



Performance of Dromedary Camels (*Camelus Dromedaries*) Fed Diets Containing Varying Levels of Crude Protein

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ABSTRACT

A study was conducted to evaluate the performance of dromedary camels fed diets containing varying levels of crude protein (CP) (14, 16 and 18% CP). Eighteen (18) growing male and female camels with an average body weight of 199 ± 2.5 kg were used for the study. The camels were housed in individual pens equipped with feeding and water troughs. The camels were randomly allocated to 3 diets containing varying levels of CP (14, 16 and 18%) and 2 sexes (males and females) in 3 x 2 factorial arrangements, replicated 3 times in a completely randomized design (CRD). The feeding trial lasted for 90 days. Camels fed 14% CP performed significantly higher (64.50 kg) compared to those on 16 (40.00 kg) and 18% (54.70 kg) CP diets. The average daily weight gain was significantly higher (716.67 g/d) in camels on 14% CP diet followed by those on an 18% CP diet (607.78 g/d). Similarly, Camels on a 14% CP diet recorded a significantly ($P < 0.05$) higher FCR (6.89) and higher DM, CP and CF digestibility compared to those on 16 and 18% CP. However, no significant ($P > 0.05$) difference was observed in most of the serum biochemical parameters measured. The feed cost in Naira per kilogram (kg) increased with an increase in crude protein levels in the diets from ₦68.51/kg to ₦77.91/kg. The feed cost/kg gain was higher (₦77.91/kg) at 18% CP level and lower (₦68.51/kg) at 14% CP level. It was concluded that a diet containing 14% CP improved the growth performance of dromedary camels and was economically better than diets containing 16 and 18% CP, hence a diet containing 14% CP is recommended for camels in the study area.

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INTRODUCTION

The family *Camelidae* includes two subfamilies: *Camelinae* (Old World Camelids) and *Laminae* (New World Camelids). There are two species of camel within the genus *Camelus*. The Dromedary one-humped camel (*Camelus dromedaries*) is most widely distributed in the hot arid areas of the Middle East and Africa, whereas the Bactrian two-humped camel (*Camelus bactrianus*) is found in parts of central Asia and China (Kadim *et al.*, 2008). The camel originated

in North America and was domesticated by secondary nomads around 4000 years ago in South Arabia, primarily for transport and labour rather than as a producer of meat, milk, or clothing (Wilson, 1998). Camels are multipurpose animals with females used primarily as milk producers, the males for transport or draught, and both sexes providing meat as a tertiary product.

The role of the camel as a meat producer is becoming more important due to the



versatile role it plays rather than as a symbol of social prestige, which was the role it used to play but which has since greatly diminished (Dawood and Alkanhal, 1995). However, nutrition remains a major challenge in camel production and management, especially in developing countries, where camels rely on depleted communal rangelands for grazing (Solomon *et al.*, 2017).

There is a need to improve the livestock sector in Nigeria to satisfy the growth in beef demand expected in the country in the coming years. Nigeria is currently consuming 360,000 tons of beef a year, but it's predicted that this volume will rise to 1.3 million by 2050 (PTP, 2014). Although the marketing systems for camel meat are not well organized, there is evidence of high demand for fresh camel meat even among societies not herding camels (Kurtu, 2004). Therefore, with the growing demand for meat in Nigeria, camel meat could be a cheap option to meet the growing needs of meat, especially for low-income population groups. However, camels depend mainly on natural vegetation for feed and their growth rates and productivity, in general, are reflected by the availability and quality of feed each year. After weaning, the growth rates of camel calf are in turn affected by feed availability and their nutritional value (Chibsa *et al.*, 2014). Therefore, this study aimed to determine the effect of varying levels of crude protein on the performance of dromedary camels.

MATERIALS AND METHODS

Location and Description of the Study Area

The experiment was conducted at the Experimental pens of Beef Research Programme, National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika, Kaduna State. Shika is in the Northern Guinea Savanna ecological zone which lies between Latitude 10°11'N and Longitude 7°8' E, at an altitude of 650m above sea level (Google earth, 2020).

