Vol 18 No 1, p 91-95

EFFECT OF REPLACING ORGANIC WITH INORGANIC INGREDIENTS ON THE EFFICACY OF MINERAL SUPPLEMENTS FOR CAMELS IN THE ARID NORTHERN KENYA

S.G. Kuria[1], H.K. Walaga[1] and I.A. Tura[2]

[1]Kenya Agricultural Research Institute, Marsabit Research Centre, P.O. Box 147-60500 Marsabit, Kenya

[2]Kenya Agricultural Research Institute, Garissa Research Centre, P.O. Box 230-70100 Garissa, Kenya

ABSTRACT

An on-station experiment was conducted in Gudas sub-station of the Kenya Agricultural Research Institute (KARI), Marsabit Research Centre located in northern Kenya to validate a modified mineral supplement for camels, hitherto formulated using local material including livestock bones. The modification was necessitated by international concern over the use of animal ingredients in the making of animal feeds due to the threat of mad cow disease. In the modified mineral supplement, the bone component was replaced with general purpose industrial chemicals which were expected to supply mineral elements previously supplied through the bones. Two hundred grams of the modified supplement were individually fed to dissimilar (in terms of parity, age and lactation stage) institute camels daily for a period of 6 months. The camels were randomly assigned the treatments such that a total of 27 camels were in the experiment with 15 treated and 12 controls. During the 6 months study period, data on milk yield and calf growth was taken on weekly basis. The results showed an increase of 17% and 25% in milk and calf growth, respectively, compared to over 30% for both parameters recorded with the original supplement. The study concluded that the original supplement exhibited more profound influence on milk yield and calf growth compared to the revised one. However, responses registered with the revised supplement were significant.

Key words: Animal feeds, camel performance, ingredient type, Kenya

The camel is faced with the daunting challenge of water scarcity but also limited nutrient availability from forage species. This situation is aggravated by the fact that camels are hardly given supplemental feeds (Vittorio *et al*, 1999) and therefore have to depend on the scarce natural forages for all their nutritional requirements, minerals inclusive (McDowell and Conrad, 1990).

Previous studies by Kuria *et al* (2004), and Kuria *et al* (2006a, b) confirmed mineral deficiencies in Marsabit district located in northern Kenya. A mineral supplement was formulated using local material, tested with pastoralists camels and found to improve milk yield and calf growth by over 30%. The objective of the current study was to validate a modified version of this mineral supplement. The components of the original formulation were a) ground livestock bones mixed with b) locally available natural salt. In the revised formulation, the bone component was replaced with industrial general purpose chemicals. Considering the importance of source of minerals in determining digestibility and the subsequent bioavailability, it would be wrong to assume that the revised supplement would have the same effect the original one had on the camel performance, thus the need to validate. This validation was done onstation.

Materials and Methods

Description of the study site

The experiment was carried out in KARI Gudas station from late October 2009 following the end of a severe drought to April 2010. The temperature range recorded during the study was 21°C to 44°C, the lower Figs have been recorded mostly in mornings and the high ones in the afternoons. The experimental period was characterised by plenty of grazing resources for camels. Vegetation in the study area was usually dominated by a mixture of bushes and shrubs interspersed with trees like *Acacia tortilis*, among others. Rainfall usually ranges from 300 to 400 mm per annum while the soils were well drained with a high proportion of sand.

SEND REPRINT REQUEST TO S.G. KURIA email: simongkuria@yahoo.com

Preparation of the supplement

The modification involved removal of the bone component in the original supplement and replacement of the same with general purpose chemicals following international concerns regarding the use of animal ingredients in the making of animal feeds due to health risks associated with mad cow disease. The mineral elements supplied by the bones in the original supplement i.e. calcium, phosphorus and magnesium were supplied through calcium carbonate, di-calcium phosphate and magnesium sulphate, respectively, in the revised supplement. These chemicals were mixed with naturally occurring salt collected from a local desert called Chalbi. Care was taken in calculating the mixing ratios so that as closely as possible maintain the original proportions of the various mineral elements in the revised supplement.

