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Invited Review Article

A brief review on the global prevalence and etiopathology of Bovine Calf Diarrhoea

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Neonatal calf diarrhoea is a well-known worldwide disease in the cattle industry which causes substantial economic losses due to high morbidity, mortality, growth retardation and treatment costs. It is a common clinical presentation, often has a multifactorial etiology, and the most frequent reason for the submission of samples to the 'Veterinary Laboratory' (Otter and Cranwell, 2007). In addition to the influence of varied environmental, nutritional, physiological and management factors, the infectious agents capable of causing diarrhoea in the neonatal calf are numerous. Difficulties in the clinical diagnosis of infectious diarrhoea arise from frequent non-specific clinical signs and lesions, the presence of asymptomatic infections, the involvement of multiple agents, and the interplay of intrinsic and extrinsic factors that predispose the host to infection (Athanassious *et al*., 1994) The prevalence and etiopathology of diarrhoea varies according to geographic location, nutritional and managemental factors, besides prevalence of endemic infections.

Prevalnce and Common Aetiology

Bulgin *et al.* (1982) found Infectious disease agents in 96 per cent of the 226, 1-to-60-day-old calves suffering from diarrhoea. *Salmonella* spp. was the most frequently isolated agent from dairy calves, whereas coronavirus was the agent most commonly associated with diarrhoea in beef calves. Multiple agents were found in 20 per cent of the dairy calves and in 12 per cent of the beef calves.

Sanford and Josephson (1982) identified cryptosporidia organisms in 42 of 161 (26%) neonatal, diarrheic calves, over a 32 months period. Forty of the 161 calves were submitted alive and cryptosporidiosis was diagnosed in 63% (25 of 40) of them.

Ernst *et al.*(1984) determined the prevalence and abundance of coccidial oocysts in a herd of beef cows and calves on fescue pastures in Georgia during 4-consecutive grazing seasons. They found twelve species of eimeria in the feces of the calves and 10 species in the feces of the cows. *Eimeria bovis* was the most prevalent species found in both the calves and cows. It occurred in 72.5 per cent of 1090 samples from the calves and 10.2 per cent of 719 samples from cows.

Torres-Medina *et al.*(1985) reported that the most common viruses causing calf hood diarrhoea throughout the world are rotaviruses and coronaviruses. Rotaviruses can produce high-morbidity outbreaks of diarrhoea in calves less than 10 days of age. Coronavirus infections can produce high-morbidity outbreaks of diarrhoea in calves less than 20 days of age, with variable mortality due to secondary complications.

Krogh and Henriksen (1985) recorded 203 cases of bovine cryptosporidiosis, over a period of two years, in three days to five weeks old calves. In 111 cases (55%) a monoinfection with cryptosporidia occurred, while in the rest of the cases mixed infections with other agents associated with calf diarrhoea were demonstrated, especially rotavirus (61) and coronavirus (32); in addition, mixed infections with ETEC (4), septicaemic *E. coli* (2), salmonellosis (11), and BVD and coccidiosis (one case each) were observed.

Reynolds *et al*. (1986) examined faecal samples from calves with diarrhoea in 45 outbreaks for six enteropathogens. Rotavirus and coronavirus were detected by ELISA in 208 (42%) and 69 (14%) of 490 calves respectively. Cryptosporidium were detected in 106 of 465 (23%), *Salmonella* spp. in 58 of 490 (12%) and enterotoxigenic *E. coli* bearing the K99 adhesin (K99+ *E coli*) in nine of 310 calves (3%). In the faeces of 20 per cent of calves with diarrhoea more than one enteropathogen was detected; in 31 per cent, no enteropathogen was found. Faeces samples from 385 healthy calves in the same outbreaks were also examined. There was a significant statistical association of disease with the presence of rotavirus, coronavirus, cryptosporidium and *Salmonella* spp.

