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Review

Review of some diseases of dairy animals and treatment by ethno-veterinary medicines

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ABSTRACT

In the rural areas of India, ruminants (goats, sheep, cows and buffaloes) are reared mainly to obtain milk and meat, used as soil manures and are a source of dung useful as fuel and organic fertilizer. These livestock are more prone to different contagious diseases, especially in a sub-tropical country like India. There are many allopathic medicines used to treat dairy animal diseases but their cost happens to be high with side effects sometimes. Due to the high cost of medicines, poor people cannot afford them. Based on interactions with traditional medicine practitioners, it has been observed that more than three dozen medicinal plants are used to cure various diseases such as mastitis, foot and mouth disease, blue tongue, Johne's disease, lesions, rinderpest, piglet diarrhea or scour, bovine, rhinotracheitis, theileriosis, tetanus, bovine babesiosis, listeriosis as well as the signs of enteritis, arthritis, stomatitis, salivation from the mouth, wounding, conjunctivitis, viral infections etc., in animals. The viral infections wreak havoc on the economy of animal farmers. Viral infections are not a new disease of animals but new viruses are spreading worldwide including in Asian countries very fast, these days. A vaccination program is being launched in India to protect animals from such diseases. Among ethnomedicinal plants, leaves are the major part used (42%), followed by the whole plant, fruit (10%), and rhizome, stem, seed (8%), tuber, latex (4%) and gum, bark, petiole constituting to 2%.

Keywords: Ethnomedicine, medicinal plants, folklore medicine, ethnoveterinary, veterinary diseases, livestock.

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INTRODUCTION

Globally, dairy farming has a significant role as it creates employment and provides means of financial support to about 1 billion people through more than a million dairy farms. Dairies supply healthy and nutritious milk and milk products to billions of customers every day. India, the largest producer of milk in the world, having a share of around 22%, engages more than 80 million people in dairy farming as their main source of income. The value of milk group output was at 8.32 lakh crores in 2020-21 (Anonymous, 2021). With a large financial and social involvement, dairy farming needs to be responsible and sustainable in terms of good quality products for the customer and animal health and welfare for the producer. The cost of animal health services is very high and the availability of these services for small dairy farmers is very low. Milk is a highly consumed food and is very important for human health. Milk and other dairy products, which contain drug residues beyond the maximum residue limit, cause serious health problems to consumers (Van den Meersche et al., 2016). Further, there is an emergent alarm regarding the development of drug-resistant bacteria with enormous health consequences. Recognizing the importance, the World Health Organization has developed a global action plan (WHO Statistics, 2015), and guidelines for developing national action plans (WHO Statistics, 2016) and is monitoring global progress (WHO Statistics, 2018).

India is considered a rapidly growing dairy animal industry and is likely to attain self-sufficiency in the production of livestock products in the future (Dhama et al., 2014). The dairy animal industry has a large contribution to the Indian economy and its overall contribution is 28 to 32% of the agricultural GDP and 4 to 6% of the national GDP. It also constitutes 8 to 10% of the country's labour power (Hemadri and Hiremath, 2011). India has the largest livestock population in the world with 528 million domesticated animals with first place in the world in buffalo population (105.3 million), second in cattle (199 million) and goat (140.5 million) population, and third in sheep (71.5 million) population (Hemadri and Hiremath, 2011; Biswal et al., 2012; Dhama et al., 2014; Chand et al., 2015). The livestock population in India is threatened especially by disease outbreaks, floods, droughts and other climatic anomalies. There are several diseases affecting livestock that causes a serious effect on the production of animals, human health, and trade of livestock and animal products, as a result, the overall economic development is affected (Gibbs, 1981; Depa et al., 2012; Dhama et al., 2014). In order to compete in the international market, improved quality and quantity of livestock products is necessary, in turn leading to disease-free animal health status (Bhanuprakash et al., 2011; Awase et al., 2013; Bayry, 2013; Chand et al., 2015). In recent times, emerging and re-emerging diseases of livestock, poultry and humans have tremendously increased. Of zoonotic significance, many diseases like brucellosis, tuberculosis, glanders, corona, influenza, FMD, Nipah and Hendra viral diseases (Dhama et al., 2014; Chakraborty et al., 2014; Kumar et al., 2015). Besides that several other viral diseases of animals in India such as peste des petits ruminants (PPR), foot and mouth disease (FMD), sheeppox, goatpox, bluetongue (BT), camelpox, malignant catarrhal fever (MCF), infectious bovine rhinotracheitis (IBR) and bacterial disease like black quarter (BQ), haemorrhagic septicaemia (HS), anthrax and brucellosis were endemic and has a potential of crossing continental boundaries (Arya and Bhatia, 1992; Benkirane and De Alwis, 2002; Bhanuprakash et al., 2011; Biswal et al., 2012; Saminathan et al., 2013; Bayry, 2013; Chand et al., 2015; Kumar et al., 2015). The development of new serotype variations in pathogens creates additional risks and warning to the livestock. The higher presence of emerging diseases might be due to many factors like crowded livestock and human population, increased contact between livestock and humans with wild animals and birds, deforestation and lack of public awareness (Depa et al., 2012; Chakraborty et al., 2014). The factors like global enlargement of cultivating land, population growth, climate changes, intensive industrialization, movement of vectors, hiding/reduced reporting of the disease and outbreaks of illegal and unregulated trade are other reasons for the emergence and spreading of the diseases (Gibbs, 1981; Dhama et al., 2014). Two-third part of the global population including both humans and livestock are living in developing and underdeveloped countries and most of the diseases are supposed to have emerged from them. Sincere scientific implementations and political decisions at the national and international levels are necessary to tackle these infectious diseases (Bhanuprakash et al., 2011; Hemadri and Hiremath, 2011; Biswal et al., 2012).

