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Studies on the supply of immunoglobulin G to newborn camel calves (*Camelus dromedarius*)

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SUMMARY. A major problem in camel productivity is the high mortality rate of camel calves in the first 3 months. The causes for mortality are mainly poor management practice and infectious diseases. The purpose of this research, carried out on a ranch in Kenya, was to determine the immunoglobulin G (IgG) concentration in camel colostrum as well as the extent of the calves' passive immunization by maternal antibodies. IgG concentration in colostrum and in the serum of the calf were measured during the first 3 d of life. Evaluation was carried out by comparing the respective values with those for horses and cattle. The average IgG concentration in the camel colostrum was higher than that found in literature for horses and cattle. IgG concentration in the serum of the camel calves reached its maximum 24 h after birth. In 39 % of the examined calves, this maximum concentration was below 4 g/l, which is considered to be the critical value in horses and cattle. 61 % of the calves achieved an IgG concentration of over 4 g/l. Since there is no correlation between IgG level in colostrum and early mortality, the results indicate that low colostrum intake during the first 24 h of life and not low IgG concentration in colostrum is presumably one of the main causes of early calf mortality. Therefore, it was recommended that the care of the newborn calves by herdsmen should be improved.

KEYWORDS: Immunoglobulin G, camel, *Camelus dromedarius*, colostrum, passive immunization.

Camels are slow reproducers. A female camel is sexually mature at the age of 4–5 years. Pregnancy is just over 12 months and the calving interval in pastoral production systems is normally 24 months or more. Female camels can remain fertile up to the age of 25 years and it is often reported that they produce 8–10 calves during a lifetime. In pastoral production systems, however, only a small proportion of the breeding female can reach this production performance (Schwartz & Dioli, 1992; Farah, 1996). Beside this natural productivity limitation, the main factor affecting herd growth is calf mortality, which is high during the postnatal and pre-weaning stages. In a survey carried out in eastern Sudan, Agab & Abbas (1998) reported a 48 % mortality rate among calves under 6 months of age and 14·6 % after that time.

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Calf mortality between 30 and 50% has also been reported in Kenya (Mukasa-Mugerwa, 1981), Tunisia (Burgemeister, 1974) and Somalia (Hussein, 1987).

All these studies showed the main reasons for the high postnatal mortality to be poor management practice and diseases. The newborn calf has no natural protection against diseases, as there is no antibody transfer from the mother during fetal development. The calf can obtain immediate immunization soon after birth only through the colostrum, which has a very high concentration of antibodies. Therefore, it is vital for the calf to suckle as soon and as much as possible. Unfortunately there is a common belief among many pastoralists that colostrum causes diarrhoea and, consequently, is unsuitable for the newborn calf. This wide spread practice of withholding the colostrum from the newborn calves, depriving them of essential antibodies, is certainly a crucial factor in the frequently reported high calf mortality in pastoral production systems.

The present investigation was undertaken to examine the immunoglobulin G (IgG) concentration of camel colostrum as well as the extent of the calf's passive immunization by maternal antibodies. IgG concentration in colostrum and in the serum of the calf during the first 3 d of life were compared with the respective values in horses and cattle.

MATERIALS AND METHODS

Sample collection

The study was carried out in Ol Maisor Ranch in Kenya's Laikipia district. The camels (*Camelus dromedarius*) were fed all year around exclusively by grazing. The supply of water was *ad libitum* and, in addition to pasture, the camels were provided with a mineral lick containing P, Ca, NaCl and trace elements. On return from pasture at about 18.30, lactating camels are separated from their calves until 06.30 the following morning, when they are milked. The investigations were carried out during a 6-month period between October 1993 and April 1994. At the time of the survey, the camel herd amounted to 350 animals of three different breeds (Turkana, Somali and Pakistani) and their crossbreeds.

During the study, 39 camel births took place on the ranch, 31 of which were included in the investigation. In 26 cases colostrum samples were taken before first suckling of the calf. From 29 calves it was possible to take blood samples before the first suckling. The age of the dam was between 5 and 18 years at the time of delivery.

