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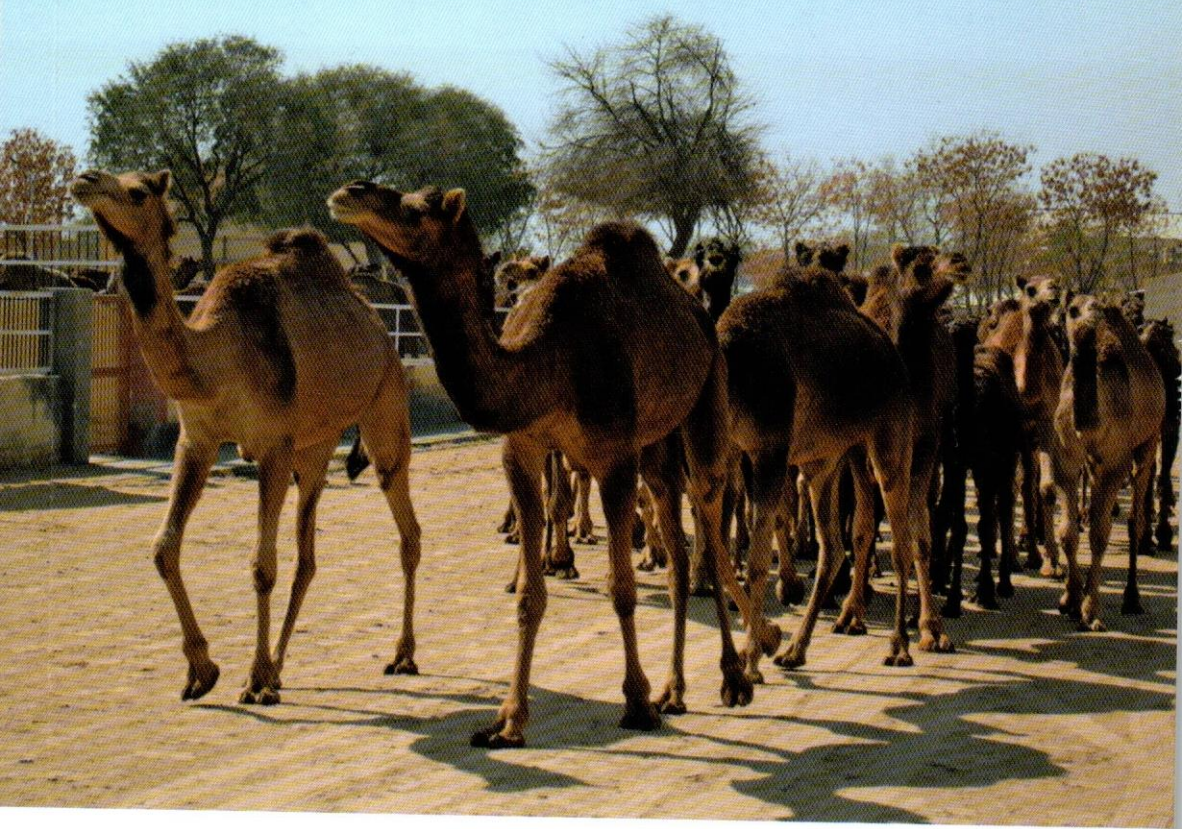
NUTRIENT REQUIREMENTS OF CAMEL



भाकृअनुप
ICAR

Indian Council of Agricultural Research
New Delhi

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भारतीय कृषि अनुसंधान परिषद
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FOREWORD

ENCOMPASSING a pivotal platform, India holds an axial sway in South Asia midst thirty-nine global biodiversity zones which have cliff-hanger in genetic richness and fragile biomes. Livestock intercepts directly onto the map of burgeoning food, energy and 'green' eco-sustainability. The future paradigm summons harnessing feed resource with precision technologies for continual nutrition to meet production needs. Amongst its varied genetic diversity, India sobriquets the global leadership in possessing premier dairy buffaloes, draft cattle, carpet wool sheep, prolific goat breeds. The multitude constraints in the interface of bio-geographic harvest have directly affected nutrition and health of these rich genetic entities. The application of nutritional and management co-ordinates devised for temperate topography needs to be customized to our agro-climatic conditions to harvest the inherent potential of our livestock.

Hence the Indian Council of Agricultural Research annals on 'Nutrient Requirements of Livestock and Poultry' of 1985 and 1998, has been re-visited with necessary revisions as envisaged on decadal issues with conventional species, lesser studied livestock viz. mithun yak, equines, camels, pet and wildlife; and fisheries, considering the canopy of their indigenous environment. The present attempt by distinguished scientists addresses the nutrient requirements in the light of precision 'livestock feed basket' to address the constraints of feeds and fodder tangled with sub-optimal feeding practices. This manual will be a preamble and also a navigating tool for livestock policy-framers, researchers, academicians, extension officials and the grassroot farmers, who harbingers the societies' nutritional security and social integration.

This valuable document very ably crafted under the chairmanship of Dr. K. Pradhan, former Vice Chancellor OUAT, Bhubaneswar and RAU, Bikaner and effectively and ably coordinated by Dr. C.S. Prasad, Director, National Institute of Animal Nutrition and Physiology with guidance from very distinguished team of scientists and support from

Dr. K.M.L. Pathak, DDG (AS) and Dr. B. Meenakumari, DDG (Fy.), ICAR shall be a referral brimstone for nutrition principles and its extrapolation to productivity. I take this opportunity to compliment the Director and team from National Institute of Animal Nutrition and Physiology for achieving this mammoth task with precision.

Dated the 15th June, 2013
New Delhi

(S. Ayyappan)

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PREFACE

THE biodiversity of genetic endowment of livestock and wild fauna vis-à-vis the feed canister is dynamic with climo-edaphic variations. Considering feed security as the prime objective of national agriculture, we need to redefine the nutrient requirements of the farm and related domestic animals. This shall lead to accuracies in feed allocation focused on desired productivity in a landscape which is continually denuding of resources. Such an endeavour shall reinforce food distribution channels and replenish national exchequer.

The present maneuver is a legacy that saw its light in its earlier versions of 1985 and 1998. This module is a tapestry of all the recent advances studied on livestock nutrition, particularly application of alternative feed sources, metabolic cybernisms, mathematical models and introduction to 'second-string' ungulates- camels. Camel- is the embodiment of sustainable 'oasis' in fragile arid and semi-arid ecosystem, wherein feed assessment, nutritive values and feeding practice need to be coordinated with scarcity. With their remarkable ability of utilization of thorns and herbs, efforts have been made to encompass the varied feed resources. This maiden attempt is bound to skirt a modular fence for utilization of conventional and locally available resources through revisiting existing feeding practices and align desired productivity.

The recommended standards on nutrient requirements of various categories of animals and birds are based on current knowledge available in India and other countries on nutritional requirements. This publication on 'Nutrient Requirements of Camel' provides an up to date and comprehensive review of published research data in India and abroad. The present edition takes into consideration the decadal changes in the national feed resource base, dynamism of livestock census and their product specific utilization. Computer models, considered to be the most effective means of taking animal variations with differing needs of nutrients have been used in the reports. Also, equations developed in calculating nutrient requirements have been taken into consideration and effectively made use of. A barrage of models and equations have been introduced to edifice the

scientific modulus leading to mathematical calculations of nutrient requirements. The reports on nutrient requirement of animals were widely circulated among scientists and other expert groups including feed industries inviting suggestions and inputs before finalization. I appreciate for their valuable feedback, enthusiasm and timely response.

