk, meat and fibers also assist him during his travel carrying his baggage. The Arab countries alone own about 12 millions dromedaries which make up 70% of the world's total ACSAD. They annually produce about 3218, 358, 95 and 14 tons of milk, meat hides and fiber, respectively according to ACSAD. So this fact directed the Arab researches to think seriously about Camels life cycle to improve camel production through highlighting its importance in the centerence on destification control that was hold in research centers. But the main objectives of projections are to transport camel research in National Research systems in countries in Africa and Asia, to coordinate among camel research centers, and document research results. As result of this effort and in addition to new technology, new information is more available for Bedouinss and small holder groups to help them to improve their income and their food security. The present study was designed to determine the maintenance requirements of protein and energy for Dromedary camel.

MATERIALS AND METHODS

This work was done at Maryout Desert Research Station of Desert Research Center. It is situated on the Northern West Coast about 40 Km Southwest of Alexandria

Four female dromedary camels aged from 5-7 year old weighing 467 to 600 kg were used in this experiment. The four animals were assigned at *random to the four experimental treatments in a Latin square design of four* periods. Each period was apart from the next by one month to allow the animals recovery them weights. Each animal was fed in a covered pen in order to avoid heat stress. According to this design this experiment lasted for fifteen months. One animal from each treatment was put in every period to avoid the effect of seasons.. In the four treatments, the animals fed as the follows T_1 (TDN 100%, DCP 100%), T_2 (TDN 100%, DCP 75%), T_3 (TDN75% DCP 100%) and T_4 TDN 75%, DCP 75%), from the maintenance requirements recommended by Farid *et al.* (1990).

The experimental rations were formulated using barley grains; commercial concentrate feed mixture (55% cotton seed cake, 30% wheat bran, 10% rice bran, 1% common salt, 2% limestone and 2% molasses), Rice straw and berseem hay (*Trifolium alexandrinum*). In order to achieve the planned levels of TDN and DCP, the feeding values of the experimental rations were calculated according the values published by Kearl (1982) before the commencement of the experiment. However, the actual feeding values were experimentally determined during the last ten days of each period to ascertain the actual levels of TDN and DCP intakes in relation to the planed levels.

Daily rations were calculated for each individual animal and offered once daily at 9:00 am. Refusals if any were collected and weighed the following morning. During the feeding time, water was available to be taken by animals for one hour daily. Live body weights were recorded every two weeks before daily feeding, each period of the experiment lasted 90 days during which all animals were fed individually. The first 80 days were primary period but the conventional digestion and N/ balance trials were done during the last 10 days. Feces were collected in rubber - lined collection bags hung on to a harness fitted to the animal. Half crescent-shaped funnel was put at female urethral opening of experimental animal which connected to rubber tube which allowed Urine to drain into glass bottles containing 50 ml sulphuric acid diluted to half strength, approximately 18 N. Five percent of the daily faces and urine were sampled separately. Fecal samples were dried over night at 105°C. Urine samples were stored in the refrigerator, till the routine analyses were done.

Proximate constituents of feeds, feed refusal and faeces, and total urinary nitrogen were analyzed using official procedures (AOAC, 1990).

The correlation and the regression analysis employed for establishing relationships between different biological parameters related to nitrogen metabolism, and for the estimation of the maintenance protein and energy requirements, were those described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Feed Intake and Nitrogen Metabolism:

The composition of the experimental diets, levels of feed intake and nitrogen metabolism data are summarized in Table I. Actual energy (TDN) and digestible crude protein (DCP) intakes were determined from the digestion and nitrogen balance trials and were expressed as percentages of recommended maintenance allowances recommended by Farid *et al* (1990), being 32 g TDN and 2.6 g DCP per kg $W^{0.73}$ for 400 kg standard camel. Actual TDN intakes were 107.3, 79.47, 110.3 and 79.13 percent of recommended allowances (Farid *et al.*, 1990) as compared to the planned levels 100, 75, 100 and 75. While, actual DCP intakes were 97.5, 76.9, 103.85 and 68.46 percent of the recommended allowances by Farid *et al.* (1990) as compared to the planned levels of 100,75, 100 and 75%.