Description of the experimental camels

The camels were all of Somali breed whose parity ranged between 1 and 4 while the age ranged between 5 and 12 years. The stage of lactation was between 3 and 17 months. The experiment lasted about 6 months with some camels being in the experiment for the 6 months while others participated in the experiment for 3 months, having been recruited later. The camels were randomly assigned the treatments i.e. either fed or not fed with the mineral supplement such that 7 camels were put on the treatment while 5 constituted the control group at the beginning of the experiment. Other camels were introduced into the experiment later on as they continued calving down such that at the end of the experiment, a total of 27 camels were in the experiment with 15 treated and 12 controls. An important observation was that the treatments were not balanced i.e. number of treated camels was higher than that of the controls. In addition, the experimental camels were not uniform in terms of age, number of parities and stage of lactation mainly due to limited sampling frame at beginning of the experiment.

Experimental design

The experimental design was a Completely Randomised Design (CRD) with 2 treatments. Repeated measurements taken from each camel on weekly basis served as replicates.

Feeding of the supplement

Each camel on treatment was given 200g of the mineral supplement every morning before releasing them for grazing. The 200g of supplement was poured into a plastic bottle, a little water added and shaken to make a paste. This paste was then orally administered into each individual camel in a seated position. The bottle would then be rinsed to ensure that each camel got its full share of 200g daily.

Milk data collection

The milk measurements were repeatedly taken on weekly basis from each experimental camel. The milk yield was determined by milking one hind and one front teat (complete stripping) in the morning while the other 2 teats were left for the calf to suckle. To estimate yield from the 4 quarters i.e. whole udder, milk from the 2 teats was multiplied by 2. This latter volume was further multiplied by 2 to get an estimate of the daily milk yield. Milk letdown was stimulated using the calf. Volume of milk produced was measured using a graduated jug. Data relating to the number of parities, age and stage of lactation of the experimental dams was also recorded.

Calf growth data collection

The calves were not receiving any supplement directly but were expected to benefit from the supplement through the milk. The calves were weighed on weekly basis using a clock scale anchored on a tripod stand. One calf was weighed at a time with the calf being wrapped round the belly to the spine with a nylon bag fitted with straps, then lifted with a winch to ensure complete suspension. Weekly weight gains (kgwk-1) were computed by getting the difference between the readings for week 2 and week one, week 3 and week 2 etc for each calf. Daily weight gains (gd-1) for each calf was computed by dividing the weekly weight gains by 7.

Statistical Analysis

The data was entered and cleaned up in Microsoft-Excel spreadsheet while the analysis was done using Statistical Analysis System (SAS, 2003). For the purpose of statistical analysis, the lactation stage (months) was categorised into 4 i.e. 1-3 months (A), 4-6 months (B), 7-9 months (C) and >9 months (D). Analysis of Variance (ANOVA) using the General Linear Model (GLM) procedure of SAS was done to test for treatment differences, effect of parity and stage of lactation on milk yield and interactions between the independent variables. The same procedure was used to analyse treatment effects on calf growth, effect of sex on growth and interaction between independent variables. In both analyses for milk yield and calf growth, age was entered as a covariate. Since the ANOVA was significant, treatment means were separated using Least Significant Differences (LSD) at 95% level of confidence. The results were either tabulated or presented in form of milk yield and calf growth calves.

Results and discussion

The mean daily milk yield for treated camels (4.4 ± 0.2 ld^{-1}) was significantly higher ($p<0.0001$) than that of the controls (3.7 ± 0.2 ld^{-1}). These Figs were higher than those earlier reported by Kuria *et al* (2004) i.e. 2.7 to 3.4 ld^{-1}. The difference is attributable to variation in the breed of camel used in the experiment, the ones in the current study being of Somali breed while those used in the previous experiment were a mixture of Somali and Rendille breeds. In similar environmental and management situations, Somali camel breed produce more milk than the Rendille (Simpkin *et al,* 1998). The quantity and quality of vegetation in Gudas where the current study was conducted was better than where the previous experiment had been conducted. This can also explain the difference in the observed responses to the supplementation. In the current study, the supplement increased milk yield of camels by 17.0% compared to 30% recorded with the original supplement. Digestibility and bioavailability of minerals in an animal body is a function of the source, among other factors. While the source of calcium, phosphorus and magnesium in the original formulation was organic in nature (livestock bones), the source of these minerals in the revised formulation was inorganic chemicals. Greater minerals bioavailability has been reported for organic sources than that observed for inorganic forms (Spears 1989, 2003; Wedekind *et al,* 1992; Greene, 2000). Worth noting is that the positive responses to mineral supplementation confirmed that the Kenya Agricultural Research Institute camels used in this study were suffering from mineral deficiencies. This is in accordance with observations by Ghosal and Shekhawat (1992) that production response to mineral supplementation is the best way of determining the level of micronutrient deficiency in camels. McDowell (1997) also observed that the higher the level of deficiency, the higher the response to specific mineral supplementation.