Management of Animals and Experimental Design

Eighteen (18) growing male and female camels with an average body weight of 199±2.5kg were purchased from the Mai'gatari

International Livestock Market in Jigawa State and were used for the study. Before the commencement of the study, the camels were dewormed orally with *Sambezole*^(R) suspension and sprayed with *Amitrix*^(R) against internal and external parasites, respectively (Ibrahim *et al.* 2017). The camels were housed in individual pens equipped with feeding and water troughs. The camels were randomly allocated to 3 diets containing varying levels of CP (14, 16 and 18% CP) in 3 x 2 factorial arrangements, replicated 3 times in a completely randomized design (CRD). There were 6 camels (3 males and 3 females) per treatment which served as replicates. The supplementary diets were offered to the camels at 2% of their body weight. The basal diet (*Digitaria smutsii*) hay was offered at 2% of their body weight. The trial lasted for 90 days.

Data Collection

Growth Performance

Feed intake was recorded throughout the experimental period which lasted for 90 days and this was done by weighing the amount of feed offered to the animals and the refusal was collected and weighed before morning feeding. The camels were weighed at the beginning of the study and fortnightly throughout the experimental period using Steelyard Avery^(R) (Walkthrough) (1000kg capacity) weighing scale. The feed offered was adjusted according to the changes in the bodyweight of the camels. Weight gain was computed by subtracting the initial weight from the final weight. Average daily weight gain (ADWG) was calculated by dividing weight gain by the number of days of the feeding trial (Abdel-Wahed, 2014). The feed conversion ratio was calculated based on a unit of feed consumed to a unit of body weight gain.

Nutrient Digestibility

At the end of the growth trial, total faeces from each animal were collected separately each day at the same time just before offering water and feeds. The total daily excreted faeces of each animal were weighed and recorded. The faeces were then mixed thoroughly and 10% was pooled daily for each camel throughout the collection period. The composite fecal samples were oven-dried at



65°C to constant weight for the determination of the dry matter. Dried samples were ground through a 1 mm sieve and preserved for

chemical analysis. The apparent nutrients digestibility (%) was calculated using the formula reported by McDonald *et al.* (2002).

$$\text{Apparent nutrient digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient in feces}}{\text{Nutrient intake}} \times 100$$

Blood Sample Collection and Evaluation

Five (10) mills of blood samples were collected from each camel through the jugular vein using 10 ml plastic disposable syringes and placed into plain bottles. The plain blood samples were allowed to clot by leaving them undisturbed at room temperature for 30 minutes. Clotted blood was centrifuged at 1,000–2,000 rpm for 10 minutes in a refrigerated centrifuge as described by Thavasu (1992). The serum was analyzed spectrophotometrically for calcium, sodium, potassium, phosphorus, urea, creatinine, total protein and albumin as described by Mohammed *et al.* (2007). Globulin was calculated by subtracting the concentration of albumin from the concentration of total protein as described by Coles (1974) and reported by Mohammed *et al.* (2007). Blood glucose level was determined by Coles (1974) method, using appropriate test kits

Cost-Benefit Analysis

The market price of all the ingredients at the time of the study was used in calculating the total cost of feed consumed by the camels throughout the experimental period. Feed cost per kg weight gain was calculated by dividing the cost of feeding by the weight gain of the camels.

Data Analysis

The data generated on weight gain, nutrient digestibility and serum biochemistry were subjected to analysis of variance (ANOVA) using

SAS Software (SAS, 2002) while significant differences among means were compared using Duncan (1955).

The model for Experiment 11 is presented below:

$$Y_{ijkl} = \mu + S_i + P_j + (S \times P)_{ij} + E_{ijk}$$

Where, Y_{ij} = Dependent variable

μ = Overall mean

S_i = Effect of i^{th} Sex (male, female)

P_j = Effect of j^{th} Levels of Crude Protein (14, 16 and 18%)

$(S \times P)_{ij}$ = Effect of ij^{th} interaction

E_{ijk} = Random Error

RESULTS AND DISCUSSION

Proximate Composition of the Experimental Diets

The proximate compositions of the experimental diets used in this study are presented in Table 1. The dry matter (DM) content of the diets ranged from 94.62 to 94.91% while the crude protein (CP) and crude fiber (CF) contents of the diets were 14.47, 16.57, 18.73 and 22.14, 20.01 and 19.80%, respectively. The ether extract (EE), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF) and nitrogen-free extract (NFE) ranged from 4.82 to 6.31, 4.70 to 6.86, 59.36 to 64.68, 40.78 to 48.66 and 53.79 to 56.27%, respectively.