Average of total nitrogen intake decreased from 830 in-group I to 574, 779 and 657 mg/ kg $W^{0.73}$ in groups II, III, VI respectively. Where as, corresponding values for the apparently digested nitrogen were 403, 329, 454.7 and 286 mg/kg $W^{0.73}$, representing 107.3%, 110.3, 79.10 and 96.5, 76.9, 79.5, 68.6 for TDN and DCP % in tested groups I, II, III, VI respectively of the recommended allowances by Farid *et al.* (1990). Although fecal nitrogen excretion decreased with decreasing protein intake in-group II, decreased with decreasing in energy intake and adequate amount of protein in a group III and decreased with decreasing in protein and energy intake in group IV. Total urinary nitrogen excretion decreased with decreasing in protein intake in group II with adequate amount of energy and decreased with decreasing protein and energy intake in group IV when comparing the previous group with the control group I.

The average nitrogen balance ranged from 56.36 to 187.97 mg/kg $W^{0.73}$ in groups receiving 68.46 to 103.85 % of the maintenance DCP allowances. The average of nitrogen retention were 125, 148, 189.87 and 53.87 mg/Kg $W^{0.73}$ when animals received in their diets (107.3 g TDN/Kg $W^{0.73}$ and 96.54 g DCP/Kg $W^{0.73}$), (110.30 g TDN/Kg $W^{0.73}$ and 76.92 g DCP/Kg $W^{0.73}$),(79.47 g TDN/Kg $W^{0.73}$ and 103.85 g DCP/Kg $W^{0.73}$) and (79 13 g TDN/Kg $W^{0.73}$ and 68.46 g DCP/Kg $W^{0.73}$) for treatments I, II, III and VI respectively.

Table 1: Composition of diets, level of protein and energy intakes, live body weight changes and nitrogen metabolism data.

Attributes	Experimental Groups			
Plane of nutrition	I TDN 100%, DCP 100%	II TDN 100% DCP 75%	III TDN 75%, DCP100%	IV TDN 75%, DCP 75%
Composition of diets, %				
Rice straw	54.96	59.6	39.62	55.56
Concentrate mixture	35.12	-	37.83	30.73
Barley grains	9.92	40.40	8.87	5.19
Berseem hay.	-	-	13.68	-
Calculated nutritive value, % in DM				
TDN	52.07±2.62	54.21±1.86	50.23±2.58	49.42±1.26
DCP	4.22±0.21	3.3±0.1	5.46±0.24	3.98±0.11
Determined feeding values:				
Digestion coefficients (%)				
CP	48.27±4.4	56.2±13.05	55.44±5.9	42.91±14.74
EE	60.10±10.5	62.44±3.2	80.52±3.75	62.56±4.1
CF	49.91±5.7	71.19±7.46	57.98±2.00	41.67±9.3
NFE	63.15±4.4	74.27±1.2	59.84±4.7	60.95±11.45
Feeding value (DM, %)				
TDN	52.89±2.3	62.66±6.0	51.76±8.7	50.09±6.8
DCP	3.85±0.23	2.97±1.18	5.49±0.7	3.5±1.24
Daily intake, I				
Dry matter, g/kg $W^{0.75}$	65.04	60.80	49.10	50.59
TDN %, from planned	107.3	110.30	79.47	79.13
DCP%, from planned	96.54	76.92	103.85	68.46
Animal performance,				
Average live weight, kg	555.28	553.28	523.52	539.96
Weight change, g/day/kg	0.25±0.67	-0.01±0.25	-0.16±0.56	-0.26±0.39
Nitrogen metabolism data, mg/day/kg $W^{0.75}$				
N-intake	830.35±86.95	574.12±71.97	79.09±92.16	657.08±54.20
Fecal-N	427.72	244.39	324.25	373.49
Digested-N	403.06	329.72	454.84	283.59
Urinary-N	277.46	181.73	264.97	229.71
N-balance	125.00±103.61	147.99±51.51	189 87±84.01	53.87±38.62

TDN and DCP intake were calculated for cows according Kearl (1982) recommended allowances of 32 g TDN and 2.6 g DCP per day unit metabolic size for the standard 400 kg camel Farid *et al.*, (1990).± S.D.