Snodgrass *et al.* (1986) collected faeces samples from 302 untreated calves on the day of onset of diarrhoea and from 49 healthy calves at 32 farms experiencing

outbreaks of diarrhoea. They sampled at least four diarrhoeic calves from each farm, and samples were examined for rotavirus, coronavirus, cryptosporidium, enterotoxigenic *E. coli* and *Salmonella* spp. Although all these enteropathogens were excreted more frequently by the diarrhoeic than by the healthy calves, the difference was significant overall only for rotavirus. Rotavirus was excreted by 18 per cent of the healthy calves, coronavirus by 4 per cent, cryptosporidium by 14 per cent, and no enterotoxigenic *E coli* or *Salmonella* spp. were detected. The most common enteropathogen in diarrhoeic calves was rotavirus, which was excreted by more than half the diarrhoeic calves. Coronavirus was excreted in high number on one farm, cryptosporidium on five farms and enterotoxigenic *E coli* on three farms. Concurrent infection with two or more microorganisms occurred in 15 per cent of diarrhoeic calves.

Waltner-Toews *et al.* (1986) screened faecal samples from calves on 78 randomly selected Holstein dairy farms in southwestern Ontario for *Salmonella*, *Campylobacter jejuni*/*coli*, enteropathogenic *E. coli*, rotavirus and coronavirus and observed 22 per cent of farms had calves infected with *Salmonella*, 13 per cent with *Campylobacter jejuni/coli*, 41 per cent with enteropathogenic *E. coli*, 19 per cent with rotavirus and 5 per cent with coronavirus.

Matfion *et al.* (1990) investigated rotavirus, *Cryptosporidium* spp, and *Salmonella* spp. in the faeces of 452 diarrhoeic calves from 36 beef and 33 dairy herds. They surveyed animals from a few days of age up to 1 month of life. Enterotoxigenic (ETEC) was evaluated in 212 calves, aged 15 days or less. A minimum of 4 calves were sampled on each farm. In beef calves rotavirus was excreted by 45.1 per cent of the animals, Cryptosporidium by 30.5 per cent and *Sàlmonella serovars Arechabaleta*, *Livingstone, Panama* and *Typhimurium* by 1.9 per cent. In dairy calves Cryptosporidium was excreted by 29.6 per cent, rotavirus by 23 per cent and *Salmonella serovar Dublin* by 1.6 per cent, ETEC was not detected in any calf. Rotavirus was the most widespread agent, detected in 32 (88.9%) beef herds and excreted by more than 50 per cent of the calves in half of these herds. In contrast, rotavirus was only detected in 19 (57.5%) dairy herds and was excreted by more than 50 per cent of the calves in 6 of these herds. Crytosporidium oocysts were identified in 27 (75%) beef and in 23 (69.7%) dairy calves. Salmonellosis due to serovar *dublin* was associated with diarrhoea in 2 dairy herds. Concurrent infection with two or three agents occurred in 36 (8%) calves and 38 (55.1%) farms; the combination rotavirus-cryptosporidium was found in 32 (6.9%) calves and in 33 (47.8) farms.

Khan and Khan (1991) examined 300 buffalo calves on monthly basis for a period of one year to study prevalence of major bacterial and viral causes of diarrhoea in buffalo calves up to 6 months of age in Lahore. Overall prevalence of *Salmonella* and *E. coli* infections was 16.3 and 15.3 per cent respectively. Rotavirus and coronavirus was found to be 2.6 and 2 per cent respectively.

Abraham *et al.* (1992) collected faeces samples from diarrhoeic dairy calves in the first 8 weeks of life and examined for the presence of 5 enteropathogens. The majority of the 108 diarrhoea cases occurred in the first 5 weeks of life and a commercial ELISA kit detected bovine enteric coronavirus (BEC) in 38.9 per cent, serogroup A rotavirus (RV) in 16.7 per cent and K99 (F5) fimbrialadhesin-positive *E. coli* (K99 ETEC) in 11.1 per cent. Concurrent infections of these enteropathogens were detected in 14.8 per cent of samples (30.8% of samples positive for these agents). They found no evidence of cryptosporidial infection using a differential staining method on faecal smears nor were salmonella excretion detected. On 2 of the 8 farms only BEC was present; the other 6 farms were positive for all 3 agents.

