Prognostic indicators of post partum viability of kids born to Escherichia coli-vaccinated or unvaccinated does

S J M Munyua, D I Karioki, D M Chibeu, J K Wabacha, A G Thaiya, J M Njenga, J M Gathuma and B Mitaru

ABSTRACT
This study was undertaken to determine some blood and other physiological parameters with potential for use as prognostic indicators of viability of newborn goat kids. Of the 143 kids born during the on-farm study, 97 were crosses of Galla × Small East African (SEA) and 46 were pure SEA. The SEA × Galla kids were 46 single males, with a mean body weight at birth of 2.77 ± 0.22 kg, 43 females with a mean body weight at birth of 2.36 ± 0.76 kg and 5 and 3 sets of female and male twins (mean body weight at birth of 1.8 ± 0.19 kg and 2.05 ± 0.07 kg for the female and male kids, respectively). The SEA kids comprised 36 single male and female kids (mean body weight at birth of 2.48 ± 0.04 kg and 10 sets of twins (both male and female) (mean body weight at birth of 1.50 ± 0.04 kg.). Pre-suckling sera obtained on-station from kids born of does vaccinated against Escherichia coli (n = 8) and unvaccinated does (n = 7) had a total protein content of <40.0 g/l and no detectable levels of IgG and A or E. coli antibodies. Sera obtained 12 hours post partum from kids that survived in both groups contained about 19–22 g of Ig g/l, 50–80 g total protein/l, blood glucose of >5 mmol/l and had an E. coli antibody titre of between 1/160 and 1/640. On the other hand, kids that died within 48 hours of birth (parturient deaths) and had been classified in categories 3 and 4 righting reaction had low (<40 g/l) total protein, low white blood cell count (4000/mℓ) and low blood glucose concentration (<4.9 mmol/l). It is concluded that kids with delayed righting reaction (>45 minutes), low rectal temperature (<36 °C), low birth weights (<1.5 kg for singles and <1.0 kg for twins), low white blood cells (<4000/ mℓ), low (<2 mmol/l) blood glucose levels, low total protein (<40.0 g/l), low (<1:160) E. coli antibody titre and IgG (≤350 mg/l) in sera obtained 12 hours after birth have a poor prognosis for survival.

Key words: Escherichia coli, goats, kid viability, prognostic indicators, vaccination.

INTRODUCTION
Haematological, biochemical and serological analysis of blood is a useful tool in the diagnosis of a variety of diseases and conditions in goats of all ages. Different reports on blood parameters, however, reveal wide variation in relation to these factors, which complicates the evaluation of clinical/haematological values for diagnostic purposes in different breeds of goats. In contrast to the findings of Perryman et al., who observed that foals are immunocompetent at birth, other workers have shown that calves, kids, lambs and piglets are immune incompetent. In addition, the latter group of workers linked this state of neonatal immune incompe- tence with increased susceptibility to disease. However, the actual relationship between the levels of serum immunoglobulin in newborn farm animals at 24–48 hours of age and subsequent morbidity and mortality is somewhat controversial, as observations in some beef herds have shown that levels of serum immunoglobulin in calves at 48 hours post partum were of no value in predicting the incidence or severity of acute, undifferentiated diarrhoea.

Although colostral antibodies have been reported to exert a protective effect on newborn kids against the establishment of colibacillosis, Newby et al. and Hauser observed that the high levels of corticosteroids produced by lambs and calves 8–10 days before parturition resulted in lymphocytopenia and a decrease in the phagocytic defence capability in the newborn, which suppress the cellular immune mechanisms, thereby decreasing perinatal resistance.

This study was conducted to determine some blood parameters of kids born to unvaccinated dams and those vaccinated against E. coli in the pre-weaning period and the use of these blood profiles and physiological parameters in conjunction with the weight at birth, righting reaction and rectal temperature as prognostic indicators of viability of newborn goat kids.