Table 1: Proximate composition of the experimental diets (%)

Parameters	T ₁	T ₂	T ₃
Dry matter	94.79	94.62	94.92
Organic matter	87.93	89.92	89.05
Crude protein	14.10	16.90	18.50
Crude fiber	22.14	20.01	19.80
Ether extract	5.98	4.82	6.31
Ash	6.86	4.70	5.87
NDF	59.36	64.68	61.00
ADF	48.66	42.60	40.78
NFE	56.27	61.27	53.79

Key: T₁ = Treatment One, T₂ = Treatment two, T₃ = Treatment three, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, NFE = Nitrogen Free Extract



Growth Performance of Dromedary Camels Fed Diets Containing Varying Levels of Crude Protein

There were significant ($P < 0.05$) differences in the growth performance of dromedary camels fed diets containing varying levels of crude protein (Table 2). Male camels had significantly higher ($P < 0.05$) values than females in all parameters measured except in total concentrate intake. Similarly, the FCR of male camels was better ($P < 0.05$) than those of females (5.33 vs. 8.68). Camels fed a diet containing 14% CP had significantly higher ($P < 0.05$) final weight (263.50), daily weight gain (716.67 g) and lower FCR (6.89) than those fed higher 16 and 18% CP diets. However, camels fed 18% CP had higher ($P < 0.05$) basal diet intake (190.30 kg) and total feed intake (494.30 kg) than those fed lower CP in the diet. There were significant interactions ($P < 0.05$) between the sex of camels and levels of CP in the diets.

Nutrient's Digestibility of Dromedary Camels Fed Diets Containing Varying Levels of Crude Protein

Results of nutrient digestibility of diets containing varying levels of crude protein fed to dromedary camels are shown in Table 3. There were no significant differences ($P > 0.05$) in digestibility coefficients between male and female camels except in CP and CF digestibility. Male camels had significantly lower ($P < 0.05$) CP digestibility (74.04%) than the females (78.84%). However, higher CF digestibility was observed in male (68.30%) than female (63.30%) camels, respectively. Digestibility values of camels fed 14% CP were significantly higher ($P < 0.05$) than those fed higher levels of CP except in EE and Ash retention. However, the digestibility of CP and CF of camels fed 14% and 18% CP were at par ($P < 0.05$). Interactions were not significant

($P > 0.05$) except in male camels fed 16% CP ($P < 0.05$) level.

Blood Biochemical Profile of Dromedary Camels Fed Diets Containing Varying Levels of Crude Protein

Table 4 shows the results of the effect of sex, varying levels of crude protein and their interaction on the blood biochemical profile of dromedary camels. There were no significant differences ($P > 0.05$) in all blood biochemical profiles of both male and female camels, respectively. However, the sodium content of camels fed a diet containing 14% and 16% CP was similar ($P > 0.05$) but camels fed 14% CP had significantly higher ($P < 0.05$) sodium content than those fed 18% CP in the diet. All interactions were not significant ($P > 0.05$).

Cost-Benefit Analysis of Feeding Dromedary Camels

The economic benefits analysis in this study was based on feed cost as other costs such as cost required for pens, purchase of camels, labour and others were the same hence were not considered in the estimation. The result of the cost-benefits analysis is presented in Table 5. The result showed that the feed cost per kilogram (Kg) of concentrate increased with an increase in the CP content of the diets. The feed cost per kg was higher (₦77.91) in the diet containing 18% CP. However, the feed cost per kg gain was higher (₦64.50) at 14% CP and the lowest at 16% CP and this indicated that the 14% CP level was economically better than of 16 and 18% CP levels. The value of gain (₦/kg) was ₦64,500.00, ₦40,000.00, and ₦54,700.00 for feeding diets containing 14, 16 and 18% CP, respectively.



Table 3: Effect of Sex, varying levels of Crude Protein (CP) and their Interactions on Growth Performance of Dromedary Camels