My gratitude to the constant support of Dr. S. Ayyappan, Secretary DARE and DG, ICAR and his vision has illuminated a saga with myriad aspiration. This artifact crafted under the chairmanship of Dr. K. Pradhan, ably supported by Dr. C.S. Prasad, Director, NIANP and fuelled through the erudite team of intellect professional, spread across the National Agricultural Research System- the National Institute of Animal Nutrition and Physiology, in particular, shall be a referral brimstone for nutrition principles and its extrapolation to productivity. The help rendered by Shri R. R. Lokeshwar, former Chief Editor, Indian Journal of Animal Sciences, ICAR, New Delhi in editing the draft report is thankfully acknowledged. I especially acknowledge the efforts of Dr. K.T.Sampath, former Director, NIANP in preparing the report. I appreciate the contribution of Dr. N.V. Patil, Director, NRC on Camel, the Convener of the Sub-Committee on Camel and Equine feed requirements. I laud the team's effort and wish its efficacies to address farm feed basket for a vibrant barn wealth.

(K.M.L. Pathak)

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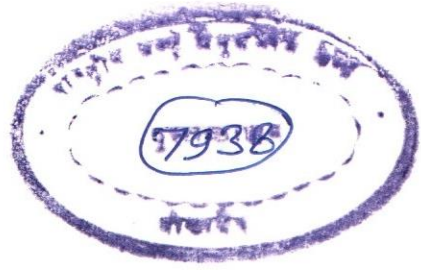

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CONTENTS

ACRONYMS

ADG	Average Daily Gain
BW	Body Weight
DMI	Dry Matter Intake
DM	Dry Matter
CP	Crude Protein
BSF	Border Security Force
BW	Body Weight
CFB	Complete Feed Blocks
ICAR	Indian Council of Agricultural Research
Ig G	Immunoglobulin G
MF	Moth Fodder
NPN	Non Protein Nitrogen
SRL	Strained Rumen Liquor

Introduction

The camel is an even-toed ungulate within the genus *Camelus*. It bears distinctive fatty deposits (humps) on its back. There are two species of camels: the Dromedary or Arabian camel having a single hump native to the dry desert areas of West Asia and the Bactrian camel having two humps native to Central and East Asia. Both the species, domesticated as beasts of burden, provide milk and meat. Almost 26 million dromedaries are domesticated, a quarter of the world's camel population is found in Somalia and in the Somali Region of Ethiopia. India ranks 10th in the world for camel population. The Indian dromedaries are mainly confined to the north-western part of the country. The states of Rajasthan (0.42 million), Haryana (0.128 million), Punjab (0.043 million) and Gujarat (0.058 million) inhabit almost 93.12% of the total camel population. However, the population of bactrians is about 150. They are found in the cold desert of Nubra valley of Ladakh in Jammu and Kashmir (Livestock Census, 2007).

In the dry land ecosystem camel rearing is regarded as a fairly constant resource of income for sustenance. Camels are in high demand for ploughing in sandy areas where they represent the most efficient cost effective traction energy source. Marketing of camel is an important trade in Rajasthan where it is widely used as draft animal. Camels are mostly traded between the breeders at big animal fairs such as Nagaur, Pushkar, Tilwara, Phalodi and Gogameri in Rajasthan. At these livestock fairs generally price level has been increasing substantially over the years. These fairs have also been providing camel-linked job opportunities and vocation, and economic subsistence to the camel breeding communities.

The western Rajasthan, particularly the arid region, is best suited for camel production. Many camel breeding families consume camel milk and in Gujarat it is sold at the same price as that of cattle / buffalo. In India although milk potential of camel has not been exploited commercially, in some parts of Rajasthan, Gujarat and Madhya Pradesh expanding peri-urban camel milk market is developing. It has low fat, protein and lactose (Table 1) with potential anti-microbial activities and therapeutic values and has more similarity with that of human milk (Wernery, 2006).

Table 1. Milk composition (%) of camel and domestic livestock

Source	Total solids	Fat	Protein	Lactose
Cow	13	4.5	3.4	4.8
Buffalo	17	7.4	3.8	4.8
Goat	13	4.1	3.4	4.6
Sheep	18	7.1	5.8	4.6
Human	12	3.8	1.0	7.0
Camel	9-13	2.0	3.0	4.0

Copper (1.3-1.8 ppm), iron (1.3-2.5 ppm) and vitamin C (24-36mg/l) levels are higher in camel milk in comparison to 0.1-0.2 ppm Cu, 0.3-0.8 ppm Fe and 3-23 mg/l vitamin C in cow milk

Camel milk contains several enzymes like Lactoferrin, Lactoperoxidase, Peptidoglycan recognition protein, N-acetyl-glucosaminidase, Lysozyme and different Immunoglobulins (IgGs) with anti-bacterial and anti-viral properties. These have tremendous advantage over milk of other species. Absence of beta-lactoglobulin responsible for infant allergy, high amount of alpha-lactalbumin having high nutritional value and high amount of lactoferrin make camel milk a valuable functional food. Camel milk contains five times more vitamin C than cow milk. It is a strong anti-oxidant essential for brain function and growth, and protects against respiratory diseases. Because of the presence of insulin, camel milk has proved its therapeutic / medicinal value in the treatment of tuberculosis and diabetes (Agrawal *et al.*, 2005).

Camel racing is a popular cultural event and huge amount of money is involved in Gulf and Arabian countries. Jaisalmeri camels of Indian origin have high racing potential. It is a versatile work animal suitable for draft, riding and baggage.

Feeding systems

Camels are linked closely to the dry, cold, semi-arid and arid regions of the world where climate is typically characterized by low, scanty, erratic rainfall, dusty and high wind velocity, low and high temperatures during winter/summer seasons, sandy soil, shifting sand dunes, low availability of

water resulting into drought tolerant and drought resistant vegetation varieties of thorny shrubs, bushes and trees, and famine-like conditions. For other grazing ruminants, it is difficult to obtain their daily feed and water requirements but camel is aptly adapted to such climates. Feeds and fodders of camels are, different from those for other domestic animals. Camels are mostly reared by the farmers on zero input mostly on pasture lands, rangelands, forests and agricultural land after harvesting crops. They can subsist on forage rejected by other animals, e.g. Camel thorn, Acacia and salt bushes. An important feature of their feeding habits is that it is not in conflict with those of other domestic livestock in terms of type or height at which they browse. Feeds selected are high in moisture, nitrogen, electrolytes and tannins. Camels also graze on various types of grasses when available during monsoon. They normally do not eat at one place and they are continually on the move, even if food is plentiful. They eat a variety of plants on the way covering large areas while browsing and grazing. They can cover a distance of 50–70 km a day. Camels graze in the early morning and late afternoon which are the coolest times of the day. Plants selected by camels have high water and protein contents. Camels manage to store sufficient energy in hump fat during the season when food is plentiful, to enable them to survive the times of poor forage. In critical areas camels are accused of causing severe damage to slow-growing trees and shrubs. Their feeding habits are such that they actually preserve the environment.

Common feed resources

Around 50 percent of 682 plant species in Indian arid zone are ephemeral and seasonal; the majority appear during monsoon season. About 60 plant species appear dominantly during rainy season.

Grasses: The common grasses found in desert rangelands are available only for short periods of rainy season and disappear soon after the rainy season is over. These grasses contain 29.3 to 46.6 percent dry matter (DM) with crude protein (CP) content ranging from 5.9 to 10.2 percent except in Blue Panic (*Panicum antidotale*) which has 15.6 percent CP content. The nutritional value of grasses is affected by maturity of plants.

Crop residues: Main crop residues fed to camels in semi- intensive and intensive system of feeding are dry chaffed moth and groundnut fodders, guar, gram straw and wheat straw which are fed mixed with other roughages.

Creepers/ shrubs/ bushes and top feeds

The common feeds in this category available for camels are *phog* leaves, *kheemp* and *Z.nummularia* (pala) leaves. Camels feed on *murali kakani*

which has highest crude protein content (23.4%) indicating the ability of camels in selection of feeds rich in nutrient. Tree and shrub leaves in early stages of growth are fairly rich sources of proteins and contain very less fibre. However, with the progressive plant growth and maturity, there is a decrease in the nutritional value and increase in fibre and tannic acid contents. The tannic acid renders the proteins of leaves unavailable to the animals but camels have remarkable ability to digest tree leaves which needs to be explored.