Athanassious *et al.*(1994) employed direct electron microscopy, enzyme-linked immunosorbent assay, and protein A-gold immunoelectron microscopy for the identification of bovine coronavirus and type A rotavirus. Two hundred and forty-nine samples from diarrhoeic calves and winter dysenteric cattle from seven geographic areas in Quebec were examined for the presence of viruses by direct electron microscopy of negatively stained preparations. In addition, all the samples were analyzed by enzyme-linked immunosorbent assay and a random selection of 47 samples were also analyzed by protein A-gold immunoelectron microscopy. They found 39 per cent of samples examined by direct electron microscopy contained viral particles; bovine coronavirus and type A rotavirus. Overall agreement between any two of the methods used compared favourably with results obtained by others using similar methods. The presence of coronavirus and rotavirus in faecal samples obtained from neonatal calves and the presence of coronavirus in samples from winter dysenteric adult cattle suggested their etiological roles in the respective diseases.

Busato *et al*. (1998) performed a matched case

control study to describe the epidemiological features of potential enteric pathogens for calves reared in 53 cow-calf herds located in western Switzerland. They collected faecal samples from 106 diarrhoeic calves and 126 healthy control calves less than 4 months of age. They were analysed for the presence of infectious agents related to calf diarrhoea including enterotoxigenic *E. coli*, verotoxin producing *E. coli* (VTEC), *Campylobacter* sp., *Yersinia* sp., *Salmonella* sp., rotavirus, coronavirus, helminths and coccidian protozoa. They found significant associations between diarrhoea and infection with rotavirus, *Campylobacter coli* and the presence of verotoxin in faecal samples.

Perez *et al.* (1998) performed a case-control study on calves under 3 months of age with and without diarrhea by weekly visits to 15 farms in Costa Rica. Faecal samples were collected over a 6-month period from 194 calves with clinical signs and from 186 control calves. Coronavirus and rotavirus were less frequently encountered in either one of the groups (in 9 and 7 % of scouring calves and in 1 and 2 % of controls, respectively). *Escherichia coli* were detected in 94 per cent of all the faecal samples, but isolates from only three samples from calves with diarrhea contained the K99 antigen. Similarly, *Salmonella* was found only in scouring calves. *Cryptosporidium* oocysts were detected in animals with signs of diarrhea.

Ruest *et al*. (1998) determined the prevalence of *Giardia* spp. and *Cryptosporidium* spp. infections in dairy in calves sampled from 505 dairy farms. They reported 45.7 per cent of the farms positive for *Giardia* spp. and 88.7 per cent infected with *Cryptosporidium* spp.

de La Fuente and Luzón (1999) screened faeces samples from 218, 1 to 30-day-old, diarrheic dairy calves in 65 dairy herds for the presence of Cryptosporidium and concurrent infections with rotavirus, coronavirus, F5 *E. coli* and *Salmonella* spp. They grouped calves according to their age as: 1-7, 8-14, 15-21 and 22-30 days. Cryptosporidium was the only enteropathogen detected in 60 of the 114 (52.6%) diarrheic calves. Concurrent infections with other enteropathogen (s) were detected in 64.3, 46.3, 39.5 and 0 per cent of the cryptosporidium-infected calves in the age groups 1-7, 8-14, 15-21 and 22-30 days, respectively. A significant age-associated decrease in the detection rate of mixed infections ($p < 0.05$) was found. The detection rates of the other enteropathogens considered in calves with cryptosporidium infection were 87 per cent for rotavirus, 11.1 per cent for coronavirus, 27.8 per cent for F5+ E. coli and 1.8 per cent for *Salmonella*.