Parameters	Sex			Levels of CP (%)				Interactions						
	M	F	SEM	14	16	18	SEM	M Vs 14	M Vs 16	M Vs 18	F Vs 14	F Vs 16	F Vs 18	SEM
IW (kg)	199.00	199.00	1.25	199.00	199.00	199.00	2.50	199.00	199.00	199.00	199.00	199.00	199.00	2.50
FW (kg)	279.00 ^a	254.00 ^b	4.50	263.50 ^a	239.00 ^c	253.70 ^b	4.20	265.70	247.50 ^a	255.30	261.30	231.00 ^b	252.00 ^b	2.90
TWG (kg)	80.00 ^a	55.00 ^b	2.25	64.50 ^a	40.00 ^c	54.70 ^b	1.40	66.70	48.50 ^a	56.30	62.30	32.00 ^b	53.00	2.42
DWG (g)	888.89 ^a	611.11 ^b	25.40	716.67 ^a	444.44 ^c	607.78 ^b	10.08	740.11 ^a	538.89 ^b	625.56 ^a	692.22 ^b	355.56 ^b	588.89 ^b	6.54
TCl (kg)	273.00 ^b	336.00 ^a	4.10	315.00	294.00	304.00	8.80	283.00 ^b	260.00 ^b	276.00 ^b	347.00 ^a	328.00 ^a	330.00 ^a	1.50
ACI (kg)	3.03 ^b	3.73 ^a	0.05	3.50	3.27	3.38	0.09	3.14 ^b	2.89 ^b	3.07 ^b	3.86 ^a	3.64 ^a	3.67 ^a	0.21
TBI (kg)	153.60 ^a	141.30 ^b	2.00	130.00 ^b	122.00 ^b	190.30 ^a	5.01	129.80	113.00 ^b	181.00 ^b	130.20	130.90 ^a	199.60 ^a	4.68
ADBI (kg)	1.71 ^a	1.57 ^b	0.02	1.44 ^b	1.36 ^b	2.11 ^a	0.07	1.44	1.26 ^b	2.01 ^b	1.45	1.45 ^a	2.22 ^a	0.10
TFI (kg)	426.60 ^b	477.30 ^a	6.10	445.00 ^b	416.00 ^c	494.30 ^a	5.75	413.00 ^b	373.00 ^b	457.00 ^b	477.00 ^a	459.00 ^a	530.00 ^a	23.28
ADFI (kg)	4.74 ^b	5.30 ^a	0.07	4.94 ^b	4.63 ^c	5.49 ^a	0.06	4.59 ^b	4.15 ^b	5.08 ^b	5.30 ^a	5.10 ^a	5.88 ^a	0.26
FCR	5.33 ^a	8.68 ^b	1.00	6.89 ^a	10.41 ^c	9.02 ^b	0.05	6.20 ^a	7.69 ^a	8.11 ^a	7.66 ^b	14.34 ^b	10.00 ^b	0.08

^{abc} = Means with different superscripts along the row differed significantly (P<0.05). M = Male, F = Female, SEM: Standard Error of mean, IW: Initial weight, FW: Final weight, DWG = Daily Weight Gain, TCI: Total Concentrate Intake, TBI: Total Basal Diet Intake, ADBI = Average Total Basal Intake, TFI: Total feed intake, ADFI = Average Daily Feed Intake, FCR: Feed conversion ratio.



Table 4: Effect of Sex, varying levels of Crude Protein (CP) and their Interactions on Nutrient Digestibility of Dromedary Camels

Parameters (%)	Sex			Levels of CP (%)				Interactions						
	M	F	SEM	14	16	18	SEM	MVs14	M Vs 16	M Vs 18	F Vs 14	F Vs 16	F Vs 18	SEM
DM	79.06	79.45	0.46	80.96 ^a	78.51 ^b	78.29 ^b	0.56	81.43	78.25	77.48	80.48	78.77	79.10	0.89
CP	74.04 ^b	78.84 ^a	1.10	85.41 ^a	71.56 ^c	76.84 ^a	1.35	89.85	66.48	74.77	80.97	76.63	78.90	2.87
CF	68.30 ^a	63.30 ^b	2.38	73.70 ^a	61.00 ^b	62.80 ^b	2.92	76.80	64.00	64.20	70.60	58.00	61.50	4.13
EE	57.20	60.40	1.89	59.00 ^b	51.40 ^c	66.00 ^a	2.31	59.60 ^b	51.90	60.20	71.70 ^a	51.00	58.40	3.27
ASH	64.90	56.10	5.00	56.10 ^b	47.30 ^b	78.20 ^a	6.12	61.50	57.80 ^a	75.60	54.40	33.20	80.90	3.66
NFE	88.52	89.90	1.46	92.15 ^a	90.85 ^a	84.62 ^b	1.78	91.95	89.09	84.52	92.62	92.35	84.73	2.52
NDF	51.00	50.90	1.76	52.80	55.10	44.80	2.15	50.00	55.80	47.10	55.60	54.40	42.60	3.04
ADF	45.50	43.10	2.91	50.30	45.20	37.50	3.57	46.10 ^b	43.60	39.70	54.40 ^a	46.80	35.20	3.05
E	1482.29	1482.29	0.01	1690.74 ^a	1482.28 ^b	1273.85 ^c	10.56	1690.74	1482.28	1273.85	1690.74	1482.28	1273.85	13.21
E_P	94.73	94.73	0.01	120.77 ^a	92.64 ^b	70.77 ^c	4.51	120.77	92.64	70.77	120.77	92.64	70.77	8.36
P	16.00	16.00	0.01	14.00 ^c	16.00 ^b	18.00 ^a	0.03	14.00 ^c	16.00 ^b	18.00 ^a	14.00 ^c	16.00 ^b	18.00 ^a	0.01

