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TREATMENT AND PREVENTION OF RICKETS AND OSTEOMALACIA IN BACTRIAN CAMELS (*Camelus bactrianus)*

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ABSTRACT

A series of experimental trials on the methods of treatment and prevention of rickets and osteomalacia in Bactrian Camels (*Camelus bactrianus*) was carried out. The results confirmed that these diseases were mainly caused by phosphorus deficiency, which could be cured with supplementary bone meal, phosphate or mineral mixtures and out field investigations clinical signs disappeared within 15 days. Over the same period, the concentrations of phosphorus and alkaline phosphatase in blood returned to normal. The disease may be effectively prevented by use of mineral blocks (block salt licks) or dosing orally with soluble glass boluses of copper, selenium and cobalt. We conclude that rickets and osteomalacia are mainly caused by phosphorus and copper deficiencies in the pasture.

Keywords : bactrian camel, minerals, osteomalacia, phosphorus deficiency, prophylaxis, rickets, treatment

For a long time past, rickets and osteomalacia in bactrian camels have caused the major economic losses in Badanjiling and Tenggeli deserts in China. As in other animals, rickets is a disease of young growing bactrian camels and is characterised by stiffness in the gait, enlargement of the costochondral junctions and abnormal curvature in the long bones, especially in the forelegs. Osteomalacia usually occurs in mature bactrian camels and is characterised by fragile bones, general weakness, lameness, emaciation and stiffness; affected animals often are seen chewing bones, rocks and other objects. In this area, animals are grazed throughout the year and rickets and osteomalacia usually occur between February and June. Although the preliminary observations showed that these diseases had a long history (Liu, 2002), it had not been studied because of adverse natural environment and poor transport facilities in this area. The local farmers and herdsmen urgently desired a means of preventing and treating these diseases. Following investigations by means of an epidemiological study and clinical and naked-eye pathological observations, together with laboratory determinations of serum biochemical values and various mineral elements in soils and forages from the affected and control areas as well as in blood, hair and tissues (Liu, 2003), it appeared that a deficiency of phosphorus was the most likely cause of these diseases, possibly coupled with copper deficiency. A series of experiments designed to confirm this hypothesis and to develop methods for preventing and treating the disease were therefore undertaken.

Materials and Methods

Experimental design

Two clinical trials and two intervention studies were conducted on animals in the field. The animals from five similar herds in which the incidence of the disease was high were used. Some of these camels received supplementary minerals, while the remainder were controls.

Eighty-seven cases of osteomalacia, in camels aged 4-13 years and 73 cases of rickets, in camels aged less than 2 years, were selected from the Badanjiling desert in Alashanyouqi in Inner Mongolia for treatment (trials 1 and 2). The prophylactic trials used 732 Bactrian camels from five herds for trial 3 and trial 4. The numbers of animals used and the treatments accorded each group are shown in Table I.

The animals were grazed for 9-11 h each day on the same pasture on which the disease had occurred previously. They were supplied with water once

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Table 1. Experimental Design.

Trial	Number of animals			Administration
	YC	AFC	Total	
Trial 1	10	15	25	150-250g bone meal daily for 10 days
	11	12	23	150-200g disodium phosphate daily for 10 days
	15	14	29	30-60g monosodium dihydrogen phosphate daily for 10 days
Trial 2	10	15	25	11000 units/kg B.W vitamin D_2 (calciferol) in oil, intramuscular injection, only once.
	12	14	26	150-200g mineral mixture daily for 1 week.
	15	17	32	11000 units/kg B.W vitamin D_2 and 150-120g mineral mixture daily for 7 days.
Trial 3	54	124	178	Mineral licks (bricks) for free lick during February to July.
	48	68	116	Untreated
Trial 4	110	156	266	1-2 boluses 100g copper, selenium and cobalt soluble glass bolus.
	80	92	172	Untreated

YC, young camel; AFC, adult female camel.

Bone meal, disoduim phosphate and monosodium dihydrogen phosphate, Alashanyouqi Feedstuff Company Ltd.