Table 1 shows how the mean milk yield of camels varied with lactation stage. The daily milk yield increased from lactation stage A to C and declined from C to D. This means the peak yield for the supplemented camels was attained between the 7th and 8th month of lactation. These results compares favourably with earlier reports by Kuria *et al* (2004) who recorded peak production at between 5th and 7th month of lactation. Farah (1996), Simpkin *et al* (1998) and Yagil (2000) had earlier observed that most of the milk in camels was produced within the first 6 to 7 months of lactation. It is important to note that at commencement of the experiment, all the camels had lactated for over 3 months and appear to have already attained an early production peak (Fig 1). This early production peak may have been induced by feed and heat stress associated with severe drought conditions which prevailed when the camels were calving down. However, the supplementation increased persistence in milk yield with the normal peak production of almost 5 ld^{-1} a day being attained between 2 and 3 months later unlike the milk yield of the control camels which continued declining even with plenty of quality forage available during the period. Following the attainment of peak production by the supplemented camels, the daily milk yield declined steadily. A graphical presentation of how the milk yield of treated and control camels changed with time is presented in Fig 1.

Table 1. Effect of lactation stage on the daily milk yield of camels.

Milk yield (litres)			
Level of Lactation	**N**	**Mean***	**S.E.**
A	195	3.9a	0.11
B	115	4.4b	0.12
C	130	4.5b	0.12
D	98	3.4c	0.09

*Mean values followed by different letter superscript differ significantly (p=0.0019)

Table 2 shows how the mean milk yield of camels varied with parity. Camels in parity 2 produced significantly higher ($p<0.0001$) milk than those in parity 1. On the other hand, camels in parity 3 produced significantly less ($p<0.0001$) milk than those in parity 2 while those in parity 4 produced milk equal to ($p>0.05$) camels in parity 3. It was not immediately clear why camels in parity 3 produced less milk than those in parity 2 as this disagreed with previous reports (Bekele *et al,* 2002; Hulsebusch *et al,* 1994; Simpkin, 1996). Bekele *et al* (2002) observed that camels in the parity 4 showed the highest mean daily average off-take and showed a higher peak than other parities. Simpkin (1996) reported increasing mean daily milk yields from parity 1 through 2, peaking at parity 3 with a decline from parity 4. Simpkin (1996) results were in agreement with those of Hulsebusch *et al* (1994).

Table 2. Effect of parity on the daily milk yield of camels.

Milk yield			
Level of Parity	**N**	**Mean***	**Std error**
1	298	3.8a	0.07
2	126	4.7b	0.11
3	82	4.2c	0.14
4	32	4.2c	0.09

*Mean values followed by different letter superscript differ significantly ($p<0.0001$).

Interactions

Interactions between the various factors considered in the study were tested using the GLM procedure of SAS. The parity*treatment and lactation* treatment interactions were both significant at p=0.0024 and 0.0417, respectively. However, time*treatment interaction was not significant (p=0.2601).

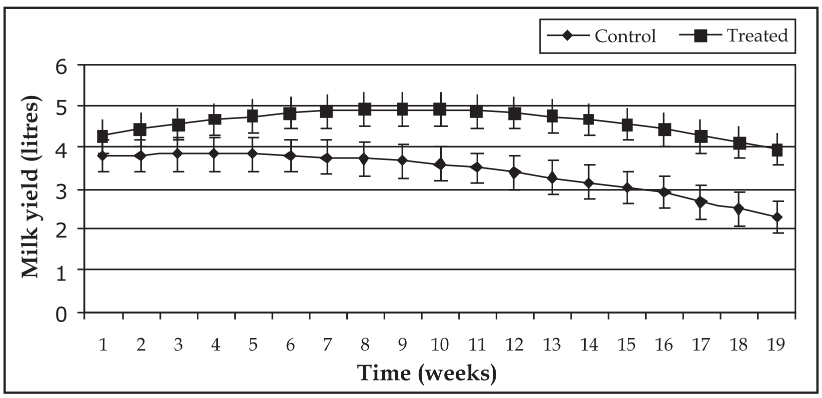

Fig 1. Effect of the mineral supplement on the daily milk yield of camels.