The following samples were taken:

- milk from the dam immediately after delivery and 6, 12, 24, 48 and 72 h later,
- blood from the dam at the time of delivery,
- blood from the newborn calf immediately after birth but before the first colostrum intake, and additionally after 24, 48 and 72 h.

The blood samples were taken from the jugular vein using a Becton-Dickinson Vacutainer, centrifuged within 1 h of sampling and the serum was immediately frozen at $-18\ ^\circ\text{C}$. The colostrum samples were taken as composite milk (four teats) and stored in sterile milk tubes at $-18\ ^\circ\text{C}$ until analysis.

Sample analysis

The IgG concentration was determined in the laboratory of the Clinic of Obstetrics, University of Zurich, by means of radial immune diffusion (RID), as described by Mancini *et al.* (1965) and the anti-camel IgG antibodies were produced according to Kamber (1996). Ten blood samples of camels were pooled and IgG was
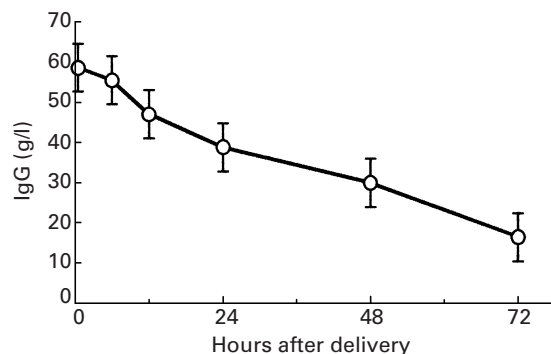
Fig. 1. Average immunoglobulin G (IgG) concentration in the colostrum of the camels during the first 72 h after giving birth.

isolated by FPLC using a protein A-sepharose column. The purity of IgG was determined by SDS–PAGE. Two rabbits were immunized three times along with complete and incomplete Freud's adjuvant. Blood was collected 4 weeks after the last injection. The content of anti-camel IgG was determined by an Ouchterlony test using 1 % agarose H and barbital buffer. The pre-immune serum gave negative results and one rabbit did not produce antibodies.

The data were collected using EpiInfo (WHO) and evaluated with Statview 2 (SAS Institute). For continuous variables the paired t-test was used and for nominal values the χ^2 test. The significance threshold was set at an α error value of 5 %, $P = 0.05$. The standard deviation is indicated in the corresponding text.

RESULTS

The IgG concentration in the colostrum of the 26 dams at the time of birth was 58.6 ± 15.4 g/l and 24 h post-partum, it decreased to 38.8 ± 17.9 g/l. This decrease in the IgG concentration of the colostrum within the first 24 h was significant ($P < 0.0001$). After 24 h the concentration continued to decrease markedly and was only 16.5 ± 11.5 g/l after 72 h. The changes in the IgG concentration in the colostrum of the dams during the first 72 h are shown in Fig. 1.

The IgG concentration in the serum of the dams at the time of birth was 17.6 ± 2.7 g/l, the value ranging between 13.3 and 22.3 g/l. There was no relationship between the IgG concentration in the serum of the dams and the IgG concentration in the colostrum.

From 29 of the 31 calves it was possible to take pre-colostral blood samples. The average IgG content of the pre-colostral calf serum was 0.2 ± 0.3 g/l. Twenty-four of the 29 calves examined had a pre-colostral serum IgG concentration below 0.2 g/l. The concentrations for the remaining five calves ranged between 0.5 and 1.3 g/l (Fig. 2).

The IgG concentration in the blood serum of calves increased significantly within the first 24 h and the mean increase was 7.8 g/l. After the first 24 h there was no further increase and the mean concentration then decreased slowly. The changes in the IgG concentration in the serum of the calves over 72 h are shown in Fig. 3.