Vitamin D_2, Shanghai Medicinal Company Ltd.

Mineral mixture (40% w/w salt, 20% w/w calcium, 12% w/w phosphorus, 2% w/w copper, 0.1% w/w selenium, 0.5% w/w cobalt, 0.5% w/w manganese, 0.2% w/w iodine, 1.5% w/w zinc, 1% w/w iron), Alashanyouqi Feedstuff Ltd.

Mineral lick (brick) (2kg, 5% w/w calcium, 3% w/w phosphorus, 1% w/w trace elements), Alashanyouqi Feedstuff Ltd.

Copper, selenium and cobalt soluble glass bolus (13.4% w/w copper, 0.3% w/w selenium and 0.5% w/w cobalt), Pilkington Controlled Release Systems Ltd., UK, Cosecure®.

every second day, and kept in an open pen during the night, without any concentrates being offered. The camels (trial 3) licked free-choice mineral blocks in a feeder constructed of durable wood and designed to minimize effects of rain after grazing during on February 15 to July 31. Each camel (trial 4) was dosed orally with a 100g soluble glass bolus containing copper, selenium and cobalt (manufactured by Pilkington Controlles Release Systems Ltd., UK) in young camels and two boluses in adult camels during November to December.

Clinical observation

Clinical signs were recorded by following the herd during the day and evening. Signs of lameness and stiffness in the gait and abnormal curvature in the forelegs were specifically noted, as well as pica, drinking and intake of herbage, defecation and urination.

Sample collection

Blood samples, 15mL were obtained from the jugular vein of 40 treated camels (10 each from trials 1-4, before and after treatment), using 1% sodium heparin as anticoagulant. Samples were stored at -20°C for analysis of trace elements. Serum samples for biochemical values were taken in tubes without anticoagulant and were refrigerated until they arrived at the laboratory in < 5 h. The serum was separated by centrifugation (1000g, 10 min) and stored frozen in plastic vials.

Analysis of mineral elements

Copper, iron, zinc, manganese, calcium were determined by atomic absorption spectrophotometry (AAS), selenium was assayed by hydride generation atomic absorption spectrophotometry; phosphorus was determined by spectrophotometry (Wang, 1991). The accuracy of the analytical values was checked by reference to certified values of elements in the National Bureau of Standards (NBS) Standard Reference Material, bovine liver SRM 1577a.

Biochemical examination

The serum contents of ceruloplasmin (Cp), alkaline phosphatase (AKP), calcium (Ca), inorganic phosphorus (IP) were determined on an automatic analyzer using commercial test kits (Nanjing Medicine University Biochemical Co.). Quality control serum (Shanghai Biochemical Co.) was used to validate the blood biochemistry data. Serum triiodothyronine (T_3), thyroxine (T_4) and parathyroid hormone (PTH) concentrations were determined by radioimmunoassay (RIA) using commercial test kits (Tianjing Medicine Biochemical Co.). All the serum biochemical values were measured at room temperature.

Result

Clinical observations

Treated cases in trial 1 and trial 2 recovered gradually in 5-15 days. Signs of lameness and stiffness in the gait in most animals were significantly improved by 3-7 days after treatment commenced. A general improvement in appetite and condition occurred quickly and was accompanied by a return to normal

blood values of phosphorus and alkaline phosphatase. Only lesser deformities in the forelegs recovered with suitable treatment and more severe deformities still persisted even following prolonged treatment.

The results of prevention of the disease in the field experiment are given in Table II and III. Mineral blocks (block salt licks) for free-choice lick performed well at preventing symptoms during February to July, although a few camels were lame and showed stiffness of gait and some fractures. Dosing with copper, selenium and cobalt soluble glass boluses were similarly effective. There was a great incidence of symptom in untreated controls (trial 3 and 4) and some had clear signs of rickets and osteomalacia during March to July.