MATERIALS AND METHODS

On-farm study

Study areas
The study areas representative of sedentary and semi-sedentary production systems as shown previously during a field survey were purposefully selected. Machakos and Lower Thika districts were representative of sedentary production systems, while Narok and Kajiado districts were representative of semi-sedentary production systems. In each of the districts, 2 farms were selected on the basis of their accessibility and security throughout the year, farmers’ willingness and ability to participate, availability of personnel able to weigh the dams and kids and collect colostrum in sample bottles provided and record these and any other significant events. In addition the selected farms were within 100 km of the Nairobi University Veterinary School Clinic and had a herd of >50 goats with definable ownership. The latter criterion was essential because most producers in the semi-sedentary and pastoral production systems do not allow either counting, because they consider it a taboo, or sampling as the goats are owned by various members of the ‘family unit’.

Doe and kid performance and sample collection
The 8 recruited farms were visited once every 4 weeks for 12 months, to collect data on goat production (including flock structure, reproductive performance and wastage) and feed and water resources.
and their availability in different seasons. The kids were allowed to run with the dams and were weighed by a paid farm assistant at birth and at 2-week intervals until weaned at 4 months. Daily weight gains were calculated as for the on-station kids before purchase, were prophylactically treated with tetracyclines (Norbrook, UK) (10 mg/kg body weight i.m.) for 4 days before being transported to Kabete by road to reduce likelihood of the goats developing transit fever or any other stress-related opportunistic infections.

During the 2 weeks’ adaptation period at the station the does were tagged, weighed, sprayed with Steladone®-300EC (Clofenviphos, Kenya Swiss) and drenched with Rintal® based on manufacturers’ instructions (Fenbendazole, Bayer EA). This treatment regime was repeated monthly.

Throughout the study period the goats were housed in 2 well-ventilated and well-lit 2.4 × 3.1 m cubicles where they were provided with water and salt licks ad libitum. They were also provided with 2 bales of hay, 3 kg of a mixture of bran and maize germ (3:1) per cubicle every morning and allowed to graze outside from mid-morning to late afternoon.

**Immunisation**

By the end of the adaptation period, 15 does that had not lost >20% of their body weight were randomly divided into 2 groups of 8 and 7 does each. To enhance the concentration of *E. coli* antibodies, the 1st group (8 does) was vaccinated in the neck region with crude sonicated *E. coli* antigen (strain 0126 K71 (B16) – protein concentration 130 mg/μl25). Each doe received a total of 3 ml/1 ml of the crude antigen in 2 ml of complete Freud’s adjuvant (Sigma Chemicals, UK) in 3 divided doses. This vaccination regime was followed by a booster vaccination after 2, 13 and 20 weeks. The 2nd group of 7 does (controls) were injected with 1 ml saline solution in 2 ml of the same adjuvants at similar intervals.

**Sample and data collection**

EDTA blood and serum samples: 1 ml EDTA blood was used for routine haematology, while 3 ml of blood collected in plain venoject tubes (Becton Dickson vacutainer system, England) were used for harvesting serum used to measure total protein (TP), *E. coli* antibody titre (Ecoli ab) and immunoglobulin (IgA and IgG)26 from all kids, whenever it was possible and practical to do so without endangering a kid’s life. Kids were bled before suckling, at 6, 12, 24, 48 and 96 hours and subsequently at 2-week intervals.

Any kids showing signs of weakness or pale mucous membranes and accelerated heart rate (>120 heart beats per minute) after blood collection were not bled again until their condition had stabilised. Kids falling sick during the study period were monitored but not treated, to reproduce the situation in most goat-producing areas of Kenya, where producers believe it is ‘uneconomical’ to treat goat kids. The collected serum was preserved with 200–500 g sodium azide and stored at −20 °C till required.