The animals maintained their live body weights only when they received average TDN 110.3 with DCP 76.92 percent in-group I or more of their DCP 96.54 and TDN 107.3 percent of maintenance allowances.

Factorial Estimation of protein for Requirements Maintenance:

Metabolic faecal nitrogen (MFN) was estimated from the statistical relationship between digested (Y) and total (X) nitrogen intakes (Elliot and Topps, 1963), the absolute value of the constant being the estimate of MFN

$Y = 0.30125 + 0.2510\, X \pm 0.115$

$(n = 16,\ r = 0.454^{*},\ P < 0.05)$.

The estimated value of 0.301 g MFN / 100 g DM intake (equivalent to

0.170 g N/kg $W^{0.73}$ was lower than 0.578 g reported by Farid (1995) for camel, the 0.563 reported by Salem (1990) for local Barki sheep and the 0.50 g general accepted average for ruminants (ARC, 1965).

Endogenous urinary nitrogen (EUN) was also estimated in the present experiment from the relationship between urinary nitrogen excretion (Y) and digested nitrogen intake (X), both are expressed in mg N/kg $W^{0.73}$ as in (Faird *et al.*, 1983).

$$Y = 144.41 + 0.2798 \cdot \pm 100.0,$$

$$(n = 16, r = 0.353^*, P < 0.05).$$

At Zero DN intake the estimate of EUN excretion amounted to 144.41 mg N/kg $W^{0.73}$ daily. Much higher values (200 mg/day/kg $W^{0.73}$) were recorded for lambs (Black *et al.*, 1973) and also for calves (Stobo and Roy, 1973). Salem (1990) recorded a lower value 68 mg N/kg $W^{0.73}$ for Barki sheep, and Abou Raya *et al.* (1971) 93 mg N, for local sheep (Ossimi and Rahmani), which also agreed with 88.5 mg N value, reported by the British Agricultural Research Council (ARC, 1965). Singh and Mahamdevan (1970) recorded a lower value (38 mg N/kg $W^{0.73}$) for Indian pesi sheep; and a lower value of EUN 42.70 mg N/kg $W^{0.73}$ for camels (Farid, 1995).

The average data of animals of group I, II, III which were in positive Nitrogen balance were used to calculate the apparent biological value (BV) of dietary protein under present experimental conditions. The following equation was used (Mitchell, 1924):

$$BV = \frac{NI - (FN - MFN) - (UN - EUN)}{NI - (FN - MFN)} = 73.64 \text{ percent}$$

The maintenance requirements were calculated by the factorial methods as follows (Pachauri and Negi, 1980);

$$\text{DN requirements} = \frac{EUN \cdot 100}{BV} + MFN = 366.12 \text{ mg DN /kg } W^{0.73}$$

This was equivalent to 2.288 g DCP/kg $W^{0.73}$. Although, it was reported that the previous value was higher than the value of Farid (1995) for camel which is 325.0 mg DN (2.03 g DCP)/kg $W^{0.73}$ and also it was higher than value reported by Salem (1990) for Barki sheep (2.03 g DCP/day/kg $W^{0.73}$), Singh and Mahadevan (1970) for Indian desi sheep (0.875g DCP/day/kg $W^{0.73}$, while Kearl, (1982) for sheep, goats, cattle and buffaloes being 2.43, 3.25, 3 22 and 2.87 g DCP/kg $W^{0.73}$, respectively. The small difference in DN estimated by factorial methods in the present work and Farid (1995) study may be due to differences of level energy intake and energy protein interaction Broster *et al.* (1969) and the differ in the number of animals in each experiment. The nutritional requirements are differ between breeds (Doney and Russel., 1968) and are affected by environmental conditions (Yousri *et al.*, 1977).