^{abc} = Means with different superscripts along the row differed significantly ($P < 0.05$), M = Male, F = Female, SEM: Standard Error of mean, DM = DRY Matter, CP = Crude Protein, CF = Crude Fiber, EE = Ether Extract, NFE = Nitrogen Free Extract, NDF = Neutral Detergent Fiber, ADF = Acid Detergent Fiber, E = Energy, E_P = Energy Protein Ratio, P = protein

Table 5: Effect of Sex, varying levels of Crude Protein (CP) and their Interactions on Blood Biochemical Profile of Dromedary Camels

Parameters (%)	Sex			Levels of CP (%)				Interactions						
	M	F	SEM	14	16	18	SEM	MVs14	MVs 16	MVs 18	F Vs 14	FVs 16	FVs 18	SEM
TP g/dl	4.19	4.66	0.31	4.53	4.28	4.45	0.38	4.50	4.03	4.03	4.57	4.53	4.87	0.53
ALB g/dl	2.11	2.22	0.08	2.17	2.22	2.17	0.10	2.10	2.03	2.20	2.23	2.40	2.04	0.15
GLO g/dl	2.08	2.44	0.32	2.36	2.06	2.28	0.39	2.27	2.00	1.90	2.47	2.13	2.77	0.56
GLU mg/dL	70.29	68.65	4.14	74.59	72.07	66.67	5.05	72.07	70.99	67.21	67.21	4.03	3.67	0.40
CR mg/dl	1.10	1.09	0.08	1.11	1.00	1.23	0.89	1.09	1.05	1.17	1.12	0.87	1.63	0.13
TRG mmol	1.99	2.19	0.23	2.28	2.00	1.96	0.28	2.43	1.90	1.63	2.13	2.10	2.33	0.39
Na mmol/l	142.80	145.20	2.03	147.30 ^a	142.80 ^{ab}	141.80 ^b	2.48	145.70	144.30	138.30	149.00	141.30	145.30	3.51
K mmol/l	4.92	4.90	0.24	4.97	4.85	4.92	0.30	4.87	5.27	4.63	5.07	4.43	5.20	0.42

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Ca mmol/L	2.54	2.23	0.15	2.27	2.50	2.40	0.19	2.37	2.60	2.67	2.17	2.40	2.13	0.27
P mg/Dl	1.02	1.11	0.22	1.05	0.78	1.37	0.67	1.13	0.59	1.33	0.97	0.97	1.40	0.77
UREA mmol/l	2.88	3.04	0.25	3.30	2.43	3.15	0.87	3.20	2.33	3.10	3.40	2.53	3.20	0.88

^{ab} = Means with different superscripts along the row differed significantly ($P < 0.05$). M = Male, F = Female, SEM: Standard Error of mean, TP = Total protein, ALB = Albumin, GLO = Globulin, GLU = Glucose, CR = Creatinine, TRG = Triglycerides, Na = Sodium, K = Potassium, Ca = Calcium, Mg = Magnesium, P = Phosphorus,



Table 6: Cost benefits analysis feeding diets containing varying levels of crude protein to dromedary camels

Parameters	Varying levels of Crude Protein (%)			SEM
	14	16	18	
Cost/kg feed (₦)	68.51 ^a	73.21 ^b	77.91 ^c	1.00
Total feed consumed (kg)	445.00	416.00	494.30	19.75
Cost of feeding (₦/Camel)	30,486.95 ^a	30,455.36 ^b	38,510.91 ^c	2.34
Weight gain (kg)	64.50 ^a	40.00 ^c	54.70 ^b	4.84
Cost of feed/kg gain (₦/kg)	472.666.00	761.38	704.04	1.87
Value of gain (₦)	64,500.00	40,000.00	54,700.00	1.01
Cost over gain (₦)	7.33	0.02	0.01	0.00