In the semi –arid and arid regions it is the general practice to harvest leaves of khejri (*Cineraria prosopis*), pala (*Zizyphus nummularia*) and other trees during winter months, sundry and store them for use as supplementation to the livestock during feed scarcity period. Tree leaves are also provided to camels in semi-intensive and intensive systems which apart from providing maintenance ration can provide extra nutrients for production.

Camels reared under intensive system and used for carting and riding are given dry leguminous crop residues left after removal of seeds such as guar, moth, gram and groundnut. Non-leguminous straws are not normally given to camels. Draft camels of rural and urban areas are kept at home and generally not sent for grazing. They are fed dry roughage such as moth straw, guar phalgati and gram straw, and dried leaves of pala, khejri, babool and phog collected during rainy season. Owners do not give concentrates to camels except during sickness. Concentrates are given to camels used for draft purpose and maintained by organized camel herds and institutions. Working camels are generally provided with 0.5-1.0 kg jaggery.

The main feeds and fodders of camels living in cold desert region of Nubra Valley in Ladakh are tree leaves (locally called *changma, chhowkchang, chhowk* and *Jantik*), creeper *beecho*, alfala hay and whole grasses (locally called longtol, *burche*). The proximate composition of grasses, crops residues, creepers, shrubs/bushes and trees available as camel feeds is given in Annexure I (Saini *et al.*, 2012a Unpublished data).

Special features of camel digestive system

Camels have unique morphological, anatomical, physiological and behavioural characteristics which make them to produce, reproduce and perform better than other animals under harsh desert ecosystem.

Camels, because of their height, browse on trees at a height of 3.5 m and thus do not compete with other animals. They cover long distances for grazing and browsing. Their constant movement causes less damage to the vegetation; rather they improve the rangeland through better bush/shrub and tree control than sheep, goats and cattle. Camels are, thus, very beneficial to the rural farmers and suitable to the desert ecosystem.

Anatomically the prehensile upper lips are able to browse thorny plants like *Acacia and Zizyphus* which other animals cannot utilize. Although camels ruminate they are not true ruminants, as they have only three stomachs, compared to the bovine's four compartments (Phillipson, 1979); the missing compartment is the omasum, or the third stomach. The sac-like compartments are found in the caudal part of the first compartment, the rumen; its main function is rapid absorption of solutes and water (Engelhardt and Rubsamen, 1979). It is assumed that these water cells are able to store water (Colbert, 1955). Numerous endocrine cells in the stomach wall (Engelhardt and Rubsamen, 1979) play an important role in the control of water and electrolyte balance of the camel during dehydration (Yagil and Etzion, 1979).

The efficient mechanism of thermoregulation, and water stress adaptation and conservation allow the camel to lose heat efficiently from the skin surface thus giving efficient cooling effect. It can minimize water loss by concentrating urine through kidneys and can withstand body weight loss up to 30 percent, which is not possible in other livestock. It can remain without water for 10 days in summer and for 20 days in winter without any adverse effect and can recoup the loss in a single water intake (Rai *et al.*,1994; Rai *et al.*, 1995a). Rate of water loss, less than 1 litre per day during hot summer months, is lowest in camels than in other domestic livestock due to special kidney modifications to excrete concentrated urine (Gauthier-Pilters and Dagg, 1981), less thyroxin production during dehydration reducing basal metabolism and pulmonary water loss, and ability to store heat without body water loss through sweating. When environmental temperature goes up in summer and water contents of forages do not meet the water requirements, twice a weak watering can maintain the health of camels without any adverse effect.

The efficient adaptable digestive system allows camels to maintain themselves on poor quality and scanty vegetation of desert and this is partly attributed to anatomical features of digestive tract (presence of anterior and posterior sacs, absence of papillae in the rumen, fusion of omasum and abomasum) and partly to its digestive physiology. The reduced rate of dry matter and water intake and water excretion is pronounced in the camel as compared to those in sheep and goats (Mokhtar *et al.*, 1989). On low protein diet, relative body weight loss in sheep was 3.15 g/day/kg body weight as against only 0.58 g/day/kg body weight in camel. Camels excrete less N than sheep and are in better state of nitrogen balance (Farid *et al.*, 1979). Camels have higher rumen protein synthesis efficiency and lower blood urea-N than goats and sheep which is of greater significance in nitrogen conservation via urea recycling or a direct diffusion through the rumen. Observations on nitrogen and its fractions, viz. protein nitrogen,

non protein nitrogen (NPN), ammonia-N, residual nitrogen in strained rumen liquor (SRL), blood urea and blood creatinine, indicate peculiar mechanism related to nitrogen conservation in this species. The unique attribute of adaptation to low protein diet is through urea recycling in gastro-intestinal tract. Urea recycling increases from 27 to 86 percent when dietary protein decreases from 13.6 to 6.1 percent. This might be due to high absorption rate in fore-stomach. Higher rate of endogenous urea degradation, higher plasma glucose concentrations and glucose entry rate, higher activity of 3-hydroxy butyrate dehydrogenase in the rumen epithelium and liver coupled with low ketone bodies in camel as compared to those in sheep, goats and calves are adaptive mechanisms to desert conditions (Emmanuel, 1979).

Unlike in cattle, buffaloes, sheep and goats, the small feed particles in the rumen fluid of camels are continuously removed and moved into the intestine while larger feed particles are retained for fine grinding and digestion during their retention time (46-50 hours) in their digestive tract, which is longer than that in cattle, sheep and goats. Longer retention time of digesta ensures increased microbial digestion and efficient utilization of energy. Retention time of digesta and the rate of passage of digesta through the digestive tract are influenced by the type of ration; feeding of concentrate lowers the retention time as compared to the feeding of roughages. The mean rumen volume of camel has been recorded approximately as 10-11 per cent of the body weight. The relatively lower volume associated with higher concentration of metabolites apparently appears advantageous for the rate of absorption and efficient utilization of energy.

Nutrient requirements

Dry matter intake

The camel generally eats about 1.0-2.5 kg dry matter / 100 kg of body weight depending on its physiological status. Dry matter intake (DMI) depends on the animal, type of feed and environmental factors. Animal factor depends on age, body weight and physiological status. Low DMI has been reported by several workers. The DMI is 45.8 to 52.0 g/ kg $W^{0.75}$ or 1.02 percent of body weight which is lower in comparison to those of other ruminants (Farid *et al.,* 1985). Dry matter intake / 100 kg live weight decreases with increase in body weight. Growing camels weighing 326 kg consume 1.33 percent of live weight or 56.6 g/kg $W^{0.75}$ (Al-Motairy, 1991). This is close to 54.8 g/kg $W^{0.75}$ reported by Gihad *et al.* (1989) in camels fed low protein diet but higher than 53.8 g/kg $W^{0.75}$ or 1.14% of live weight for camels fed high protein diet in Egypt. Growing

camels weighing 184-219 kg consume 1.41-1.52% DM of live weight or 61 g/kg $W^{0.75}$ in Tunisia (Kamoun *et al.,* 1989). Growing camel calves (1-2 years) have DMI of 2.22, 2.45 and 2.58 percent body weight and 82.28, 91.99 and 97.31 g/Kg$W^{0.75}$ respectively on diets containing 0, 20 and 40% higher energy levels. Jakhmola and Roy (1992) observed that in one year old camel calves DMI was 1.61, 2.21 and 2.10 percent BW basis, and 60.6, 86.29 and 81.70 g/kg $W^{0.75}$on diets having low, medium and high protein levels, respectively. Mature camels weighing 300 kg BW consume 1-1.2 percent of body weight or 46.7 g/kg $W^{0.75}$ on feeding berseem hay (Sooud *et al.*, 1989). Lactating camels weighing 528 kg and yielding 7.3 kg milk had DM intake of 1.4-1.8 percent while non-lactating camels consumed 58 percent less DM than lactating ones (Basmail, 1989).