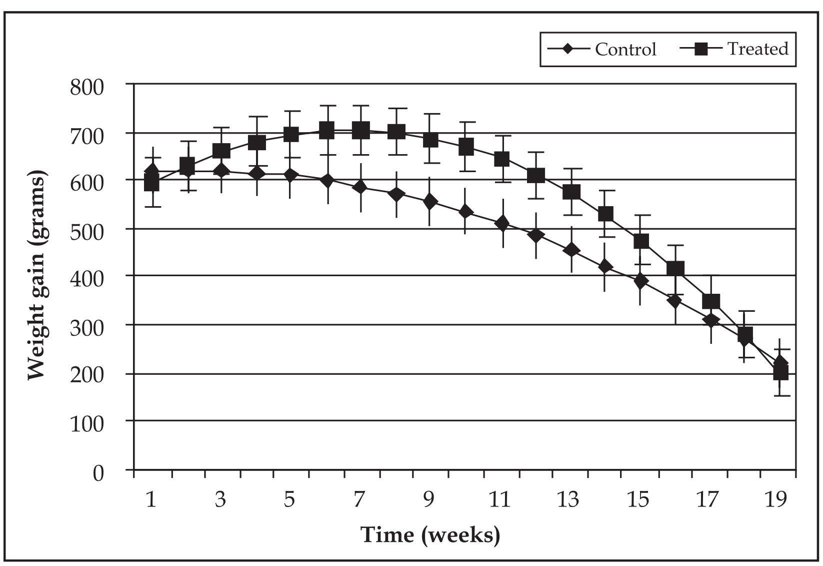

Fig 2. Effect of the mineral supplement on the daily weight gain of camel calves .

Calf growth

The mean daily weight gain for calves from supplemented dams (561.7±36.3) was significantly higher ($p<0.0001$) than that of calves from the control dams (448.9±37.7). The supplement increased the calf growth rate by 25.1% compared to 48% recorded with the original supplement (Kuria *et al,* 2004). The superior performance of camels on the original supplement may be attributed to higher bioavailability of mineral elements due to the organic nature of the source. This explanation agrees with Greene (2000) who observed that there is usually considerable difference in bioavailability of minerals from different sources noting that organic sources (bones in this case) are more bio-available than inorganic sources (the case in the revised supplement). The male camel calves (treated and untreated) registered an average daily weight gain of 531.5± 36.3 which was significantly higher ($p<0.05$) than 479.1±37.7 for females. However, the interactions between treatment and time were insignificant ($p>0.05$).

Fig 2 is a graphical presentation of the effect of supplementation on calf growth. At the beginning of the experiment, the calves appear to have already attained the maximum growth rate of about 600gd^{-1}. The control camel calves maintained this growth rate for the first 4 weeks of the experiment. However, the calves whose mothers were supplemented steadily gained weight, attaining the maximum growth of 700gd^{-1} at the 6th week of the experiment (about four a half months of age) and maintaining it for the following 3 weeks. Thereafter, the calves whose mothers were supplemented continued gaining weight at a declining rate that was higher than for the controls. Worth noting is that at the 18th week of the experiment (about seven and half months of age), both treated and control camel calves were at par in terms of daily weight gain (about 270gd^{-1}). However, the higher daily weight gain registered by the calves whose mothers were supplemented during the first 8 weeks of the experiment put them ahead of the control camel calves in terms of live weight meaning the former were heavier than the latter by the time the experiment ended.

Conclusions

The original supplement exhibited more profound influence on milk yield and calf growth compared to the modified one. However, responses registered with the modified supplement were significant. It is recommended that the modified supplement is commercially produced and promoted among camel pastoralists of northern Kenya in order to address mineral deficiencies facing camels in the area.