As shown in Fig. 4, the distribution of the IgG concentration 24 h after the birth allows us to distinguish between two groups: group A with an IgG concentration above and group B with an IgG concentration below 4.0 g/l, which is considered to be the threshold value in horses and cattle (McGuire *et al*. 1977; Rumbaugh *et al*.
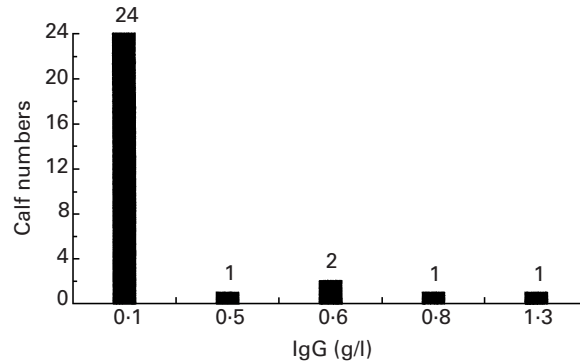
Fig. 2. Frequency of different immunoglobulin G (IgG) concentrations in the serum of camel calves before colostrum intake ($n = 29$).
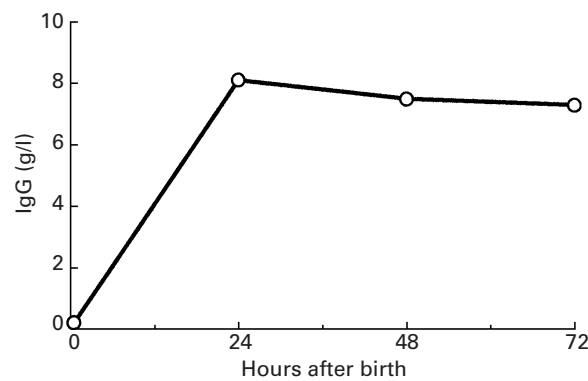
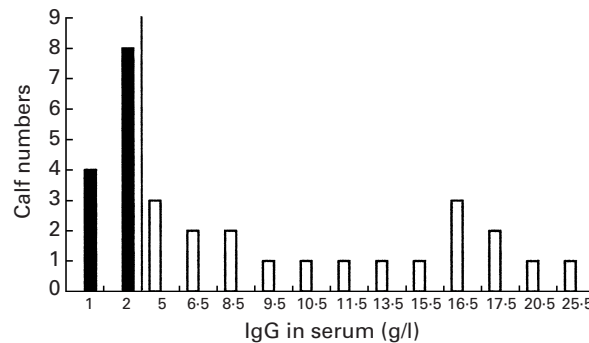Fig. 3. Immunoglobulin G (IgG) concentration in calf's serum during the first 72 h after birth.

Fig. 4. Frequency of different immunoglobulin G (IgG) concentrations in the individual calf's serum 24 h after birth ($n = 31$); ■ below 4·0 g/l, □ above 4·0 g/l.

1979; Dudan & Hirni, 1989; Bostedt & Thein, 1990; LeBlanc, 1990). For group A the value for the IgG concentration at 24 h after birth was $12·5 \pm 5·9$ g/l ($n = 19$), while for group B it was only $1·4 \pm 0·6$ g/l ($n = 12$).

The concentrations before the first intake of milk (time 0) were not significantly different for the two groups. In group A, the serum IgG concentration rose in the first 24 h from $0·2 \pm 0·2$ to $12·5 \pm 5·9$ g/l. In group B, this increase was significantly lower, from $0·2 \pm 0·4$ to $1·4 \pm 0·6$ g/l.
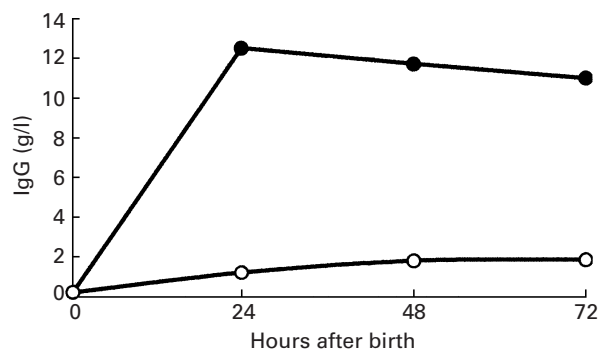
Fig. 5. Course of immunoglobulin G (IgG) concentration in the serum of two calf groups during the first 72 h after birth; ● above 4 g/l, ○ below 4 g/l.