Mineral analysis

The data are presented in Table IV as means ±SD, the differences between the mean values in the different experimental groups were assessed by Student's *t*-test. The concentrations of phosphorus in blood significantly increased in all treated groups ($p<0.01$ or $p<0.05$), but the concentrations of phosphorus were lower in trial 4 than those in trial 3 ($p<0.05$). The concentrations of copper and selenium in blood increased in treated groups with minerals and were significantly higher in trial 4 than those in trial 3 and in untreated controls ($p<0.01$). The values for other mineral elements were not significantly different from those before treatment or from the normal reference values ($p>0.05$).

Table 2. The result of prevention for the disease in trial 3.

Symptoms	YC (54)[a]		AFC (124)		Untreated YC (48)		Untreated AFC (68)	
	BT	AT	BT	AT	BT	AT	BT	AT
Pica	54	12	124	23	48	48	68	68
Emaciation	54	10	105	21	48	48	47	62
Lameness	2	0	5	0	3	10	3	16
Stiffness	5	0	23	0	5	12	4	21
Bowed and deformed legs	2	1	0	0	1	9	0	0
Knock-kneed condition	0	0	0	0	0	3	0	0
Weakness	0	0	0	0	0	3	0	9
Recumbency	0	0	0	0	0	2	0	6
Fracture	0	0	0	1	0	4	0	3
Death		0		0		3		3

YC, young camel; AFC, adult female camel; BT, before trial; AT, after trial.
[a]Number of camels.

Table 3. The result of prevention for the disease in trial 4.

Symptoms	YC (110)[a]		AFC (156)		Untreated YC (80)		Untreated AFC (92)	
	BT	AT	BT	AT	BT	AT	BT	AT
Pica	110	24	156	29	80	80	92	92
Emaciation	98	67	132	87	49	68	57	83
Lameness	6	2	12	3	3	21	5	20
Stiffness	4	2	27	5	5	30	6	38
Bowed and deformed legs	3	1	0	0	1	12	0	2
Knock-kneed condition	0	0	0	0	0	8	0	0
Weakness	0	0	0	0	0	8	0	11
Recumbency	0	0	0	0	0	6	0	8
Fracture	0	1	0	1	0	2	0	5
Death		0		1		3		5

YC, young camel; AFC, adult female camel; BT, before trial; AT, after trial.
[a]Number of camels.

Table 4. The concentrations of mineral elements in the whole blood (mean ± SD) of bactrian camels before and after treatment for the disease.

	n	Ca	P	Cu	Zn	Mn	Fe	Se
Trial 1								
Before treatment	10	117.4±34.6	243.6±63.7	0.78±0.21	14.9±2.3	0.45±0.12	423.7±87.6	0.21±0.11
After treatment	10	123.4±32.3	299.4±53.4[a]	0.80±0.17	15.1±1.8	0.51±0.14	435.4±56.9	0.29±0.17
Trial 2								
Before treatment	10	121.2±26.9	251.3±32.6	0.73±0.16	14.2±2.7	0.52±0.15	433.1±67.5	0.23±0.13
After treatment	10	124.7±31.0	294.3±47.8[a]	0.86±0.24	16.8±1.4	0.58±0.21	466.2±21.8	0.28±0.18
Trial 3								
Before treatment	10	123.6±23.5	237.9±33.7	0.76±0.14	14.8±1.2	0.46±0.11	421.6±23.9	0.22±0.11
After treatment	10	128.9±31.4	287.4±22.9[a]	0.88±0.15[b]	15.9±2.2	0.55±0.12	452.1±19.2	0.28±0.14
Untreated controls	10	119.8±26.8	236.5±21.8	0.80±0.18	14.6±2.4	0.48±0.14	433.9±33.2	0.24±0.10
Trial 4								
Before treatment	10	122.4±21.0	224.6±20.6	0.75±0.15	15.1±1.7	0.50±0.21	437.8±43.6	0.22±0.14
After treatment	10	128.6±21.7	291.7±26.8[a]	0.90±0.17[a]	16.4±2.1	0.48±0.13	447.2±33.1	0.32±0.13[a]
Untreated controls	10	124.3±11.3	231.7±30.7	0.78±0.12	14.4±1.5	0.47±0.17	440.1±27.9	0.25±0.15

[a]p<0.01, [b]P<0.05.