Acknowledgements

The team wishes to sincerely thank the Director KARI and the coordination unit, Kenya Arid and Semi Arid Lands Research Project for the financial support. The Assistant Director, Range Management encouraged the team while conducting the field experiment and this effort too is appreciated. The input by Mr. Seth Amboga, biometrician from KARI Embu in terms of data management and analysis is also treasured by the team.

References

Bekele T, Zeleke M and Baars RMT (2002). Milk production performance of the one humped camel (*Camelus dromedarius*) under pastoral management in semi-arid eastern Ethiopia. Journal of Livestock Production Science 76(1-2):37-44.

Farah Z (1996). Camel Milk Properties and Products. St. Gallen, Switzerland: SKAT.

Ghosal AK and Shekhwat VS (1992). Observations on serum trace elements levels (Zinc, Copper and Iron) in camels (*Camelus dromedarius*) in the arid tracts of Thar Desert in Indiia. Revue dbElevage et de Medecine Veterinaire des Pays Tropicaux (Paris) 45(1):43-48.

Greene LW (2000). Designing mineral supplementation of forage programs for beef cattle. Journal of Animal Science 78 (E-Supplementary): E13.

Hulsebusch CG, Kaufmann BA, Atkins AJ and Evans JO (1994). Milk production of Somali and Turkana type dromedaries under semi-arid conditions in Kenya. Proceedings of conference on 'Chameaux et Dromedaires, Animaux Laitiers', Nouakchott, Mauritanie, 24-26th October 1994. UCEC, CIRAD.

Kuria SG, Gachuiri CK, Wanyoike MM and Wahome RG (2004). Effect of mineral supplementation on milk yield and calf growth of camels in Marsabit District of Kenya. Journal of Camel Practice and Research 11(2):87-96.

Kuria SG, Wahome RG, Wanyoike MM and Gachuiri CK (2006a). Effect of mineral supplement on plasma minerals concentration of camels (*Camelus dromedarius*) in Kenya. International Journal of Agriculture and Biology 8(2):168-171.

Kuria SG, Gachuiri CK, Wahome RG and Wanyoike MM (2006b). Mineral profile in the plasma of free ranging camels (*Camelus dromedarius*) in Kenya. Indian Journal of Animal Sciences 76(12):1068-1070.

McDowell LR (1997). Minerals for grazing ruminants in tropical regions. Animal Science Department, Centre for Tropical Agriculture, University of Florida, USA.

McDowell LR and Conrad JH (1990). In: Seventh International Symposium on Trace Elements in Man and Animals (TEMA-7), Dubrovnik, Yugoslavia. pp 36-1.

Statistical Analysis System Users Guide (2003). Statistics Version 6 Edition, SAS Inst, Inc, Cary, NC, USA.

Simpkin SP (1996). The effect of breed and management on milk yield of camels in Kenya. PhD Thesis, university of Newcastle, UK.

Simpkin SP, Mbui MK, Kuria SG and Lucas DK (1998). An analysis of the present knowledge of camel breeds and their productivity in the ASAL regions of Kenya. Technical Report, Kenya Agricultural Research Institute, National Arid Lands Research Centre, Marsabit-Kenya.

Spears JW (1989). Zinc methionine for ruminants: Relative bioavailability of zinc in lambs and effects of growth and performance of growing heifers. Journal of Animal Science 67:835-843.

Spears JW (2003). Trace mineral bioavailability in ruminants. Journal of Nutrition 133:1506S-1509S.

Vittorio DO, Donata C, Ernesto B, Antonella B and Giovanni SE (1999). Effects of trace element supplementation on milk yield and composition in camels. International Dairy Journal 10:873-879.

Wedekind JK, Hortin AE and Baker D H (1992). Methodology for assessing zinc bioavailability: Efficacy estimates for zinc methionine, zinc sulfate and zinc oxide. Journal of Animal Science 70:178-187.

Yagil R (2000). Ecophysiology of the desert camel (*Camelus dromedarius*). In: Selected Topics on Camelids. Editor: Gahlot TK pp 51-60. Camel Publishing House, Bikaner, 334001, India.