Naciri *et al.*(1999) carried out a study to find the importance of *Cryptosporidium parvum* in diarrheal of neonatal calves in suckling and dairy calves in France. They systematically researched in faeces for the presence of different agents causing neonatal diarrhoea and found only 6.1 per cent were infected by *E. coli* K99, 14.3 per cent by rotavirus, 6.8 per cent by coronavirus, 0.3 per cent by *Salmonella* but 50 per cent excreted *C. parvum* oocysts.

García *et al.* (2000) screened faeces samples from 218, one to 30 days old, diarrheic dairy calves in 65 dairy herds for the presence of rotavirus and concurrent infections. Calves were grouped according to their age as follows: 1-7, 8-14, 15-21 and 22-30 days. Rotavirus infection was detected in 46.9, 45.6, 33.8 and 48.3 per cent of the calves in the respective age-groups. No significant differences in the detection rate of rotavirus were found among calves on the different age-groups. Rotavirus was the only enteropathogen detected in 39 of the 93 (41.9%) diarrheic calves positive to this agent. Concurrent infections with other enteropathogen (s) were detected in 31.3, 33.3, 20.6 and 3.4 per cent of the rotavirus infected calves in the age-groups 1-7, 8-14, 15-21 and 22-30 days, respectively. A significant age-associated decrease in the detection rate of mixed infections ($p < 0.01$) was found. The detection rates of the other enteropathogens considered in calves with rotavirus infection were 20.4 per cent for coronavirus, 85.2 per cent for cryptosporidium, 16.7 per cent for F5+ *E. coli* and 1.8 per cent for *Salmonella*.

Cryptosporidiosis was reported to be the major cause of calfhood diarrhoea worldwide and in humans it accounted for up to 20 per cent of all cases of childhood diarrhoea in developing countries and is a potentially fatal complication of AIDS (Pérez, 2010). Cryptosporidia were ubiquitous and disease has been described in over 79 host species.

de Sousa *et al.*(2000) made a survey of data related to 304 diarrhoeic calves, from birth to 12 months of age from 1980 to 1991. Epidemiological and clinical aspects were investigated, including distribution by month, age, sex, probable aetiology and association with other diseases, dehydration status, temperature and cardiac and respiratory rates. Their results showed that calf diarrhoea is a relatively common problem

(28.04%), especially early in life, usually caused by viral and/or bacterial (54.93 %) and helminthic (28.95 %) infections, without seasonal pattern or sex predilection, and frequently concomitant with other diseases (43.75%), like pneumonia and anaplasmosis, resulting in varied dehydration degrees and tachycardia.

Miraglia *et al.*(2001) observed that neonatal enteric diseases cause economic losses due to the mortality of calves and also due to the costs of the treatment and the impaired development of the calves. The main aetiological agents of diarrhoea in the first month of life were *E.coli*, rotavirus, and coronavirus.

Ambrosim *et al.* (2002) examined fecal samples collected from 266 calves of dairy breeds to study the frequency of various enteropathogens. They isolated 127 *E. coli* strains, 60 of them enterotoxigenic, as well as 23 *Enterobacter cloacae* strains, 18 *Klebsiella pneumoniae* strains, 15 *Citrobacter freundii* strains, 7 Salmonella strains of different serotypes, and one *Pseudomonas aeruginosa* strain. Thirty-six preparations positive for *Cryptosporidium* spp. were also identified, among which four were classified as *Cryptosporidium parvum*.

Castro-Hermida *et al.* (2002) carried out an epidemiological study on farms in Galicia (NW Spain) to investigate the prevalence of and the risk factors associated with the spread of infection by *Cryptosporidium parvum* in calves of less than 3 weeks of age. Of the 844 calves, studied microscopically, 404 (47.9%) were found to have the parasite in their faeces.