Both feed quality and dry matter intake influence the rate of feed passage in the digestive tract and feed digestibility. When given fibrous diets at maintenance level, camels reject the coarse and select the concentrated components of the ration. While feed factor includes palatability, quality, maturity stage and level of feeding, the system of camel management also influences the DMI. The DMI was 32.4 g/ kg $W^{0.75}$ or 0.68 percent of body weight when fed ration of berseem hay and barley straw at maintenance level. Under stall-fed conditions, voluntary intake of low quality roughages is generally less which increases on concentrate supplementation (Table 2).

Table 2. DM (kg/day) and water intake (l/day) of camels

Camel category	BW (kg)	DMI%	DMI(kg/d)	Water intake (l/d)	Water intake (l/kg DMI)
Growing camels	260	1.88	4.88	16.94	3.47
Adult male camels	540	1.39	7.52	30.60	4.08
Adult non-pregnant,	440	1.42	6.21	19.30	3.10
Pregnant camels	650	1.66	10.79	19.13	1.87
Lactating camels	500	2.35	11.66	39.50	3.31
Breeding male (rutting)	640	0.76	4.86	9.82	2.07
Draft camels-resting	660	0.87	5.77	21.33	3.83
Draft camels-working	640	1.73	11.03	36.63	3.40
Race camels-resting	490	1.42	6.99	16.50	2.36
Racing camels	480	1.63	7.87	20.70	2.60
Pack camels	630	1.46	9.26	23.20	2.50

Sourc: Nagpal, 2007; Nagpal and Jabbar, 2005; Nagpal and Rai, 1993; Nagpal and Sahani, 2001; Nagpal *et al.,* 1993, 1996, 1998c, 2000a,b, 2003, 2005b.

Water intake

The Camel is extremely efficient in water utilization. It conserves water through its ability to vary body temperature as much as 7°C during

the day, gain heat during day time and dissipate in the cool night hours without body water loss. It thus, reduces its water requirement to shed extra heat load through sweating or panting and can go without drinking water for several days even some months when high moisture forages are available. The camel has remarkable ability to conserve water for thermo-regulation and maintenance of normal physiological functions. Camels can withstand up to 20 percent of body weight loss due to continuous dehydration and then consume large quantities of water in a short period, up to 100 to 125 litres in one drinking, and can regain normal body weight as soon as water becomes available.

Water requirements of camels are related to body size, feed intake and environmental conditions (Table 2). Camels need comparatively less water per unit dry matter intake or per unit body mass than sheep and conserve water during water deprivation. They digest dry matter and dietary nitrogen better than sheep when maintained on similar diets. Nitrogen retention is better in camels than in sheep under water restriction.

Normally, camels are watered twice a week and they consume about 50-190 ml / kg body weight depending upon moisture in fodder, weather, DMI, stress and frequency of watering. Water requirements of lactating and working camels are comparatively more than of non-working camels. The normal water intake is 2.8 to 4.0 l/ kg DM but the environmental temperature has a remarkable effect on water intake which increases in summer and hot humid conditions and is reduced in winter months. Studies indicated that in growing camel calves fed on dry roughages (*moth straw*) and succulent fodder (green barley), the weekly watering schedule was not able to meet their water requirements. They needed extra drinking water for maintaining growth rate during winter.

Dehydration and rehydration studies (Table 3) on male camels maintained solely on dry roughage diet indicated that water deprivation for 20 days in winter and 10 days in summer and hot humid months is possible. After rehydration, DM intake, digestibility, N-balance and body weights improved more in winter than in summer and hot humid season, in accordance with the degree of water, heat and work stress. Water deprivation in summer aggravated the situation as DMI decreased drastically on 7th day onwards along with the Na and K status. After rehydration,

Table 3. Loss of body weight as affected by dehydration and rehydration in camels

Season	Period of dehydration (days)	DMI (kg/d)			Body weight loss (%)
		Initial	At the end of dehydration	After rehydration	
Winter	20	6.67	2.56	5.70	11.70
Summer	10	8.55	0.094	3.32	17.30
Hot humid	10	9.86	0.00	3.72	21.80

sodium and potassium concentration returned to pre-hydration value. Camels lost 17.3 percent of body weight after dehydration and regained original weight after 96 hours of rehydration. In hot humid condition, camels lost the body weight on dehydration though digestibility of nutrients was restored after 72 hours of rehydration but the intake, excretion and balance of nitrogen could not be recovered. Water deprivation reduced the urine volume while nitrogen concentration in urine increased 5 folds due to the reduced kidney function and urine flow. Therefore, due attention should be accorded to the availability of water depending on physiological status and season.

Maintenance

Camels need 1kg DMI /100 kg body weight for maintenance of their live weight below which they lose their weights (Mokhtar *et al.,* 1989). Male camels weighing 540 to 635 kg and without any work consumed 1.31 to 1.40 kg DM / 100 kg body weight at stall/ rest with no health loss (Nagpal and Rai, 1993; Rai *et al.,* 1994, 1995a, b). Adult dry female camels fed on sole moth straw ration consumed 1.32 kg/ 100 kg DM and maintained their body weights (Nagpal *et al.*, 1998 c). These figures are lower than the minimum 1.5 kg DM/100 kg body weight requirements of cattle and buffaloes.

Wilson (1984) suggested the maintenance requirement for a 500 kg male camel as 54 MJ ME and 300 g DCP. For each additional 1 hr work, a camel requires approximately 8.2 MJ ME and for 10 hr work 136 MJ ME and 300 g DCP with no additional protein. For females, the energy requirement is 45 MJ ME and 260g DCP, and about 5 MJ ME and 50 g DCP for each additional 1 kg of milk. Energy and protein requirement increased by about 25-40 percent for maintenance when camels were sent for grazing or were used for 2-4 hours work. Guerouli and Filali (1992) estimated the maintenance requirement for a 300 kg camel to be 5,424 kcal/day or 75 cal /kg $W^{0.75}$. An average value of 0.435 MJ ME and 2.70 g digestible protein / kg $W^{0.75}$ was used to estimate the energy and protein requirements for maintenance of the dromedary camels by Wardeh (1997). Gihad and Bodevy (1992) calculated the protein requirements for camel maintenance from nitrogen balance and factorial methods as 2.85 g CP or 1.45 g DCP with average digestibility of 51.81 percent, which was lower than 4.09, 4.74 and 4.15 g CP values for dairy cow, sheep and goats, respectively.

Adult non-working male camels and non-producing non-pregnant, non-lactating camels require nutrients for maintaining their body functions. Their voluntary DM intake varies from 1.32 to 1.40 kg/100 kg body weight.

The assumptions based on which the nutrient requirements of adult camels have been calculated are DMI 1.20 kg/ 100 kg body weight, digestible protein 2.2 g/kg metabolic body weight, ME of 2.2 g/kg metabolic body weight and dietary Ca and P at 0.4 and 0.2 % of DM respectively (Table 4).