₦ = Naira, Kg = Kilogram,

DISCUSSION

Chemical Composition of the Experimental Diets Containing Varying Levels of Crude Protein

The values of DM obtained in this study were higher than 90.82, 91.16, 91.23 and 91.81% reported by Ibrahim *et al.* (2019). The similar DM content of 90.00, 0.48 and 91.40 was reported by Mahmoud and EL-Bana (2013). However, Nazik *et al.* (2015) recorded a DM content of 96.50% which is higher than values obtained in this study. Adel and El-Metwaly (2012) reported lower values of 89.96 and 89.25% compared to the values obtained in this study. Differences in DM content of experimental diets may be attributed to differences in feed ingredients. The crude protein (CP) content used in this study ranged from 14.47 – 18.73% which was similar to 14.69 and 6.19% reported by Ibrahim *et al.* (2019) in the experimental diets used for feeding dromedary camels. However, the CP content obtained in this study was higher than 8.36, 9.00 and 7.51% reported by Mahmoud and EL-Bana (2013). Lower CP content of 11.68, 12.09, 12.89 and 9.10% was reported by Nagpal *et al.* (2005) in grain straw-based complete feed blocks for dromedary camels. The 16.40% CP content reported by Nazik *et al.* (2015) is within the range (14.47 – 18.73%) provided in this study. Adel and El-Metwaly (2012) reported a CP content of 13.14% in their experimental ration and this value is higher than 11.38, 6.81, 7.95, 9.35 and 12.20, 12.10% reported by Gihad *et al.* (1989) and Taheeh and Abdul-Raziq (2019) but lower than the values reported in this study.

The crude fiber content of the diets used in this study ranged from 20.01 – 22.45 which is higher than the reported values of 9.22 and 19.30% (Nazik *et al.*, 2015; Adel and El-Metwaly, 2012), respectively. Similarly, Ashok (2016) reported crude fiber content of 9.20% which is lower than the values obtained in this study. However, differences in the CF content of the diets might be due to the differences in the quality of the roughages used.

Effect of Sex, Varying Level of Crude Protein and Their Interaction on the Growth Performance of Dromedary Camels

There is a lot of variation regarding camelid daily growth rate which varies widely between breeds, within breeds and regions. Hammadi *et al.* (2001) reported a 580g/day daily growth rate in dromedary camels which is lower than 716.67 and 607.78g/d recorded by camels on 14 and 18% CP diets, respectively. The value (580 g/d) recorded by Hammadi *et al.* (2001) is also lower than 733.10 g/d in Indian dromedary camels (Bissa, 2000). The daily weight gain (444.44 – 716.67 g/d) obtained in this study was similar to 450 – 610 g/d and 700 g/d recorded by Yusuf (2016) and Abdulrazaq *et al.* (1996), respectively. Kamoun (1995) reported a daily growth rate of 260 g/d in camels fed only on mangroves and 550g/day in camels fed on a high dietary protein and energy diet. Reported daily weight gain was 720 g/day in Bikaneri camels (Tandon *et al.*, 1988). The value (260 g/d) reported by Kamoun (1995) was lower than the daily weight gain recorded in this study but similar to 720 g/d recorded by Tandon *et al.*



(1988). Turki *et al.* (2007) in their study on feedlot performance of dromedary camels fed different dietary regimes recorded an average daily gain of 810, 453, 590 and 399g/day for camels fed Kenana pellets, cottonseed cake, and groundnut cake-based diets, respectively. These values were similar to the values obtained in this study. Similarly, Bhakat *et al.* (2008) in their study on the effect of management systems on the growth performance of dromedary camel calves reared under organized farm conditions recorded an average total gain of 611g/d in an intensive system of management. This value was almost double the values 319 g/d obtained in a semi-intensive system of management. All these values were higher than an average daily weight gain of 180.62, 129.85, 360.77 and 261.69g/d for camels on 0, 10, 20 and 30% dried *Faidherbia albida* leaves, respectively (Ibrahim *et al.*, 2019). Weight gain in dromedary camels is associated with age, feeding condition, sex, types of feed (diets) and health.