**Rectal swabs and faecal samples**: two rectal swabs for bacteriology27 and viral isolation28 were obtained from all kids whenever any of them showed signs of diarrhoea. Stall floors were swabbed for bacterial isolation at the same time. All *E. coli* isolates were preserved in cooked meat media until they were typed and tested for pathogenicity (adherence and toxin production) using standard laboratory techniques (Wellcome Kenya and Hoechst Kenya *E. coli* typing manuals; KEMRI manual29). Faecal samples obtained from kids aged 2 months and over were processed for faecal egg count2. **Lung aspirates**: lung aspirates were collected aseptically from all fresh carcasses of kids presented and processed for bacterial isolation2.

**Righting reaction**: the righting reaction, defined as the ability of a kid to get to from lateral to sternal recumbency and attempt to stand and suckle, was divided into 4 categories. Kids were placed in category 1 if they attained sternal recumbency and attempted to stand and suckle within 30 minutes, categories 2 and 3 if the same happened within 45 and 60 minutes, respectively, and category 4 if it took more than 1 hour.

**Determination of body weight**: the weight of experimental does were recorded every 4 weeks for 9 months, while those of kids were recorded at birth and at monthly intervals thereafter. Daily weight gains were calculated by dividing final weight at weaning by the number of days.

**Collection of colostrum and milk samples**: each day for the first 5 days post partum visit 4–10 ml colostrum, and later milk, were collected in sterile universal bottles or plastic containers with 200–500 g sodium azide. In the present study, udder secretion produced in the first 4 days post partum was classified as colostrum while secretion thereafter was considered as milk.

**Data storage and statistical analysis**

Data files of flock information and clinical and laboratory results were prepared separately in DBase IV plus (Ashton-Tate Corporation, Torrance CA, USA). Separate files were prepared for each producer but were later merged into 1 district file. All statistical analyses were done using analysis of variance and descriptive statistics2.

**RESULTS**

**On-farm performance of kids from birth to weaning (120 days)**

Of the 143 kids born during the on-farm study, 97 were of Galla × Small East African (SEA) crosses and 46 of SEA. The SEA × Galla kids comprised 46 single males, 43 single females and 8 sets of twins, while the SEA kids comprised 36 single kids and 10 sets of twins. The mean weight at births of the Galla × SEA kids in the sedentary production systems were 2.77 ± 0.22 kg for single males, 2.36 ± 0.76 kg for single females, 1.8 ± 0.19 kg and 2.05 ± 0.07 kg for female and male twins, respectively. The SEA kids in the semi-sedentary production systems had a combined single male and female mean weight at birth of 2.48 ± 0.04 kg and 1.50 ± 0.04 kg for combined male and female twins (Table 1A). From birth to weaning at 120 days, single male kids grew at an average of 85.33 g/day, single female kids at 80.25 g/day, and female and male twins at 47 and 69 g/day, respectively, in the

**Outbreaks of disease and deaths** were recorded as they occurred. Kids and adult goats falling sick during the study period were examined individually and treated according to clinical and laboratory findings.

**On-station study**

Adaptation of the experimental goats

Thirty pregnant Small East African (SEA) × Galla cross does aged between 2 and 4 years and 1 buck were purchased in the Kajado district. The does, which were confirmed healthy and pregnant by a thorough clinical examination before purchase, were prophylactically treated with tetracyclines (Norbrook, UK) (10 mg/kg body weight i.m.) for 4 days before being transported to Kabete by road to reduce likelihood of the goats developing transit fever or any other stress-related opportunistic infections.

During the 2 weeks’ adaptation period at the station the does were tagged, weighed, sprayed with Steladone®-300EC (Clofenviphos, Kenya Swiss) and drenched with Rintal® based on manufacturers’ instructions (Fenbendazole, Bayer EA). This treatment regime was repeated monthly.

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SEA × Galla flocks in the sedentary production systems. In comparison the SEA kids in the semi-sedentary system grew at an average of 62.5 g/day for single kids and 42.5 g/day for twins (Table 1B).