Table 4. Nutrient requirements (per day) for maintenance of adult camels

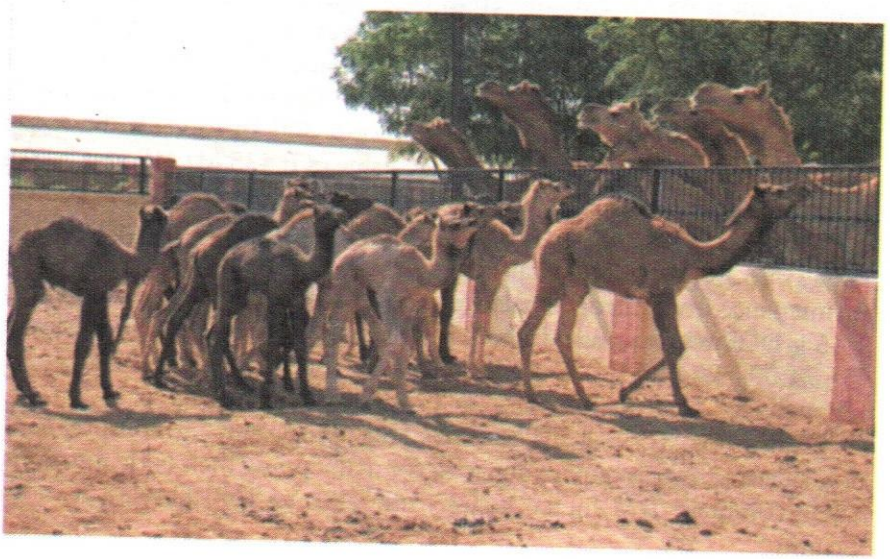
BW (kg)	BW ($kgW^{0.75}$)	DM (kg/d)	DMI (% BW)	CP (g)	DCP (g)	TDN (kg)	ME (Mcal)	Ca (g)	P (g)
500	105.74	6.00	1.20	422.3	232.6	3.05	10.99	24.0	12.0
550	113.57	6.44	1.17	454.3	249.9	3.28	11.81	25.8	12.9
600	121.23	6.88	1.15	484.9	266.7	3.50	12.60	27.5	13.8
650	128.73	7.30	1.12	514.9	283.2	3.72	13.38	29.2	14.6
700	136.09	7.72	1.10	544.4	299.4	3.93	14.15	30.9	15.4
750	143.32	8.13	1.08	573.3	315.3	4.14	14.90	32.5	16.3

Source: Nagpal and Rai, 1993; Rai *et al.*, 1994, 1995a, b Nagpal *et al.*, 1998c

Growth

Growth period of camel is about 4 years to reach mature body weight of 500 kg. Growth continues till adult camel weighs 700-800 kg at the age of 9-10 years.

The camel colostrum changes to normal milk in 7 to 10 days. Calves to attain a growth rate of 600 to 650 g/ day initially require on an average 10-15 kg milk/day. During pre-ruminant stage calves should be permitted to have free access to colostrum for the first one week after birth but excess suckling may be avoided to prevent indigestion and problem of diarrhoea.



Creep feeding can also be practised in case of alternate nourishment in breeding farm situations. A camel calf is allowed to suckle 3-4 times a day. If the she-camel dies shortly after giving birth to a calf, bottle-feeding may be adopted. Calf sucks the dam until weaned and may drink milk up to 4-6 litres/day. Camel calves start nibbling when they are 6-8 weeks old.

Nagpal *et al.*, (1998a) obtained higher growth rate during the first 3 months (709 g/day) which averaged 442 g/day over 11 months in camel calves kept on dam's milk and moth fodder. Weaning is not practised under field conditions but after 3 months the calf starts nibbling dry and green fodder as the rumen starts functioning. Vitamin A supplementation is essential to prevent night blindness during this period of growth. Practically weaning at 3.0-4.5 months of age is possible, and feeding on guar phalgati, green doob grass and concentrate mixture up to 9 months of age resulted in body weight gain from 132 to 189.5 kg during nine weeks at an average daily gain (ADG) of 402 g/day. The corresponding average intake and feed efficiency were 2.31 kg DM/ 100 kg body weight and 8.78 kg feed / kg live weight gain, respectively.

The following feeding schedule (Table 5) can be practiced for attaining optimum growth from birth to 11 months of age.

Table 5. Schedule of feeding milk and feed to camel calves up to 11 months of age

Month	Body weight (kg)	ADG (g/day)	DM intake (kg/day)			Feed efficiency	Water intakel/day
			Milk	Moth straw	Total		
Birth	39.74	-			-	-	
1.	49.78	0.52	0.63	-	0.63	1.55	
2.	69.50	0.70	0.53	-	0.53	0.77	
3.	103.60	1.10	0.65	-	0.65	0.62	
4.	115.90	0.40	0.65	1.12	1.77	4.53	
5.	131.80	0.51	0.55	1.19	1.74	3.44	
6.	146.80	0.50	0.75	1.53	2.28	4.67	
7.	156.20	0.30	0.65	1.56	2.21	7.75	1.50
8.	156.80	0.32	0.52	1.53	2.05	-	3.25
9.	166.80	0.33	0.44	1.56	2.00	8.19	3.87
10.	176.40	0.30	0.40	1.42	1.82	6.58	2.50
11.	185.50	0.30	0.27	2.61	2.88	7.48	3.26

Source: Nagpal *et al.* (1998a)

One- year- old camel calves having body weight of about 200 kg need medium plane of nutrition to maintain optimum ADG of over 400g (Jakhmola and Roy, 1992). Grazing camel calves of 1.5-3.0 years of age had ADG of 237 – 310 g because of poor grazing resources. Those fed at the stall gained at the rate of 357-427 g/day indicating the need for nutrient supplementation during the growth period. Feeding of complete feed blocks having 9 to 14% CP and 64% TDN for 12 months to camel calves of 18

Table 6. Nutrient requirements of growing camels (ADG 350 g)

Body weight	BW (kgW $^{0.75}$)	DM (kg/day)	CP (g/day)	DCP (g/day)	TDN (kg/day)	ME (Mcal/day)	Ca (g/day)	P (g/day)
100	31.62	2.21	243.3	158.1	1.42	5.12	11.1	6.6
150	42.86	3.00	329.7	214.3	1.93	6.94	15.0	9.0
200	53.18	3.72	409.1	265.9	2.39	8.62	18.6	11.2
250	62.87	4.40	483.6	314.4	2.83	10.19	22.0	13.2
300	72.08	5.05	554.5	360.4	3.24	11.68	25.2	15.1
350	80.92	5.66	622.5	404.6	3.64	13.11	28.3	17.0
400	89.44	6.26	688.2	447.2	4.02	14.49	31.3	18.8
450	97.70	6.84	751.6	488.5	4.40	15.83	34.2	20.5
500	105.74	7.40	813.4	528.7	4.76	17.13	37.0	22.2

Source- Jakhmola and Roy, (1992), Nagpal *et al.*,(2011)

months of age have been compared (Nagpal *et al.*, 2011). Assuming a requirement of 70 g DM, 5.0 g digestible protein, 45 g TDN /kg metabolic body weight and 0.5 percent Ca, 0.35 percent P of DMI, the nutrient requirements for adult camels and camel calves growing at the rate of 350 g/day is proposed (Table 6).

Pregnancy

Gestation period of camel is around 389 days. The body weight gain of camels during the last 4 months of pregnancy depends on plane of nutrition. It was 0.44 kg/d on sole dry chaffed moth fodder feeding which increased to 0.50 kg/day on daily supplementation of concentrate and to 0.82 kg/day on 2.0 kg/day concentrate supplementation (Jakhmola and Roy, 1996). Pregnant camels fed on moth chara (straw) with 2.0 kg/day concentrate ration consumed higher DM (23-29%), higher DCP (24-36%) and TDN (40-93%) as compared to dry camels because of higher nutrient demand (Nagpal *et al.*, 1998c). It is suggested to give 20 percent extra nutrients during ninth and tenth months and 50 percent extra nutrients from 11th month till calving. The ratio of protein to energy should be 26g digestible protein /4.18 MJ ME (Wardeh, 1997).