Estimation of the Requirements protein for Maintenance from Nitrogen Balance and live weight changes

Apart from the factorial method, the maintenance requirements of camel for digestible protein can be estimated from nitrogen balance data. If live weight changes were not taken into consideration, an estimate of minimum requirements would be obtained at nitrogen equilibrium. On the other hand, if live weight changes were taken into consideration, an estimate of the maintenance allowance would be obtained. This is the case since in a nitrogen balance experiment equilibrium exists when retained nitrogen equals zero. This estimation is low because of losing nitrogen that can't be calculated in form of fiber growth, sweat, scurf, dermal cells and hoofs. A linear regression relationship between the relative daily weight change (X) in g/day/kg and observed nitrogen balance values (Y) in mg N/day/ kg $W^{0.73}$ (X) as in (Farid *et al.*, 1983):

$$Y = 119.42 + 47.96\,X \pm 10.5$$

$(n = 16,\ r = 0.173^{N.S},\ P>0.05)$.

In this equation, the intercept value a = 119.42 mg retained N/day / kg $W^{0.73}$ represents an estimate of retained nitrogen needed for the animal to maintain its live body weight, i.e. it would account for nitrogen retained in fiber growth and nitrogen losses in sweat and scurf for camels, the nitrogen losses did not usually account for conventional nitrogen balance trials. Although the correlation coefficient was not statistically significant ($P> 0.05$), the value of 119.42 mg/kg $W^{0.73}$ was considered approximate. It is greater than 0.05g, advocated by ARC (1965).

In order to complete the information needed for DN requirements for maintenance, it was essential to arrive at a value for nitrogen losses in sweat, scurf and for the deposited in fiber (wool) growth. The following assumptions were put forward; a 500 kg camel would produce on average 3.5 kg greasy clip per year. At 80% scouring this would yield 2.4 kg clean fibers that are considered as crude protein. This amounts to a daily deposition of 11.3 mg N/kg $W^{0.73}$ No estimate of nitrogen losses in sweat and scurf is available camel. Blaxter (1959) calculated such losses in temperate breeds of cattle as 5 mg therefore, the values accepted for cattle ARC, (1965), are used namely 20 mg/ N/ kg $W^{0.73}$ for sum of nitrogen deposited in fiber grow and that lost in sweat and scurf. Assuming an efficiency of utilization of digested nitrogen for fiber growth as 75 percent, the daily fiber growth in camel would require 26.67 mg DN/day/ kg $W^{0.73}$ as the total.

When the nitrogen balance values (Y) were related to apparently digested nitrogen intake (X), both in mg N/day/kg $W^{0.73}$, the following relationship was established:

$$Y = 0.6704\,X - 128.606 \pm 10.111$$

$(n = 16,\ r = 0.6789^{*},\ P < 0.05)$.

Solving the equation at nitrogen equilibrium ($Y = 0$) or at live body weight maintenance ($Y=119.42$) yielded the corresponding two estimates of protein maintenance requirements, being 191.835 and 369.97 mg ND/day/kg $W^{0.73}$, respectively.

The relation between total urinary nitrogen excretion (Y) and the apparently digested nitrogen intake (X) gave similar results of previous one when the relation solved as follows

Y=X (nitrogen equilibrium) and Y= (-119.42 -X) this value is equal the DN requirements for maintenance of body weight.