Björkman *et al.* (2003) investigated the presence and significance of *Cryptosporidium parvum* and *Giardia intestinalis* in Swedish dairy calves in comparison with rotavirus, coronavirus and *Escherichia coli* K99+. Faecal samples were collected from each heifer calf that had diarrhoea between birth and 90 days of age, and also from a healthy calf of the same age. In total, 270 samples were collected and analysed. *C. parvum,* alone or together with *G. intestinalis* and/or rotavirus, was detected in 16 (11%) and 6 (5%) of the samples from diarrhoeic and healthy calves, respectively. *G. intestinalis* was found in 42 (29%) of the diarrhoea samples and in 29 (23%) of the samples from healthy calves. Rotavirus and coronavirus were demonstrated in 24 and 3 per cent of the diarrhoea samples, respectively, whereas *E. coli* K99+ was only found in samples from 2 healthy calves. *C. parvum* and *G. intestinalis* were found in samples from calves 7 to 84 days of age and during all seasons.

Achá *et al.*(2004) investigated the prevalence of diarrhoea in calves in 8 dairy farms in Mozambique at 4 occasions during 2 consecutive years. A total of 1241 calves up to 6 months of age were reared in the farms, and 63 (5%) of them had signs of diarrhoea.

Trotz-Williams *et al. (2005)* detected *Cryptosporidium parvum* infection in 203 (40.6%) of 500 Ontario dairy calves aged 7 to 21 d, from 51 farms with a history of calf diarrhoea. Within farm prevalence ranged from 0 to 70 per cent, and both shedding and intensity of shedding were significantly associated with diarrhoea.

Watanabe *et al*. (2005) conducted faecal survey of cryptosporidium infection in cattle and goats in Taiwan and found prevalence of 37.6 (173/460) and 35.8 per cent (44/123), respectively.

Singh *et al.* (2006) studied the prevalence of *Cryptosporidium* spp. in dairy farms in Punjab, India. The cryptosporidium oocysts were detected from 50 and 25.68 per cent from 80 diarrheic and 74 non-diarrheic animals, respectively. The *Cryptosporidium* spp. appears to be common in dairy calves and an important contributor of calf diarrhoea in the Punjab province. The prevalence of the infection peaked in young calves between 0 and 30 days in both the diarrhoeic and non-diarrhoeic groups (86.4 and 66.6 %, respectively).

Klockiewicz *et al.* (2007) performed field survey to study the epidemiology of calf coccidiosis in Poland. The faecal samples were examined with the McMaster's method. Various species were identified morphologically with the light microscope. It was found that the *Eimeria* spp. occurred in 93.0 per cent of the investigated farms. But the highly pathogenic species (*E. bovis* and *E. zuernii*) were found in 88.4 per cent of the investigated farms.

Del Coco *et al.* (2008) evaluated the prevalence of *Cryptosporidium* spp. among dairy calves ≤ 30 days old, with and without diarrhoea, in a rural area of Argentina. A total of 280 calves were studied. The overall prevalence of cryptosporidial infection was 17 per cent. The analysis of the macroscopic characteristics of the faeces of all the studied calves showed that 57.1 per cent were diarrhoeic. The 100 per cent of the infected calves were ≤14 days old.

El-Khodery and Osman (2008) described the prevalence and risk factors associated with cryptosporidiosis in buffalo calves in Egypt. During one year, 458 faecal samples were collected from buffalo calves less than 3 month age in 55 small scale herds and

examined for the presence of cryptosporidium oocysts. They gathered data describing age, gender, season, and herd management practices to assess potential risk factors. Faecal examination showed that 14.19 per cent of the examined calves were positive for *Cryptosporidium* spp. Calves at 1-15 days were at the highest risk ($P < 0.001$), and a significant relationship between season and infection ($P < 0.05$) was recorded.

El-Naker *et al.* (2008) examined 1200 neonatal calves in three different farms in various localities in Egypt and revealed that 200 calves suffered from variable degrees of diarrhoea and dehydration. Rota viruses were isolated from 38 samples, Corona viruses from 25 samples, the mixed infection between Rota and Corona viruses was observed in 10 samples. They isolated *E-coli* spp. from 45 samples and *Salmonella* spp. from 10 samples and one sample had mixed infection. *Clostridium perfringens* spp. was isolated from 10.5 per cent of the samples. Sixty (60) out of 200 samples were infected with *Cryptosporidium parvum* oocysts.