Pregnant Indian camels fed on diets consisting of guar straw, groundnut haulms and concentrate mixture showed that 12% CP and 60% TDN resulted in higher DMI of 1.65 with 1.44 kg/day body weight gain during last quarter of pregnancy and loss in body weight at calving was 14.20 % (Nagpal, 2007). Nutrient requirements of pregnant camels were calculated based on the research data assuming following requirements DM 1.60 kg / 100 kg body weight, crude protein 9.5% , digestible protein 6.0 %, ME 8.0 MJ/kg DM, Ca 0.45 percent and P 0.25 percent of dry matter intake (Table 7) .

Table 7. Nutrient requirements of pregnant camels

Body weight (kg)	Body weight (Kg $W^{0.75}$)	DM (kg/day)	CP (g/day)	DCP (g/day)	TDN (kg/day)	ME (Mcal/day)	Ca (g/day)	P (g/day)
500	105.74	8.00	760.0	456.0	4.25	15.30	36.0	24.0
550	113.57	8.80	836.0	501.6	4.67	16.83	39.6	26.4
600	121.23	9.60	912.0	547.2	5.10	18.36	43.2	28.8
650	128.73	10.40	988.0	592.8	5.52	19.88	46.8	31.2

Source: Nagpal, (2007); Patil *et al.* (2012, Unpublished data)

Lactation

Lactation length of Indian camels varies from 12 to 18 months. Milk yield usually increases up to 6-7 months and declines thereafter. During early lactation, like in other animals, it is not possible to meet the energy requirements of lactating camels within its limits of DMI, a problem which results in body weight loss and also reduction in milk yield. Lower DMI could be corrected by nutritional manipulations in the dietary protein and/or energy. Higher plane of nutrition by combined supplementation of green barley and concentrate reduced body weight loss during early lactation in lactating camels than in animals fed no or limited supplementation (Anon, 1991). Maintenance requirement of lactating females weighing 400 kg has been estimated to be 45 MJ ME and 260 g DCP, while 5MJ ME and 50 g DCP is additionally required for one litre milk production. An extra 20% and 10% ME and protein of the maintenance requirement may be given to growing lactating females during the first and second lactations. Energy and protein requirements for maintenance need to be increased by 25-40% when camels are sent for grazing. Basmail (1989) estimated metabolizable energy requirement for lactating camels weighing 528 kg and producing 7.3 litres of milk as 93.3 MJ /day. He also observed that lactating camels may require as much as 1600 g CP depending on their age, body weight, feeding management and milk yield.

Comparison of Indian dry and lactating camels indicated that milk producing camels consumed 58% higher DM, 50% more CP and 40% more ME than the dry camels (Nagpal *et al.,* 1998d). Lactating camels in 6th month of lactation given complete feed blocks (CFB group) had significantly higher daily gain (1,117 g/day) than lactating camels (227 g/day) given sole dry moth fodder (MF group), and higher DM intake of 16.9 kg in CFB group than in 11.4 kg /day in MF group (Nagpal and Jabbar, 2005). Nutrient intakes of DCP and ME were 102.7 and 71.7% higher in CFB-fed lactating camels than in MF-fed camels, respectively, indicating higher nutrient requirement. The study indicated that Indian camels have very good potential for milk production provided they are scientifically fed and managed.

Camel milk (%) contains 1.99-2.59 protein, 2.44-3.77 fat, 4.14-5.8 lactose, 0.84 total ash, 0.95 Ca, 0.87 P and gross energy value of 512-657 kcal/kg milk. Considering the utilization efficiency of ME as 62%, the metabolizable energy requirement was calculated to be 3.45 to 4.43 MJ / kg milk. Similarly considering the protein content of milk and assuming about 1.25 times dietary protein requirement, the calculated values for protein requirement was 29-30 g/kg of milk. Considering the Ca and P values of milk, and the efficiency of their dietary utilization as 54 and 64%, about 1.76 g Ca and 1.36 g P is required for 1 litre of milk.

Indian lactating camels weighing 570-600 kg and producing 7.2 to 9.0 litres of milk required 17.9 – 25.6 M cal (75-107 MJ) metabolizable energy and 1,150-1,400 g CP. Dry matter intake of 2.25 kg/100 kg BW, 11 percent crude protein, 6 percent digestible protein, 2.15 Mcal (9.0 MJ) ME/kg DM, 0.4 percent Ca and 0.25 percent P were used to calculate nutrient requirements of lactating camels producing on an average of 8 kg (Table 8).

Table 8. Nutrient requirements of lactating camels

BW (Kg)	BW (Kg $W^{0.75}$)	DM (kg)	CP (g)	DCP (g)	TDN (kg)	ME (Mcal)	Ca (g)	P (g)
500	105.74	11.25	1,237.5	742.5	6.72	24.20	45.0	28.1
550	113.57	12.38	1,361.3	816.8	7.39	26.62	49.5	30.9
600	121.23	13.50	1,485.0	891.0	8.07	29.04	54.0	33.8
650	128.73	14.63	1,608.8	965.3	8.74	31.46	58.5	36.6

Source: Saini *et al.* (2012b, Unpublished data); Nagpal *et al.* (2012, Unpublished data)

Breeding male camels

The camel is a seasonal breeder, comes into rut during winter months and show prominent behavioural signs of sexual activity. It was observed to lose 16.24% of body weight from December to March and regain 17.1 % from April to July. To maintain the health and libido of breeding camels during this period it is important to give digestible and palatable supplementation. With nutrient supplementation of 500g of crushed barley per day the body weight loss was reduced by 63%. On supplementation of linseed oil at the rate of 150 ml/day the loss was only 15 g/100 kg (Jakhmola and Roy, 1995). Similarly, camel studs maintained on dry chaffed moth fodder and 2 kg pelleted concentrate supplement lost only 15 kg body weight in 68 days compared to 40 kg when maintained on sesame oil plus jaggery supplementation during winter (Nagpal *et al.*, 2000a).

Nutrient requirements of male breeding camels are calculated assuming requirements as 50 g DM, 3 g digestible protein and 30 g TDN per kg metabolic body weight and Ca at the rate of 0.4% and P at 0.3% of dry matter intake (Table 9).

Table 9. Nutrient requirements of male breeding camel

BW (Kg)	BW (Kg $W^{0.75}$)	DM (kg)	CP (g)	DCP (g)	TDN (kg)	ME (Mcal)	Ca (g)	P (g)
500	105.74	5.29	576.8	317.2	3.17	11.42	21.2	15.9
550	113.57	5.68	619.5	340.7	3.41	12.27	22.7	17.0
600	121.23	6.06	661.3	363.7	3.64	13.09	24.3	18.2
650	128.73	6.44	702.2	386.2	3.86	13.90	25.8	19.3
700	136.09	6.80	742.3	408.3	4.08	14.70	27.2	20.4
750	143.32	7.17	781.7	430.0	4.30	15.48	28.7	21.5

Source: Jakhmola and Roy, (1995); Nagpal *et al.* (2000a)

Working camels

Camels are used for draft power mainly for transportation and ploughing. Normally, camels are put to different draft works at the age of 4 years. Properly nourished camel can be used at 2 ½ -3 years of age but full working potential is reached after 5 years. It has been estimated that 1.25 to 2.7 times maintenance requirements will be sufficient to meet body needs. Maintenance requirement for a 500 kg male is 12.9 Mcal (54 MJ) ME and 300 g DCP. Working camels do not require any extra protein. For 1 hour work a camel requires 1.96 Mcal (8.2 MJ) ME. Camels weighing 500 kg require 32.5 Mcal (136 MJ) ME and 300 g DCP daily for 10 h work. A camel weighing 500 kg spends 0.05 Mcal (0.21 MJ) ME during training at 15-18 km/hr speed. Draft camels require more nutrients than resting camels. A camel pulling 15-18 quintals of load for 6 hours daily consumes DM at the rate of 1.8-2.0 % of body weight which was higher than that of camels at rest. Camels pulling 2-wheel and 4- wheel carts also required 50% higher N intake (g/d) than those at rest. Due to higher nutrient demand for work, the intakes of DCP (g) and ME (MJ) /kg metabolic body weight were higher by 49.2 and 57.9 percent, respectively during 2- wheel carting and 55.9 and 65.5 percent, respectively during 4-wheel carting than camels at rest (Nagpal and Sahani, 2001). Adult draft camels (634 kg) engaged in carrying 700 litre water tanker on 2- wheeled camel carts fed on complete feed blocks worked for 17.9% longer duration