In another way, the maintenance requirements of digested protein could be determined by the relation between the digested nitrogen intake, g/day/kg $W^{0.73}$ (Y), and relative daily weight change, g/day/kg (X),

$$Y = 2.30 + 0.4088\ X \pm 0.0271$$

$$(n = 15,\ r = 0.3218\ \text{n.s},\ P > 0.05).$$

By this equation, the intercept a = 2.30 *DCP/day/kg* $W^{0.73}$ *when relative* weight change g/day/Kg W (X) = 0, that illustrated the maintenance requirements of protein for camels without change in their weights under sufficient amount of energy. Although the correlation coefficient was not *statistically significant* (P> 0.05), the value of 2.30 g DCP/day/kg $W^{0.73}$ was considered not reasonable. The total requirements of protein as DN mg/kg $W^{0.73}$ including the requirements for fiber growth and that lost in sweat and scurf was equal 396.64 mg DN/day/kg $W^{0.73}$ or 2.479 DCP/day/kg $W^{0.73}$. This value was close to the value determined by Farid (1995).

Comparison with other local estimates and accepted or recommended feeding standards are summarized in Table 2. The maintenance requirements determined as nitrogen equilibrium, i.e. 191.83 mg DN/day kg $W^{0.73}$, was less than 282.90 mg estimated by Farid (1995), for camels. But it was higher than the corresponding estimates of 118 mg for Indian Desi sheep (Singh and Mahadevan, 1970), 127 mg for Cyprus Chiss non-pregnant, non lactating ewes (Papas, 1977) and 150.8 mg for Barki desert sheep (Salem, 1983). But it is nearly equal to that reported by Salem (1990), being 195.70. Differences may be due to variations among *experiments in the chemical* composition of diets (Vercoe and Hall, 1965), level of energy intake and/or the energy protein interaction (Broster *et al.*,1969), breed differences (Doney and Resussel ,1968), physiological state (Robinson and Forbes, 1966, 1970) *or environmental conditions Yousri et al.* (1977).

It was noted that the factorial estimate of the maintenance protein requirements mentioned earlier, i.e., 366. 12 mg DN/Kg $W^{0.73}$ was only one percent lower than requirement estimated from nitrogen balance data for *maintenance* of live weight, 369.97mg DN/day/Kg $W^{0.73}$ and it was much higher that reported by Farid (1995) being 325.0 mg DN/day/kg $W^{0.73}$.

Estimation of the Maintenance Requirements for energy from TDN intakes and live weight changes:

An attempt was made to predict the TDN at which camels are expected to maintain their body weight unchanged. A linear regression relationship between the TDN intakes g/day / kg $W^{0.73}$ (Y) and relative daily change in body weight (X) mg/day/kg was calculated :

$$Y = 31.123 + 5.84\ X \pm 9.43$$

$$(n = 15,\ r = 0.492^{*},\ P < 0.05)$$

Table 2: Comparison of estimated maintenance requirements for dromedary camels and recommended maintenance allowance for ruminants, per unit metabolic size (kg $W^{0.73}$).

Animal species and methods	Maintenance requirements			
	ME (Kcal)	TDN (g)	DN mg	DCP (g)
Dromedary camels:				
.1. Present study				
. Recommended allowance			387.2	2.42
Weight maintenance	116.40	32.68	369.97	
N-equilibrium	110.84	31.12	191.83	
Factorial procedure			366.12	2.29
2. Farid (1995)				
Recommended allowance			425.77	2.66
Weight maintenance	117.75	33.06	413.2	2.58
N-equilibrium	101.12	28.31	282.90	1.77
Factorial procedure			325.0	2.03
3. Farid *et al.* (1990)				
Weight maintenance	96.20	26.56	396.8	2.48
4. Wilson (1984).				
Maintenance allowance	139.17	38.5	498.24	3.11
Barki desert sheep				
1. Salem (1983)				
Weight maintenance			353	2.21
N-equilibrium	115.67	32	156.8	0.981
Factorial procedure			322	2.012
2. Salem (1990)				
Weight maintenance	99.96	27.7	373.62	2.33
N-equilibrium			195.71	1.22
Recommended allowances				
1. Developing countries Kearl (1982).				
Sheep (40 kg)	100.25	27.78	389.82	2.43
Goats (40 kg)	105.638	31.12	520.11	3.25
Cattle (400 kg)	133.58	36.52	516.30	3.22
Buffalo (400 kg)	140.80	39.00	457.68	2.87
2. National Research Council, U.S.A.				
Sheep N.R.C (1975)	113.36	31.54	439.21	2.74
Goats N.R.C. (1981)	108.94	30.36	465.05	2.91
Beef cattle N.R.C. (1976)	148.69	41.60	583.94	3.65
Dairy cattle N.R.C. (1978)	143.17	37.89	477.97	2.99

In this equation, the intercept value (a = 31.123) represents the estimate of TDN intake g/day/kg $W^{0.73}$ at Zero weight change.