There was a significant difference ($P<0.05$) in the daily feed intake of the camels across the diets. However, camels on 18% CP diet recorded a significantly higher ($P<0.05$) basal intake (BI) of 2.11 kg/day compared to those on 14 (1.44 kg/day) and 16% (1.36 kg/day) CP diets. The Higher (2.11 kg/day) BI obtained in camels on 18% CP might be due to the lower energy (1273.85 kcal/kg) content of the concentrate diet compared to 1690.74 and 1482.28 kcal/kg in diets containing 14 and 16% CP, respectively. The camels probably have higher BI to meet up their energy requirement. The total daily feed intake ranged from 4.63 – 5.49 kg with camels on an 18% CP diet having a significantly ($P<0.05$) higher (5.49^a) daily feed intake compared to those on 14 (4.94^b) and 16% (4.63^c) CP diets. However, the total daily feed intake (4.63 – 5.49 kg) obtained in this study is similar to 4.73, 4.68, 5.24 and 4.53kg recorded by Basmaeil *et al.* (2012) in Majaheem, Wodoh, Suffr and Sho'l breeds of Saudi Camels, respectively. The values recorded in this study and that of Basmaeil *et al.* (2012) were lower than 6.32, 6.16, 6.57 and 6.42kg/day reported by Ibrahim *et al.* (2019). The difference in feed intake of dromedary camels depends on several factors and these factors include nutrient content

of the feed, ingredients, environment, age and sex, etc. It is also well documented that feed and nutrients intake is important in the nutrition of animals. It determines the number of nutrients available to an animal for growth, health and production. The significantly lower FCR in male camels indicates higher feed conversion efficiency than in females. This was evident in the higher final and average daily weight gains in male camels than females. Contrarily, Pal *et al.* (2004) reported that feed conversion efficiency (FCE) was similar in both male and female calves.

Effect of Sex, Varying Levels of Crude Protein and Their Interactions on Nutrient Digestibility of Dromedary Camels.

The DM digestibility recorded in this study (78.29 – 80.96%) was higher compared to 73.34 and 76.55% reported by Adel and EL-Metwaly (2012). However, Ibrahim *et al.* (2018) obtained a higher DMD of 85.11, 81.41, 85.12 and 83.98% in dromedary camels fed diets containing 0, 10, 20 and 30% levels of dried *Faidherbia albida* leaves, respectively.

The CPD across the diets ranged from 71.56 – 85.41% which is higher than 46.80 – 65.77% CPD reported by Mahmoud and EL-Bana (2013). Hammadi *et al.* (2010) reported a significantly higher CPD of 77.1%, which is higher than the values (69.17, 71.90, 70.10 and 69.17%) reported by Ibrahim *et al.* (2018) in diets containing 0, 10, 20 and 30% dried *Faidherbia albida* leaves.

The CF digestibility obtained in this study was higher than 29.13 – 60.16% reported by Mahmoud and EL-Bana (2013). Ibrahim *et al.* (2018) recorded CF digestibility of 54.68 – 68.87% in dromedary camels which slightly similar to the values obtained in this study. Differences in nutrient digestibility might be attributed to differences in feed ingredients, age of the animals, physiological differences and fiber contents of the experimental diets.

Cost-Benefit Analysis of Feeding Diets Containing Varying Levels of Crude Protein to Dromedary Camels

There was a significant difference ($P<0.05$) in the value of gain and cost over gain



with those on the 14% CP diet having significantly higher (N64,500) value of gain and cost over gain (7.33) compared to N40,000 (0.02) and N54,700 (0.01) for those on 16 and 18% CP diets. The difference in the value of gain may be attributed to the lower cost of the feed and the relatively efficient utilization of the diet by the camels at lower CP levels.

CONCLUSION

It could be concluded that:

1. Camels on diet containing 14% CP have the highest weight gain and recorded significantly higher dry matter, crude protein and crude fiber digestibility.
2. The economic aspect showed that the cost per kg gain was higher in camels on 16 and 18% CP diets and lowest at 14% CP diet. The value of gain (N) was highest in camels on a 14% CP diet.

RECOMMENDATIONS

1. Farmers should feed their camels with diets containing 14% CP for optimum growth and development in the Northern Guinea Savanna.
2. Feeding camels with diets containing 14% CP could improve the value of gain and income over the gain of camels by 61% and 99.70% compared to diets containing 16 and 18% CP, respectively.

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