**On-station performance of kids**

At birth, kids born to unvaccinated dams had an average body weight of 2.09 ± 0.16 (n = 7) while those born to vaccinated dams weighed 2.03 ± 0.29 (n = 8). Kids falling in categories 3 (n = 3) and 4 (n = 4) righting reaction, irrespective of whether the does were vaccinated or not, died within 48 hours of birth while those in category 1 (n = 7) and 2 (n = 2) survived. The kids falling in categories 3 and 4 were not all the smallest (Table 2). One of the does had twins.

**Total protein and IgA and IgG in colostrum, milk and sera obtained from does and kids (on-farm study)**

Colostrum, milk and serum obtained from does were found to have only traces of IgA, while IgG was detected in large quantities (>10 g/l) in the same samples (Tables 2, 3). The IgG concentrations attained in serum obtained from kids between 2 and 8 weeks of age were significantly higher (P < 0.05) than those found in sera obtained from dams post partum. However, IgG concentrations in kid serum samples obtained thereafter were not significantly different (P > 0.05) (Tables 2, 3). Individual and pooled sera from pregnant dams did not have detectable *E. coli* antibodies.

**IgA and IgG concentration and *E. coli* antibody titre in sera obtained from kids (on-station study)**

Sera obtained from both groups of kids before suckling did not contain detectable amounts of immunoglobulin A and G and *E. coli* antibodies. At 12 hours the sera from kids born to vaccinated dams had an average IgG concentration of 19.5 ± 3.0 g/l and *E. coli* antibody titre of between 1/160 and 1/640. In the first 3 days post partum serum IgG concentrations in vaccinated does ranged between 18 and 19 g/l, while those in colostrum ranged between 52 and 53 g/l. Serum IgG concentration in unvaccinated does ranged between 6 and 19 g/l, while those in colostrum ranged between 4 and 45 g/l. While within groups colostral and serum IgG concentrations were not

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### Table 1: Mean weights at birth of goat kids born in sedentary and semi-sedentary production systems.

<table>
<thead>
<tr>
<th>Breed and production system</th>
<th>Birth weight (kg) of single kids</th>
<th>Birth weight (kg) of twins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male kids</td>
<td>Female kids</td>
</tr>
<tr>
<td>Galla × SEA (sedentary)</td>
<td>2.77 ± 0.22</td>
<td>2.36 ± 0.76</td>
</tr>
<tr>
<td>SEA (semi-sedentary)</td>
<td>2.48 ± 0.04</td>
<td>1.50 ± 0.04</td>
</tr>
</tbody>
</table>

### Table 2: Mean (±SE) immunoglobulin concentration (g/l) in colostrum and sera obtained from experimental does within 3 days of parturition.

<table>
<thead>
<tr>
<th>Days post partum</th>
<th>Colostrum</th>
<th>Serum</th>
<th>Colostrum</th>
<th>Serum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vaccinated</td>
<td>Unvaccinated</td>
<td>Vaccinated</td>
<td>Unvaccinated</td>
</tr>
<tr>
<td>1</td>
<td>53.2 ± 8.3 (n = 6)</td>
<td>19.1 ± 4.6 (n = 6)</td>
<td>45.0 ± 16.7 (n = 7)</td>
<td>19.5 ± 3.0 (n = 6)</td>
</tr>
<tr>
<td>2</td>
<td>21.6 ± 5.8 (n = 5)</td>
<td>18.6 ± 4.7 (n = 4)</td>
<td>25.3 ± 4.4 (n = 3)</td>
<td>15.0 ± 6.8 (n = 3)</td>
</tr>
<tr>
<td>3</td>
<td>5.3 ± 1.5 (n = 5)</td>
<td>ND</td>
<td>8.5 (n = 1)</td>
<td>ND</td>
</tr>
</tbody>
</table>

ND = not done.

### Table 3: Mean (±SE) serum concentration of total protein (TP g/l), immunoglobulin concentration (IgG g/l) and *E. coli* antibody titre (*E. coli* Ab) of kids born during the on-farm study.