Biochemical examination

The biochemical values of bactrian camels before and after treatment are given in Table V. Serum inorganic phosphorus levels increased and alkaline phosphatase activities decreased and returned to normal levels in all treated groups after experiment, this did not occur in untreated animals, but the concentrations of inorganic phosphorus were lower in trial 4 than those in trial 3 (p<0.05). The concentrations of PTH in serum were significantly lower after treatment than those before treatment and untreated controls (p<0.01). The serum contents of ceruloplasmin were significantly higher in trial 4 than those in trial 3 and the untreated controls (p<0.01). There were no significant differences in other biochemical values between before and after treatment.

Discussion

To prevent phosphorus deficiency in grazing livestock, oral supplement of bone meal, phosphate and mineral mixtures is recommended (Blood *et al*,

Table 5. Biochemical values of bactrian camels in serum before and after treatment.

	n	PTH (ng/L)	T_3 (nmol/L)	T_4 (nmol/L)	Cp (mg/L)	AKP (IU/L)	Ca (mmol/L)	IP (mmol/L)
Trial 1								
Before treatment	10	152.3±22.4	2.44±0.12	74.3±12.8	40.1±15.4	137.3±24.6	2.12±0.22	1.58±0.22
After treatment	10	113.1±31.9[a]	2.12±0.18	68.5±21.3	44.2±13.1	45.2±12.1[a]	2.19±0.12	2.32±0.35[a]
Trial 2								
Before treatment	10	158.6±27.8	2.13±0.10	77.4±21.9	42.9±11.8	126.9±22.9	2.24±0.29	1.67±0.11
After treatment	10	109.4±14.7[a]	1.98±0.32	69.1±14.8	48.2±9.0	40.1±10.7[a]	2.20±0.43	2.20±0.21[a]
Trial 3								
Before treatment	10	151.3±33.9	2.21±0.27	70.6±19.8	44.6±21.3	104.5±33.6	2.11±0.51	1.78±0.14
After treatment	10	118.5±21.0[a]	1.88±0.19	63.5±25.6	52.9±18.6[b]	42.7±21.3[a]	2.27±0.19	2.13±0.10[a]
Untreated controls	10	159.4±30.4	2.26±0.14	77.9±22.9	41.2±13.3	106.9±27.6	2.13±0.14	
Trial 4								
Before treatment	10	147.3±20.1	2.43±0.38	70.1±20.3	43.7±12.8	112.5±24.9	2.08±0.32	1.72±0.20
After treatment	10	128.3±11.2[a]	1.99±0.21	66.3±23.0	62.7±17.9[a]	77.3±14.8[a]	2.27±0.38	1.95±0.17[b]
Untreated controls	10	152.7±26.0	2.24±0.15	78.2±18.7	40.8±9.9	124.6±21.1	2.14±0.17	1.65±0.22

[a]p<0.01, [b]P<0.05.

1989; Huang and Liu, 2001; McDowell, 1992; Wang, 2002). In situations where dietary supplementation is not possible, the use of single intra-muscular injections of vitamin D_2 in oil will protect ruminants for 3-6 months. A dose rate of 11000 units/kg body weight is recommended and should maintain an adequate vitamin D status for 3-6 months (Blood *et al*, 1989; Wang, 2002). When we gave vitamin D_2 to treat rickets and osteomalacia in bactrian camels under our circumstances, a general improvement in appetite and condition occurred quickly and was accompanied by a return to normal blood levels of phosphorus and alkaline phosphatase. The deformities in the forelegs recovered with suitable treatment within 5-15 days but gross deformities generally persisted.

Among the different methods of administration, feeding animals individually by mouth is too time-consuming for herdsmen and is therefore unsuitable for herds of bactrian camels. Moreover, many animals in a severely affected area may be affected at the same time so, it is very difficult to give mineral supplementation, because of adverse natural environment and poor transport facilities. Bactrian camels are grazed on the sandy desert steppe in Badanjiling and Tenggeli desert all day and night and the only effective way is to prevent rickets and osteomalacia by providing an easy supplementation.