Although the correlation coefficient 'r' was significant ($P<0.05$), the value of 31.12g TDN/day/kg $W^{0.73}$ was considered as a reasonable estimate. It was greater than the estimated value by Farid *et al* (1990), which is 26.56 g TDN/day/kg $W^{0.73}$. The TDN for maintenance in this study was greater than the value of Farid *et al* (1990) by 14.65 percent, but Guerouali and Zine Filai (1992) illustrated that the maintenance energy requirements as g TDN/Kg $W^{0.73}$ was 28.41 which is smaller than the present study by 8.71 percent.

Although Farid (1995) indicated that the energy requirements for maintenance of body weight of camels was 28.89 g TDN/kg $W^{0.73}$ this value very close to the value determined in this study (31.12g TDN/kg $W^{0.73}$).

Estimation the daily feed intake as Dry matter intake of camels at the maintenance level of feeding from weight change and Dry matter intake.

A linear relationship was established between dry matter intake (DMI g/day/kg $W^{0.73}$ (Y) and Relatively weight change g/day/kg (X):

$$Y = 56.482 + 8.63 X \pm 0.256$$

$$(n = 15, r = 0.55^{*}, P < 0.05)$$

In this equation, the intercept value a = 56.48 DMI/day/Kg $W^{0.73}$ represent estimate of dry matter intake for animal to maintain its live body weight unchanged X= 0

Although DMI the correlation coefficient was statistically significant ($P< 0.05$), the value of 56.48 g/day/Kg $W^{0.73}$ was considered satisfactory which represent 1.04 percent of live body weight. This value is some what greater than that estimated by Farid *et al* (1990) which being 53.66 g/day/Kg $W^{0.73}$ but less than those for other ruminant species, being 68.54, 67.04, 87.2 and 99.36 g DM/Kg $W^{0.73}$ for sheep, goats, cattle and buffaloes, respectively (Kearl, 1982). But Guerouali and Zine Filali (1992) reported that dry matter intake for camels to maintain body weight unchanged was 64.31 g DMI/Kg $W^{0.73}$, which is greater than the value in the present study by 13.86%.

Predication of TDN and DCP maintenance requirements through maintaining body weight unchanged:

One of the definitions and methods of assessing maintenance requirements is the amount of nutrients required to maintain body weight unchanged. Single and multiple regressions of relative body with change expressed as g/kg body weight/day and daily TDN and DCP intakes (g/ Kg $W^{0.73}$), their ratios and their squares were calculated. It was noticed that the inclusion of TDN, DCP, $(TDN)^2$, $(DCP)^2$ and (TDN × DCP) separately or in combination as independent variables together with TDN and DCP intakes progressively increased. Regarding the accuracy of the regression, the best fit was when the five variables TDN, DCP, TDN^2, DCP^2 and (TDN × DCP) were included in the regression reaching significant at ($P< 0.001$) level with $r = 0.6585^{**}$.

Relative Weight Change g/day/Kg W (RWC) = 0 117683 TDN - 1.631002 DCP - 0.001992 TDN^2 + 0.313638 DCP^2 + 0.014698 (TDN × DCP) - 0.757887 ± 2 64413197.