<table>
<thead>
<tr>
<th>Kids’ ages</th>
<th>TP (g/l)</th>
<th>IgG (g/l)</th>
<th><em>E. coli</em> Ab</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 weeks</td>
<td>60.03 ± 2.20</td>
<td>36.4 ± 4.4</td>
<td>2572 ± 624</td>
</tr>
<tr>
<td>4 weeks</td>
<td>58.70 ± 1.23</td>
<td>37.9 ± 3.5</td>
<td>0.0</td>
</tr>
<tr>
<td>8 weeks</td>
<td>68.30 ± 2.43</td>
<td>42.9 ± 2.8</td>
<td>&lt;160</td>
</tr>
<tr>
<td>12 weeks</td>
<td>90.40 ± 3.91</td>
<td>18.2 ± 2.9</td>
<td>&lt;160</td>
</tr>
<tr>
<td>16 weeks</td>
<td>63.60 ± 4.31</td>
<td>18.2 ± 1.8</td>
<td>&lt;160</td>
</tr>
</tbody>
</table>

significantly different \((P < 0.05)\), the IgG concentrations in serum and colostrum between groups were significantly different \((P < 0.05)\) (Table 2). The concentrations of IgG in colostrum fell sharply by the 3rd day post partum (Table 1). By contrast, only traces of IgA were detectable in serum, colostrum and milk obtained from both groups (vaccinated and unvaccinated does) throughout the study.

Changes in other blood parameters in kids (on-station study)

Sera obtained from kids born to both vaccinated and unvaccinated dams had a total protein concentration of 36–59.0 g/l, while haematocrit (Hct) varied between 0.29 and 0.41, haemoglobin (Hb) concentration between 10–13.0 mmol/l, and white cell counts (WBC) between 2500 and 10 000/m³. In kids that had categories 1 and 2 righting reaction, the WBC rose rapidly to between 5000 and 10 000/m³, but remained at <4000 in those that were in categories 3 and 4 and died within 48 hours (parturient deaths) (Table 4). Categories 1 and 2 kids weighed >2.4 kg at birth and had rectal temperatures >37 °C, while those in categories 3 and 4 weighed <1.5 kg for singles and <1.0 kg for twins at birth and had rectal temperatures of <36.5 °C (Table 4).

Higher WBC of between 9800 and 15 000/m³ were observed in kids that became infected. In each case, kids in both groups responded with leucocytosis characterised by neutrophilia if they contracted gastroenteritis, pneumonia and/or polyarthritis. Haematocrit and total protein in terminally ill kids were relatively high ('false high') due to haemoconcentration.

No blood parasites were seen on either thick or thin smears prepared from blood samples collected from the kids at the station throughout the experimental period.

Blood glucose concentrations (on-station)

One set of underweight twins that weighed 0.8 and 0.9 kg at birth and died soon after birth, had a blood glucose concentration of <2.0 mmol/l and a rectal temperature of <36 °C. By comparison, a
set of twins that survived weighed 2.2 and 1.6 kg at birth and had blood glucose concentrations of 4.4 and 5.3 mmol/l. This set of twins had a rectal temperature of 39.3 °C. Four single kids born at the same time weighed between 2.4 and 2.7 kg and had blood glucose levels of between 4.7 and 5.3 mmol/l and rectal temperatures of 39.5 °C.

Four to 6 hours after birth, the underweight twins still had low (<2.0 mmol/l) blood glucose concentrations and rectal temperatures (<35.5 °C), while the surviving twins and the single kids had blood glucose concentrations ranging between 4.4 and 8.4 mmol/l from birth to the 4th day.

On-station post mortem findings and lung bacterial isolates

The 17 kids born during the on-station study died between birth and 12 weeks. One was born weak and died within an hour of birth. The 7 that died within 7 days post partum died of a variety of conditions, including pneumonia, hepatitis, gastroenteritis and nephritis. The 8 kids that died later suffered from severe gastroenteritis and/or pneumonia. One kid died of E. coli polyarthritis (Table 4). No attempts were made to treat the kids on-station.