Lower feed intake for grazing livestock with a phosphorus deficiency may relate to lameness (McDowell, 1992). Animals that must graze extensive areas to meet nutrient needs would be unable to walk the necessary distance if they were lame as a result of phosphorus deficiency. Because stiff-gaited movements hamper their ability to secure feed, animals can die from exhaustion. Direct administration of minerals to livestock in water, mineral licks, mixtures, drenches, rumen preparations, and injections is generally the most economical method in extensive husbandry. In the present study, free-choice mineral licks prevented symptoms between February and July, although a few bactrian camels still appeared lame and stiff and had some fractures. However, licks are expensive and unsuitable because of lack of transport.

Dosing with a copper, selenium and cobalt soluble glass bolus also had beneficial effect and could be used to provide those trace elements and to prevent or correct a deficient and/or marginal copper, selenium and cobalt status. The bolus matrix is phosphate, but the amount of phosphate absorbed per day is very small. Boluses not only prevent clinical signs of the disease, but also increase feed intake by improving appetite, vigour and condition. Thus it can be seen that the deficiency of P is generally not enough to cause the clinical signs described but only when Cu is also deficient, since an intra-ruminal Co-Se-Cu bullet is concluded to be an effective prophylactic agent despite the fact it releases an insignificant amount of P each day. The controlled release bolus route should provide each animal with a consistent dose in line with its requirements sustained over a long period of time, such that one treatment should ensure adequate trace element cover for a number of months. Telfer *et al* (1984) and Kendall *et al* (2001) reported that this type of bolus gave excellent results in field trails and has been previously shown to supply copper, cobalt and selenium in extensively grazed cattle and sheep for up to 345 days. Rickets in young camels and osteomalacia in mature female camels mainly occur in the sandy desert steppe, mortality being between February and June. We therefore recommend that bactrian camels are administered orally with a soluble glass bolus annually between November to December.

Rickets and osteomalacia in bactrian camels in these area caused poor performance resulting in heavy economic loss to the farmer. Under practical circumstance, clinical signs of the diseases may be effectively treated by supplying orally bone meal, mineral mixture and phosphate, or intra-muscular injection of vitamin D_2 (calciferol) in oil, and prevented by use of mineral blocks (block salt licks) for free-choice lick or dosing orally with copper, selenium and cobalt soluble glass boluses.

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Study of some aerobic bacterial causes of respiratory diseases in slaughtererd camels in Dakahlia Governorate

The total of 255 samples (85 each of lung, lymph nodes and tracheal swabs) from 85 slaughtered camels in an abattoir in Dakahlia, Egypt were subjected to bacteriological examinations. It was shown that 25 camels had respioratory diseases while the rest were apparently normal. The bacteriologilal examinations revealed that 118 (46.27%) of the examined samples were positive for bacterial isolates. 52 (28.88%) and 66 (88%) positive samples from apparently normal and diseased animals, respectively. 154 bacterial isolates could be detected and classified into 90 (58.44%) Gram positive and 64 (41.56%) Gram negative bacteria. The main bacterial isolates were 22 (18.64%) *Staphylococcus aureus*, *Corynebacterium pyogenes* (*Arcanobacterium progenes*) and *Escherichia coli*, 16 (13.55%), *Streptococcus pyogenes*, *Staphylococcus epidermidis* and *Klebsiella pneumoniae; 14 (11.86%), Streptococcus pneumoniae: 10 (8.47%), Pasteurella multocida: 8 (6.78%), Pseudomonas aeruginosa 6 (5.08%), Pasteurella haemolytica (Mannheimia haemolytica)* and *2 (1.69%) Proteus vulgaris.* The pathogenicity test for *Pasteurella multocida* isolated indicated that all isolates were pathogenic. Sensitivity test for the isolated bacteria revealed that most of isolates were highly sensitive to enrofloxacin, gentamicin and rimactan and resistant to streptomycin and ampicillin.

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