Table 10. Nutrient requirements of adult draft camels working for 6 hours

BW (Kg)	BW (Kg $W^{0.75}$)	DM (kg)	CP (g)	DCP (g)	TDN (kg)	ME (Mcal)	Ca (g)	P (g)
500	105.74	7.93	616.8	370.1	4.76	17.13	31.7	23.8
550	113.57	8.52	662.5	397.5	5.11	18.40	34.1	25.6
600	121.23	9.09	707.2	424.3	5.46	19.64	36.4	27.3
650	128.73	9.65	750.9	450.6	5.79	20.85	38.6	29.0
700	136.09	10.21	793.9	476.3	6.12	22.05	40.8	30.6
750	143.32	10.75	836.0	501.6	6.45	23.22	43.0	32.3

Nagpal and Sahani, 2001

and made 19.7 % more rounds yielding about 11% more income than those fed on sole groundnut straw, moth straw/ guar phalgati (Nagpal *et al.*, 2005b). Nutrient requirements of working camels are calculated assuming requirements as 75 g DM, 3.5 g digestible protein and 45 g TDN per kg metabolic body weight and Ca at the rate of 0.4 and P at 0.3% of dry matter respectively (Table 10).

Race camels

Race camels require more concentrated diet than bulky feeds. Indian female camels kept on sole roughage diet of dry moth fodder initially adapted to exercise regimen of daily 1 km race at a speed of 30 km/hr in the morning for 3 months (Nagpal *et al.*, 2000b). Because of higher metabolic activity, adult female camels during exercise consumed 94.62 % more digestible protein and 55.30 % more metabolizable energy than those at rest. Racing camels had daily intake of 8.8 kg DM, 0.69 kg digestible protein and 23.8 Mcal (99.2 MJ) ME in comparison to daily intake of 7.0 kg DM, 0.35 kg digestible protein and 15.2 Mcal (63.8 MJ) ME by the camels at rest.

Pack and riding camels

Indian camels fall broadly into 2 categories, viz. baggage and riding camels. In a study involving adult Bikaneri male camels, after completing safari of about 950 km they were again sent daily for 6 hr on 40 km journey with 1.5 h rest in between, carrying either 100 kg pack load or two riders (114 kg) on their back (Nagpal *et al.*, 1996). Daily intake of nutrients /kg $W^{0.75}$ was 73.2 g DM, 3.41 g DCP and 0.14 Mcal (0.59 MJ) ME. The daily average retention of N, Na, K, Ca, P and Mg worked out to be 18.41, 8.97, 9.21, 13.96 and 0.24 percent, respectively, indicating no deficiency of these nutrients. The results indicated that pack camels given only moth fodder could cope up with mild work stress.

Conclusion

In the present scenario of shifting from extensive to semi- intensive system of rearing and the continued role of camels as a multi-utility species, there is a need for better understanding of the nutrient requirements of camels for different physiological phases/functions like growth, lactation, breeding and draught. This will facilitate better feed formulation leading to better production and productivity in camels as well as efficient utilization of various feed resources. The difficulties experienced in conducting metabolism and feeding trials in camels for different productive functions have been addressed to a great extent by establishing specialized

research facilities at the National Research Centre on Camel (ICAR). Nutrient requirements of camels in the present publication have been largely derived from the results of the experiments conducted at National Research Centre on Camel and other experiments carried out at other locations. Additionally, feeding guidelines have also been provided to various categories of camels and it is hoped that the information would be helpful for rearing of camels of various classes in a scientific way leading to better production and productivity in camels.

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A1. Proximate composition of commonly used feeds (% DM)

S. No.	Plant	Stage	DM	CP	EE	CF	TA	NFE	Ref.
A. Grasses									
1.	Grumman (*Panicum antidotale*)	Flowering Seed	22.82 28.26	15.63 15.53	4.8 3.0	23.25 23.25	13.05 8.50	43.27 49.72	Anon. (1997)
2.	Sewan (*Lasiurus indicus*)	Veg. Post seed Shedding MatureDry	30.58 44.40 52.68 78.32 94.50	9.40 5.89 8.76 5.42 4.40	1.40 1.60 1.52 0.88 2.25	33.25 34.50 33.25 33.25 32.25	9.40 6.15 7.38 5.30 4.70	46.55 51.86 49.09 55.15 56.40	Anon. (1997) do do do Purohit (1994)
3.	Dhaman (*Cenchurus setigerus*)	Flowering	28.03	8.76	2.60	31.00	17.75	39.89	Anon. (1997)
4.	Boor (*Andropogan limoges*)	Flowering	33.94	7.33	2.76	32.00	7.50	50.41	—do—
5.	Bhurut (*Cenchrus titflorus*)	Flowering	29.29	10.19	2.60	20.25	15.50	51.46	—do—
6.	Dachab (*Cyperus tiflorus*)	Veg.	46.61	7.73	1.80	30.05	20.50	39.92	—do—
B. Crop residues									
1.	Moth straw (*Phaseolus aconitifolius*)	Mature Dry	93.47 95.22	9.00 10.50	2.80 2.30	13.00 26.50	16.05 12.50	59.15 48.20	Nagpal *et al.* 1998a; Sandoo (1994)
2.	Gaur phalgati (*Cyamposis tetragonoloba*)	Mature	93.47	6.81	0.59	28.21	9.40	54.99	Nagpal *et al.* (2002a)
3.	Groundnut (*Arachis hypogea*)	Veg.Flowering Mature	17.92 20.28 29.59	18.63 17.68 12.27	3.68 3.00 1.80	10.00 12.50 14.00	10.90 8.20 10.75	56.79 58.62 61.18	Nagpal (2010)
		Straw	92.80	8.11	1.83	32.54	13.86	43.66	Purohit (1994)
4.	Gram straw	Mature	92.50	9.10	1.05	27.10	12.34	50.41	Nagpal *et al.* (2005a)

S. No.	Plant	Stage	DM	CP	EE	CF	TA	NFE	Ref.
C. Creepers									
1.	Bakeria (*Indigofera cordifolia*. Roth)	Flowering	32.16	12.74	1.60	10.40	22.85	52.41	Nagpal *et al.* (2002b)
2.	Gokhru (*Tribullus terrestris*)	Flowering	28.19	19.11	3.08	16.75	15.75	45.31	Nagpal *et al.* (2002b)
D. Bushes/Shrubs									
1.	Pala (*Zizyphus-nummularia*)	Veg. Flowering	53.20 55.37	14.33 13.70	3.12 3.80	18.55 16.50	15.17 10.80	48.83 55.20	Nagpal *et al.*(2002b)
2.	Bui (*Aerva tomentosa*)	Veg.Flowering	27.08 33.90	16.56 13.85	2.0 1.50	14.50 18.50	15.10 13.70	51.84 52.45	Nagpal *et al.* (2002b)
3.	Phog (*Calliganum polygonoides*)	Veg. (pink nodes)	25.92	10.59	1.60	21.75	9.50	56.5 6	Nagpal *et al.* (2002b)
4.	Murali kakani (*Lycium barbarum linn*)	Veg.	28.97	23.41	3.48	9.40	15.75	47.96	Nagpal *et al.* (2002b)
5.	Kheemp (*Leptadenia pyrotechnica forzk*)	Veg.	30.28	10.51	-	19.10	20.95	-	Nagpal *et al.*(2002b)
E. Tree leaves									
1.	Jal (*Salvodora oleidius*)	Seed	30.05	15.77	2.00	8.15	27.50	46.58	Nagpal *et al.* (2002b)
		Dry leaves	91.21	12.21	2.97	10.53	16.56.	57.73	Purohit (1994)
2.	Israeli babool (*Acacia tortilis*)	Veg.	39.01	17.04	5.6	13.33	12.75	51.28	Nagpal *et al.* (2002b)
3.	Khejri (*Prosopis cineraria*)	Veg.	38.78	12.42	4.60	20.67	20.83	41.48	Nagpal *et al.*(2002b)
		Dry	94.62	16.24	2.03	14.01	16.24	51.28	Purohit (1994)
4.	Parkin sonia	Flowering	39.14	27.71	4.40	8.50	14.30	45.09	Nagpal *et al.* (2002b)
5.	Ardu (*Ailanthus excelsa*)	Veg.	30.61	22.61	5.00	16.75	12.00	43.64	Nagpal *et al*, (2002b)