E. coli (47 %, 7 samples), Pasteurella spp. (13 %, 2 samples), S. zooepidemicus (13 %, 2 samples) and mixed cultures of S. aureus and Proteus spp. (27 %, 4 samples) were isolated from 15 lung specimens pre -

Table 5: Prevalence of diarrhoeagenic agents from kids with diarrhoea compared to their prevalence in kids without diarrhoea both on-farm and on-station.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Affected kids (n = 52)</th>
<th>Unaffected kids (n = 14)</th>
<th>Stall floor (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escherichia coli</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAEC</td>
<td>6 (11.5 %)</td>
<td>1 (7 %)</td>
<td>0</td>
</tr>
<tr>
<td>EPEC</td>
<td>15 (28.9 %)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ETEC</td>
<td>8 (15.4 %)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Conjugativitisa</td>
<td>11 (21.2 %)</td>
<td>6 (43 %)</td>
<td>1 (2e)</td>
</tr>
<tr>
<td>Conjugativitisb</td>
<td>15 (28.9 %)</td>
<td>1 (7 %)</td>
<td>0</td>
</tr>
<tr>
<td>Beyond scopeb</td>
<td>17 (33 %)</td>
<td>9 (64 %)</td>
<td>3</td>
</tr>
<tr>
<td>Helminthsis</td>
<td>10 (19 %)</td>
<td>1 (7 %)</td>
<td>ND</td>
</tr>
<tr>
<td>Coccidiosis</td>
<td>5 (10 %)</td>
<td>1 (7 %)</td>
<td>ND</td>
</tr>
<tr>
<td>Other bacteriab</td>
<td>10 (19 %)</td>
<td>2 (14 %)</td>
<td>ND</td>
</tr>
</tbody>
</table>

aE. coli isolates: EAEC = enteroadherent E. coli; EPEC = enteropathogenic E. coli; ETEC = enterotoxigenic E. coli; EHEC = enterohaemorrhagic E. coli.
bDoubtful.
cDevelopment of conjunctivitis in guinea-pigs at 24 h and 48 h after exposure to E. coli strains.
dBeyond scope of the test kits used.
eNot done.
fOther bacterial isolates included Streptococcus spp. and Bacillus spp.

helminthosis. In 2 kids with polyarthritis, widespread accumulation of pus in joints, hepatitis, cystitis and widespread petechial haemorrhages were the main features. In kids that died within the first 3 weeks of birth, nephritis and hepatitis were common findings on histopathological examination.

Prevalence of diarrhoeagenic agents (on-station and on-farm)

E. coli was the most frequently isolated bacterial pathogen (90 %) from rectal swabs obtained from pre-weaned kids with gastroenteritis characterised by diarrhoea. Other diarrhoeagenic agents commonly identified in pre-weaned kids on-farm included helminths and coccidia. During a similar period the local SEA goat kids gained weight twins still had low (<2.0 mmol/l) blood glucose concentrations and rectal temperatures (<35.5 °C), while the surviving twins and the single kids had blood glucose concentrations ranging between 4.4 and 8.4 mmol/l from birth to the 4th day.

On-farm post mortem findings and lung bacterial isolates

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On-farm post mortem findings and lung bacterial isolates

The commonest cause of death on-farm was gastroenteritis with septicaemia, pneumonia, hepatitis and colostrum (obtained up to 4 days post partum) than in concomitant serum. Antibody titres were significantly higher (P < 0.05) in colostrum collected from vaccinated does. The rapid fall, within 3 days of kidding, in colostral IgG and E. coli antibodies, observed in both groups of does in the present study reaffirmed the importance of feeding sufficient (in quantity and quality) colostrum as soon after parturition as practical18,22. Total protein, IgA and IgG levels in the same serum samples did not differ significantly between the 2 groups.