In the subsequent variations, the concentration of IgG in the serum of group B remained well below the limit of 4 g/l and showed no further significant change. The IgG values for group A, on the other hand, although decreasing continuously after 24 h, still amounted to $11 \cdot 1 \pm 4 \cdot 1$ g/l 72 h after the birth (Fig. 5).

There was no significant difference between the birth weights of the two groups of calves and the weight was $38 \cdot 9 \pm 7 \cdot 3$ kg.

DISCUSSION

The main objective of the present investigation was to find out whether inadequate IgG concentration in the colostrum, or inadequate passive immunization of the calves, could be a reason for high calf mortality (Roy, 1990). According to some researchers, low IgG concentrations in the colostrum lead to a poorer passive immunization of calves (McGuire *et al.* 1977; Schmidt *et al.* 1982; Hancock, 1985; Morris *et al.* 1985).

The IgG concentrations in the camel colostrum were higher on average than the values found in the literature for other domestic animals. In colostrum from horses IgG concentration was 15–50 g/l and in cattle it was between 34 and 39 g/l, whereas in sheep it ranges between 17 and 20 g/l (Perryman & Crawford, 1979; Eder, 1987; Buschmann, 1990). This means that the concentration of IgG in camel colostrum is similar to, or even higher than, that of other domestic animals. In the present study the lowest IgG concentration measured in the camel colostrum was $20 \cdot 9$ g/l. A relationship between the IgG concentration in the camel colostrum and that in the serum of the calves could not be determined, due to the unknown amount of colostrum intake. It can, however, be assumed that the limiting factor in the passive immunization of camel calves is not the level of IgG concentration in colostrum but rather the quantity of colostrum received by the newborn calves. An elevated pre-colostral IgG titre may be evidence of prior intra-uterine infection. The pre-colostral titres had no influence on the subsequent development of the IgG concentrations in the calf sera. Also Schenker's (1987) finding that calves with elevated pre-colostral IgG titres show a lower birth weight could not be confirmed. If a 24 h limit value of 4 g/l is applied to the camel calves studied, the IgG concentrations in serum of 12 calves (39 %) with only $1 \cdot 4 \pm 0 \cdot 6$ g/l must be considered as insufficient. For 19 calves (61 %), on the other hand, adequate passive immunization occurred, as their average IgG concentration 24 h post-natum was $12 \cdot 5 \pm 5 \cdot 9$ g/l and ranged from $4 \cdot 7$ to $26 \cdot 0$ g/l.

The ranch on which the investigations took place had in recent years a calf

mortality rate of 20–30%. Of the 31 calves examined up to the age of 3 weeks, two (approximately 6%) died during the period of this investigation. In neither case was the cause of death an infectious disease (fracture/ileus). Thus, no link could be established between mortality and insufficient IgG supply. The same applies to perinatal health problems without a fatal outcome. The fact that an intervention study on the subject of supplying the calves with colostrum was taking place affected the herdsmen's attitude to this particular aspect. It must be assumed, therefore, that the calves were given much less attention before this study, thus receiving less colostrum. Through the continuous inspection visits to the herds, the calves' problems could be quickly recognized and remedied during the investigation, which otherwise was not necessarily the case.

The care of the calves by the herdsmen has been found to be one of the main problems. The husbandry conditions of the calves must be optimized. This can be achieved by bringing the females into a big enclosed area before calving. It is then not necessary to tie up the newborn calves. They will be able to develop initiative themselves in deciding when to suck, and would not be exclusively dependent on the caring behaviour of the mothers. If the calves are not able to suck by themselves within 12 h after birth, assistance from the herdsmen is needed. The absorption of IgG after this time decreases significantly, as shown in this study. Calves which after birth cannot stand up by themselves must be put on their feet at an early stage and led to the udder. If, despite all efforts, a calf has not yet suckled in the first 6 h after the birth, the dam must be milked and the calf given milk from a bottle. In addition, if possible, a reserve of frozen colostrum should be set up at the ranch in case a dam does not produce enough milk or does not allow the calf to suck.

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