$(n = 15, R^2 = 0.4337, P<0.001)$

Under uncontrolled feeding conditions as it prevails in the extensive systems in the desert, the animals might consume excess or less TDN and or

DCP than maintenance requirements. In order to illustrate such situations, the previous equation was applied assuming that the animals receive varying levels of DCP (1.61 to 5.0 g DCP/day/kg $W^{0.73}$ in 0.1 increments representing (70 to 217% of maintenance requirements, at each of varying levels of TDN intake from 12.45 to 40.46 g TDN/day/kg $W^{0.73}$ representing 40 to 130% of maintenance TDN requirements.. The data indicated that when the animals received low TDN intakes (40, 50, 60, 70, 80 and 90 %) of maintenance requirements, the animals would be able to maintain constant weight when they receive 4.32, 4.00, 3.65, 3.32, 3.02 and 2.70 g DCP/kg $W^{0.73}$ (representing 188, 174, 159, 144, 131 and 117% of DCP maintenance requirements, respectively). This is biologically sound since excess protein might be katabolized and the keto acids so produced are used as a source of energy to a certain extent, which was limiting when TDN intake was very low (40%).. The animal can utilize this indicating that the DCP intake was in excess of what when they received limited energy allowances. This was in agreement with the finding of Black (1958) and Ørskov (1975) who reported that a protein requirement is dependent on the level of energy intake.

The data also indicated that when the animals receive their TDN maintenance requirement (100% = 31.123 g/day/kg $W^{0.73}$), they would maintain constant body weight (Zero body) weight change) when they received 2.42g DCP intake/day/kg $W^{0.73}$ or 387.2 mg DN/ kg $W^{0.73}$.

The maintenance allowance was calculated Table (2) including 3% safety margin and 5% for minimum activity for camels ranging in weight from 467 to 600 kilograms. It appeared that 387.2 mg apparently digested nitrogen/day/kg $W^{0.73}$ was an acceptable estimate of the protein requirements for maintaining body weight, including the nitrogen deposited in fiber growth and that lost in sweat and scurf. This value is less than the 425.77 mg estimated by Farid (1995) and 498.24mg estimate by Wilson (1984) for camels. When comparing between camels and other ruminants the maintenance allowance of DCP for camel was below those for goats, cattle and buffaloes Table (2) and nearly equal to the recommended allowances for sheep breeds in the developing countries Kearl (1982).

The approximate requirements of TDN allowances for maintenance of live weight, including a margin of safety for minimum activity, being 32.68g TDN/Kg $W^{0.73}$ daily, was nearly equal the 33.06 g estimated by Farid (1995) and was less than 38.59 estimated by Wilson (1984) for camels. When comparing between camels and other ruminants the maintenance allowance of TDN for camels were below those for cattle and buffaloes and nearly equal to the recommended allowances for sheep and goats (Table 2). In support of these findings MacFarlane (1968) reported on low metabolic rate of camels, a value of 50 Kcal/Kg $w^{0.75}$ compared with 63 and 90 Kcal/Kg $w^{0.75}$ for sheep and cattle, respectively. Yousef *et al.* (1987) reported similar results when comparing resting and exercised camels and men in Australia.

In addition, increasing DCP intakes improved body weight to the extent that animals would gain weight to certain extent and then the response levels off at higher levels of DCP intake. This confirms that total katabolized protein can be used to certain extent as a source of energy especially with such mature animals, which tend mainly to deposit fat.

It is unlikely, however, that the animals would be able to consume high TDN when DCP intake is low due to limitations encountered on rate of rumen fermentation and hence voluntary feed intake for sheep, goats, cattle and *buffalo. However,* camels are known for the efficiency of their nitrogen utilization under stress, both through urea recycling to the rumen, and at kidney level (Farid *et al.*, 1984). The extra energy required for maintenance at low levels of nitrogen intake probably represents the increased energy requirements of the rumen microbes and tissues involved in enhancing nitrogen utilization. The same was also true at higher level of TDN intakes (110 - 130% of *maintenance requirements*).

It should be pointed out however that absolute body weigh change could only be valid under the assumption that body composition remained unchanged.

In future studies the concept of body composition should be taken into consideration for accurate assessment of nutrient requirements.