Manya *et al.* (2008) screened 562 faecal samples and 18 intestinal scrapings during monsoon and post monsoon months followed by summer and winter seasons in cattle and buffaloes. Prevalence of bovine coccidiosis among cattle was found to be (20.76%) and buffaloes (25%). Clinical coccidiosis was more pronounced in calves aged between 3–6 months.

Nasir *et al*. (2009) studied the prevalence of *Cryptosporidium parvum* in Lahore, Pakistan and its association with diarrhoea in dairy calves. For this purpose they analyzed 500 faecal Samples (n=250 cow calves, n=250 buffalo calves) from different dairy farms and home-bred dairy calves. Overall, 25.6 per cent calves were shedding *C. parvum* with prevalence 27.2 and 24 per cent in cow and buffalo calves, respectively.

Pandit (2009) screened 971 cattle calves under two different managemental practices for different eimerian oocysts and observed that 711 were found to be positive for Eimeria parasites. Nearly 70.7 and 75.8 per cent of calves from organized and un-organized managements were found to harbour Eimeria infection, respectively (Pandit 2009).

Moussa *et al.*(2010) isolated *Salmonella* species using bacteriological examination from faecal samples of 85 diarrheic calves and 65 apparently healthy contact calves. *Salmonella* were isolated from 43.53 per cent of diarrheic calves and 27.69 per cent of apparently healthy contact calves. *Salmonella typhimurium* were isolated from diarrheic and contact calves in percentages of 17.65 and 15.38 respectively; whereas *Salmonella entertidis* were isolated in percentages of 11.76 and 7.69, respectively. *Salmonella dublin* were isolated from the diarrheic calves in a percentage of 8.24 and in contact calves in a percentage of 4.62, but *Salmonella anatum* were isolated from diarrheic calves only in a percentage of 5.88.

Majeed *et al.* (2011) attended an outbreak of neonatal calf diarrhoea that occurred in Friesian calves on 8 dairy farms at Sulaibiya area, Kuwait. Faecal and blood samples were collected randomly from diarrheic calves aged 1-3 weeks. They detected cryptosporidium oocysts in 38.8 per cent (31/80) of the faecal samples, rotavirus in 28.8 per cent (19/66) and BVD virus antibodies 62 per cent (49/79) in serum samples, coronavirus was not detected in 66 faecal samples tested. Cryptosporidium was detected on the 8 farms tested and found concurrently with rotavirus on 6 farms.

Rehman *et al*(2011) examined 584 fecal samples for eimeria and found that 275 (47.09%) were infected with six species of eimeria. Among the identified species of eimeria, *Eimeria bovis* was found to be the highest prevalent species (52.36%), followed in order by *Eimeria zuernii*, *Eimeria canadensis*, *Eimeria ellipsoidalis*, *Eimeria alabamensis*, and *Eimeria cylindrica* with prevalence of 48.27, 34.83, 29.31, 24.14, and 8.62 per cent respectively. Calves had significantly higher prevalence ($P<0.05$) of eimeria than adults.

Koutny *et al.* (2012) examined faecal samples from calves (868) from 296 farms all over Austria and observed 97.97 per cent of the investigated farms excreted eimeria oocysts, and 83.67 per cent of the individual samples were positive(Koutny *et al*., 2012) .

Izzo *et al.* (2012) determined the prevalence of various enteropathogens in bovine calves with diarrhoea in 597 faecal samples in Australia. Rotavirus was the most common pathogen identified (477/597, 79.9%) followed by *C. parvum* (349/597, 58.5%). Other pathogens identified were Enterotoxigenic *E. coli* K99 (104/597, 17.4%), *Salmonella* spp. (142/597, 23.8%) and coronavirus (129/597, 21.6%). Multiple pathogens were identified from 71.0 per cent of samples. Enteric pathogens were isolated from 95.0 per cent of samples.