S. No.	Plant	Stage	DM	CP	EE	CF	TA	NFE	Ref.
6.	Neem (*Azadirachta indica*)	Veg.	36.76	19.43	3.60	13.63	8.65	54.69	Nagpal *et al.* (2002b)
		Dry	93.70	16.03	3.15	22.47	7.50	50.85	Purohit (1994)
7.	Kikar (*Acacia nilotica*)	Flowering	50.60	15.98	6.16	7.50	8.20	62.16	Nagpal *et al*, (2002b)
8.	Sirus (*Albizzia lebbeck*)	Veg.	41.51	30.66	7.00	12.50	5.80	44.04	Nagpal *et al.* (2002b)
	Trees in Leh								
1.	Changma (local name)			14.00	2.61	6.67	11.47	65.25	Anon. (2000)
2.	Chhowkchang (local name)			12.43	4.55	9.33	8.18	65.51	—do—
3.	Chhok (local name)			18.55	5.82	8.63	7.39	59.61	—do—
4.	Jantik (*Mericaria gallica*)			10.55	5.50	10.76	11.76	61.43	—do—
	Creeper								
1.	Beecho (local name)			13.13	5.73	22.40	15.25	43.49	Anon. (2000)
	Crop residue								
1.	Alfaalfa (*Medicago sativa*)			15.23	1.93	33.00	9.10	40.74	Anon. (2000)
	Grasses								
1.	Longtol (local name)			6.65	3.80	32.14	9.41	48.00	Anon. (2000)
2.	Burche (local name)			11.20	3.63	31.85	8.42	44.90	—do—

A2. Chemical and mineral composition of common local weeds used as camel feeds (% DM)

Local feed name	Botanical Name	OM	CP	EE	CF	Ash	Cu	Mn	Zn	Fe
		%					ppm			
Dudhali	*Euphorbia thymifolia*	74.4	12.33	2.88	11.06	25.6	7.6	52.0	30.2	438.0
Dhkada		78.1	19.0	3.2	19.92	21.09	9.4	34.0	31.4	34.0
Kagaroti	*Corchorus tridens Linn.*	87.32	17.68	1.93	15.49	12.68	7.4	21.0	19.4	26.6
Bakariya	*Indigofera cordifolia*	70.34	6.2	1.64	11.79	29.66	6.0	32.2	13.6	350.0
Chawala		89.84	20.16	4.04	12.02	10.16	7.4	61.8	13.4	96.6
Murath	*Cenchrus prieurii (Kunth.) Maire. Var. prieurii*	88.15	6.33	1.7	31.85	11.85	8.0	57.0	12.4	388.0
White fuli	*Heliotropium marifolium*	83.05	22.1	3.35	4.61	16.95	4.0	60.8	10.2	432.0
Kanti	*Tribulus pentandrus*	68.53	10.3	3.99	10.61	31.47	6.8	55.2	13.6	468.0
Jhariniya	*Cyperus conglomerates*	76.29	13.66	2.43	10.14	23.71	10.4	70.2	24.0	300.0
Sinavadi	*Boerhavia spp*	76.41	7.8	3.06	11.08	23.59	5.2	53.8	13.0	428.0
Ganthiya		73.23	8.17	2.32	9.38	26.77	3.6	41.6	6.6	328.0
Sata	*Zaleya govindia (Buch.- Ham. ex G. Don.) Nair.*	51.41	19.79	2.6	3.8	48.59	7.2	30.6	13.6	212.0
Lamphdi	*Aristida funiculate*	71.17	4.95	0.78	-	28.83	3.0	30.8	6.2	280.0
Horse grass	*Cyperus rotundus*	76.92	9.98	1.65	-	23.08	10	105.8	20.4	474.0

Source : Saini *et al.*, 2012a, Unpublished data

Feeding camels under semi-intensive and intensive system

In the situations of following semi-intensive or intensive feeding practices for camel – the feeding at the barn includes either sole feeding with available crop by-products like guar phalgatti (*Cyamopsis tetragonoloba* plant stems, leaves and pod husk), moth straw (*Vigna aconitifolia*, dew bean straw with leaves), Mung Straw (*Vigna radiata*) (Green gram pod husk, leaves and plant stems), Groundnut (*Arachis hypogea*) haulms, Gram Straw (*Cicer arietinum*) i.e. Chana Khar (Gram pod husk, leaves and stems), traditional tree leaves like Khejri *(Prosopis cineraria),* Pala *(Zizypus numularia),* Jal *(Salvadora oleidius),* Ardu *(Alianthus excels)* Neem (*Azadirachta indica)* etc. which on an average provides 7-12% CP and 50-65%TDN.

In intensive system of feeding camels the complete feeds as blocks and pellets can be offered during various physiological phases. The composition in general consisted of 50:50 proportions of roughage and concentrates.

The general composition of complete feed (50:50 roughage: Concentrate) is

I) Mixture of Groundnut haulms (75) and Guar Phalgati/Moth Straw/Bajra straw/Barley straw/Wheat straw (25) -

II) Concentrate mixture having % ingredient composition as below - 50 parts:-

- Guar Korma/Mustard Seed Cake/Cotton Seed cake-16 parts
- Bajra grains - 40 parts
- Rice bran - 25 parts
- Rice polish - 5 parts
- Molasses- 10 parts
- Salt - 2 parts
- Mineral mixture -2 Parts

Having about 10.5 % CP and 65% TDN.

A3. Ingredient composition (%) of Complete feeds (blocks/TMRs/Pellets) for various categories of Camel

Ingredients/Category	Calves up to weaning	Weaning to 3 years	Lactating	Pregnant camels	Breeding males
Roughage					
a) Guar phalgati	12.5	12.5	12.5	12.5	8.75
b) Groundnut haulms	37.5	37.5	37.5	37.5	26.25
c) Barley straw	-	-	-	-	15.0
Concentrates					
a) Bajra grains	5.0	15.0	20.0	6.5	15.5
b) Barley grains	2.0	2.5	-	6.5	-
c) Rice Bran	-	-	12.5	11.5	12.5
d) Wheat Bran	6.0	4.0	-	-	-
e) Rice Polish	2.0	2.5	2.5	2.5	2.5
f) Soya Churi	-	-	8.0	-	-
g) Ground nut cake	21.0	13.0	-	7.5	-
h) Guar Korma	5.0	4.0	-	11.0	15.0
i) Molasses	5.0	5.0	5.0	2.5	2.5
j) Mineral Mix	2.0	2.0	1.0	1.0	1.0
k) Salt	2.0	2.0	1.0	1.0	1.0
Nutritive Value					
CP (%)	15.65	13.50	10.00	10.10	9.85
TDN (%)	64	66	65	68	65

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