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الاحتياجات الغذائية الحافظة من البروتين و الطاقة للجمال وحيدة السنام

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لقد بينت النتائج الخاصة بتغذية الجمال و تجارب الهضم و ميزان النيترجين أنه أمكن الأستفادة من هذه النتائج في التحقق من الأحتياجات الغذائية الحافظة من البروتين و الطاقة للجمال وحيدة السنام.

أشتملت هذه الدراسة على ١٦ حيوان. و كانت اوزان هذه الحيوانات تتراوح ما بين ٤٤٧ الى ٦٠٠ كجم.وكانت كمية الطاقة الماكولة كمركبات كلية مهضومة تتراوح ما بين ١٩,٠٨ الى ٩١,٤١ جرام/ اليوم /كجم$^{٠.٧٣}$ و أيضا البروتين المهضوم الماكول يتراوح ما بين ١٣٦,٣٦ الى ٥٦٣,٠٧ ملليجرام نيتروجين مهضوم/اليوم/كجم $^{٠.٧٣}$.وكانت كفاءة التغير في اوزان الحيوانات تختلف ما بين نقص الوزن-٠,٨٣ الى زيادة ٠,٨٣ جرام / اليوم / كجم بينما النيتروجين المحجوز يتراوح ما بين (-٦٨,٦٠ الى ٢٨٦,٧٥) ملليجرام نيتروجين مهضوم / اليوم / كجم$^{٠.٧٣}$.و استخدم النموذج المناسب من العلاقات الخطية في استنباط الاحتياجات الحافظة من الطاقة و البروتين و أيضا لمعرفة التداخل بين البروتين و الطاقة.و باستخدام النموذج العاملي وذلك لتقدير الاحتياجات الحافظة من النيتروجين. و تم تقدير الاحتياجات الحافظة من البروتين و الطاقة في حالة ثبات وزن الجسم فكانت كمية المركبات المهضومة الكلية ٣١,١٢ جرام / اليوم/ كجم$^{٠.٧٣}$ و النيتروجين المهضوم ٣٦٨ ملليجرام نيتروجين مهضوم/اليوم/ كجم$^{٠.٧٣}$.

وكانت الاحتياجات الحافظة من المركبات المهضومة الكلية ٣٢,٦٨ جرام / اليوم / كجم$^{٠.٧٣}$ و النيتروجين المهضوم ٣٨٧,٢ ملليجرام نيتروجين مهضوم/اليوم/ كجم$^{٠.٧٣}$ ويشتمل النيتروجين المهضوم على الاحتياجات من النيتروجين اللازم لنمو الوبر و المفقود من النيتروجين في العرق و قشرة الرأس وذلك في حالة التداخل بين البروتين و الطاقة.

وهذه الاحتياجات الخاصة بالجمال أقل من الاحتياجات الخاصة للابقار (٣٦,٥٢ جرام مركبات مهضومة كلية /اليوم/ كجم$^{٠.٧٣}$ و ٣,٢٢ جرام بروتين مهضوم/اليوم/ كجم$^{٠.٧٣}$) والجاموس (٣٩,٠٠ جرام مركبات مهضومة كلية/ اليوم / كجم$^{٠.٧٣}$ و٢.٨٧ جرام بروتين مهضوم/اليوم/ كجم$^{٠.٧٣}$) و الماعز(٣١,١٢ جرام مركبات مهضومة كلية /اليوم / كجم$^{٠.٧٣}$ و٣,٢٥ جرام بروتين مهضوم/اليوم/ كجم$^{٠.٧٣}$) ولايوجد احتلاف بين احتياجات الجمال و احتياجات الاغنام(٢٧,٧٨ جرام مركبات مهضومة كلية/اليوم/ كجم$^{٠.٧٣}$ و٢,٤٣ جرام بروتين مهضوم /اليوم/ كجم$^{٠.٧٣}$) في البلاد النامية.ونأمل في المستقبل ان نقوم بتقدير الاحتياجات من البروتين و الطاقة اللازمة للجمال في مرحلة النمو و الحمل و انتاج اللبن آخذين في الأعتبار تركيب الجسم.