In a study by Brar *et al.*(2017), faecal samples from 100 diarrheic calves randomly picked up out of 17

outbreaks of bovine calf diarrhoea in periurban Ludhiana, Punjab in Northern India were subjected to conventional (microscopy, modified Zeihl–Neelsen (mZN) staining) and immunological and molecular techniques (faecal antigen capture ELISA and PCR) for detection of primary *Cryptosporidium parvum* infection as well as other frequently reported concurrent pathogens, *viz*. rotavirus and coronavirus, *Salmonella* spp., *Escherichia coli*, *Clostridium perfringens* and *Eimeria* spp. The faecal antigen capture ELISA and PCR revealed 35 per cent prevalence of *C. parvum* in contrast to 25 per cent by mZN staining with a relatively higher prevalence (66·7%) in younger (8–14-day-old) calves. The detection rate of the other enteropathogens associated with *C. parvum* was 45·71 per cent for *C. perfringens* followed by *Salmonella* spp (40·0 %), rotavirus (36·0 %), coronavirus (16·0 %), *E. coli* (12·0 %) and *Eimeria* spp (4·0 %) The sensitivity for detection of *C. parvum* by ELISA and mZN staining in comparison to PCR was 97·14 and 72·72 per cent, respectively. An important finding of the study was that *C. parvum* alone was found in only 10 per cent of the diarrheic faecal samples, whereas, majority of the samples (90%) showed mixed infections ranging from a combination of two to five agents.

Sharma and Joshi (2020) reported that E. coli was the major organism (86.00 %) observed in the faecal samples of the diarrhoeic calves followed by rotavirus, *Eimeria* spp. Cryptosporidium spp. (6.00 %); Salmonella spp. (3.00 %). The prevalence of rotavirus, Cryptosporidium spp. and Eimeria spp. was found significantly higher in buffalo calves. Highest prevalence of E. coli and rotavirus was observed in faecal samples of diarrhoeic calves of 0-15 days age group. Rotavirus was not detected in faecal samples of diarrhoeic calves above 60 days age. The susceptibility of bovine calves for E. *coli* and rotavirus was found decreased with the advancement of the age. The prevalence of Salmonella spp. in diarrhoeic faecal samples of bovine calves was observed only in 16-60 days age whereas Cryptosporidium spp. was found only in 0-30 days of age.

Wei *et al.* (2021) investigated the main infectious pathogens causing neonatal calf diarrhea among cattle in China. Sixty-nine fecal samples were collected from diarrheic newborn cattle and tested for infectious agents, including bovine rotavirus, bovine coronavirus, *Escherichia coli* K99, *Cryptosporidium parvum*, and *Giardia lamblia*, as determined by rapid kit analysis and polymerase chain reaction (PCR) amplification. The PCR results showed that the percentages of samples that were positive for *C. parvum*, bovine rotavirus A, bovine coronavirus, and *G. lamblia* were 44.93, 36.23, 17.39, and 13.04 per cent, respectively. The rapid kit analysis results showed that the prevalence of *C. parvum*, rotavirus, coronavirus, and *G. lamblia* was 52.17, 31.88, 28.98, and 18.84 per cent, respectively. No *E. coli* K99 was detected by either method.

Singh *et al*. (2022) examined a total of 816 faecal samples and out of which 7 (0.85%) animals were found to be positive for bovine coronavirus. The higher prevalence was recorded in north India followed by central India. Age wise higher prevalence was recorded below 2 month calves.

In conclusion, the effective control of calf diarrhea should be based on following major steps. First, a clear understanding of pathogen characteristics (*e.g.*, mechanism underlying pathogenicity, prevalence in the field) is required. Second, advantages and disadvantages of various diagnostic methods and their application to diagnostic protocols in the field along with complete clinical history is must. Finally, proper mother and calf management is necessary for disease prevention and control.

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