Transplacental transfer of immunoglobulins rarely occurs in domestic animals except for very rare occasions in the mare14,16,20. The post partum immunoglobulin rate of absorption has been shown to depend on the amount of colostrum fed and the time of feeding post partum, the ambient temperature and litter size22,23,24. Working with the doe, Rabbani et al.21 established that, as in other species14, immunoglobulins were absorbed in the offspring to produce similar concentrations in serum as those in the dam’s serum within 24 hours. A similar situation was observed in the experimental does and their offspring in the present study. In addition, poor mothering ability, which may cause the kid not to suckle, or malnutrition, which may affect the quality and quantity of colostrum available, may greatly affect the availability and/or uptake of immunoglobulin.

Pre-suckling serum obtained from kids born to both vaccinated and unvaccinated does did not have detectable levels of E. coli antibodies, 1gA or 1gG. At 12 hours post partum, however, the kids from both groups had detectable levels of E. coli antibodies, although the kids born to vaccinated dams had levels that were twice as high as those born to unvaccinated dams. The levels of 1gG in serum collected after suckling were, however, similar in the 2 groups of kids. By contrast, only traces of 1gA were detectable in sera obtained from both groups of kids up to 96 hours post partum. Similar findings have been observed in the calf, kid and lamb, where there is little IgA and its role is taken over by colostral and milk IgG derived from serum and antigen stimulus probably in the intestines14,22,23.

The age at which the foetus becomes immunocompetent varies between species, although most of them are capable of responding to antigens by the end of the 1st trimester3. In addition, Perrymam et al.23 concluded that cellular defence mechanisms are more critical in the foal, which is immunocompetent at birth, but has little or no immunoglobulin G (IgG). In the present study, kids were

observed to be capable of responding to natural challenges with a marked leukocytosis within 12 hours of birth. It is thus postulated that, as in the foal, the cellular defence mechanisms in kids play a key role in the prevention of early postnatal infections.

Hauser et al. observed that high levels of corticosteroids, produced by lambs and calves 8–10 days before parturition, resulted in lymphopenia and a decrease in the phagocytic defence capability in the newborn that may affect the cellular immune mechanisms, thus decreasing perinatal resistance. This phenomenon may partly account for the short-lived low WBC (<4000/μl) level recorded in kids at birth. This situation may be aggravated by poor dam nutrition and mothering ability, which may lead to poor intake and weakening of the kid.

E. coli was the most frequently (90%) isolated bacterial pathogen from rectal and lung swabs obtained from pre-weaned kids with gastroenteritis and pneumonia. It is probable that this and other bacterial isolates were secondary to, including starvation. The presence of diarrhoeagenic agents, including helminths and coccidia, suggests that there may be a need to drench for helminths and treat pre-weaned kids for coccidiosis before they are released to pasture.

Blood glucose concentrations of the underweight kids that died within 48 hours of birth (parturient deaths) did not exceed 4.9 mmol/l peak. This level was equivalent to the lowest recorded for surviving single kids 12 hours (0.5 days) post partum. The blood glucose concentrations at 2–4 days post partum were within the range we recorded (7.2–11.4 mmol/l) for pre-weaned kids aged between 4 and 8 weeks. The hypothermia associated weak and under-weight kids may have been associated with the kid having exhausted its glucose reserves or an imbalance of energy needs and availability.

From the present study it was concluded that the righting reaction of <45 minutes, rectal temperature of >36.5 °C, weights at birth of >1.9 kg for single kids and >1.0 kg for twins, WBC of >5,000/μl, blood glucose concentrations of >4.5 mmol/l, total protein of >45 g/l, E. coli antibody titres of >1:160 and immunoglobulin G concentrations of >2.45 g/l at least 12 hours after birth were good prognostic indicators of kid survival. The local goat producers can monitor the righting reaction, rectal temperature and birth weights soon after birth, while practitioners in the field may count WBC and measure blood glucose concentrations using dip sticks, estimate total protein using a refractometer and measure serum immunoglobulins using silver nitrate

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