At present, a huge number of plants are discovered as having healing properties. Due to specialized biochemical capabilities, plants synthesize and accumulate a vast variety of primary and secondary metabolites or natural chemicals (Cotton, 1996). The uses of plants against common animal diseases have been listed in Table 1.

Table 1. Traditional treatment methods commonly used in dairy cattle.

S. no.	Ailments	Traditional applications
1.	Diarrhoea/Dysentery	Drenching about 1 kg fruit pulp extract of *Aegle marmelos* and mango seed kernel for 2-3 days. About 100-200 g leaf paste of *Moringa oleifera* Lamk. is given twice daily for 3 to 5 days to cattle for quick relief from diarrhoea and dysentery.
2.	Arthritis/ Inflammation	*Boswellia serrata* (Salai guggul or Shallaki): The hexane extract of gum resins of BS in combination with methanolic extract of rhizomes of *Glycyrrhiza glabra* exhibited antiarthritic activity at doses of 50 or 100 mg/kg in male Wistar rats. *Caesalpinia sappan* Linn. (Sappan wood or Patang): The ethanolic extract of bark at doses 1.2, 2.4, and 3.6 g/kg of CP wood showed antiarthritic activity on Wistar rats by declining the levels of IL-1β, IL-6, TNF-α, and prostaglandin E2 in serum. *Cannabis sativum* Linn. (Bhang): Dried flowering or fruiting tops i.e., cannabidiol at a dose of 10 and 25 mg/kg, orally, administered in collagen-induced arthritic rats significantly decreases the arthritic score and inhibits the release of inflammatory mediators. *Cinnammomum zeylicanium* Blume (Dalchini): The polyphenolic extract of the CZ bark at a dose of 8 mg/kg revealed anti-arthritic potential in male Wistar rats in the CFA model by improving the body weight and the level of serum C-reactive proteins. *Coriander sativu*m Linn. (Dhaniya): The hydroalcoholic extract of seeds at doses of 8, 16, and 32 mg/kg showed a reduction in paw swelling induced by formaldehyde and CFA methods in male Wistar rats by inhibiting the pro-inflammatory cytokines and TNF-α.

Table 1. Continues.

		Piper longum Linn. (Long pepper): The aqueous extracts of seeds of *P. longum* at two doses (200 and 400 mg/kg) showed a 46.32% inhibition in paw swelling in Freund's complete adjuvant-induced arthritis in rats by inhibiting the adherence of neutrophils to endothelial monolayer. *Punica granatum* Linn. (Pomegranate): The aqueous extract of fruits of PG shows an anti-arthritic activity at doses of 13.6-34 mg/kg by inhibiting the spectrum of signal transduction pathway in male Wistar rats. *Curcuma longa:* (Haldi) Overall dosage of ethanolic extract of *C. longa* required to improve osteoarthritis, was less than 2 g/kg and did not show any noticeable adverse effects.
3.	Mastitis/ Inflammation	*Azadirachta indica* (Neem) and *Momodica charantia* (Bitter melon): Methanolic extracts of leaves of *Azadirachta indica* showed the largest zone of inhibition (24 mm in diameter) was recorded against isolated *Corynebacterium xerosis* while the zone of inhibition (22 mm in diameter) was recorded against *Lactobacillus* spp. with the methanolic extracts of fruit of *M. charantia*. *Gardenia jasminoides Ellis* (Cape jasmine): Aqueous ethanolic extract of dried fruits of *Gardenia jasminoides* Ellis showed at 10, 25, and 50 mg/kg against the mouse model of LPS mastitis through anti-inflammatory effects by interfering with the expression of TLR4, which subsequently inhibits the downstream NF-κB and MAPK signaling pathways and the release of the pro-inflammatory cytokines TNF-α, IL1β, and IL-6. *Trachyspermum ammi* (Ajwain): Essential oil of seeds shows good antibacterial activity on major bacterial mastitis pathogens in milk. *Curcuma longa:* (Haldi) Ethanolic extract of *Curcuma longa* against the microbes causing mastitis.
4.	Worming	*Medicago arabica* (Coffee beans) (seeds and roots) and *Medico sativa* (Alfalfa) (seeds and roots): alcoholic extract of all these plants showed good nematocidal activity. *Avicennia officinalis* (Khatmi) (roots), *Artemisia absinthium* (Vilayathi Afsantin), *Chamomilla recutita* (Chamomile tree), *Fumaria officinalis* (earth smoke) and *Malva sylvestris* (Gurchanti) aqueous and methanolic extract of dried plants showed de-worming activity. *Allium sativum* L. (Garlic): Hexane extract of the plant at a dose of 40 mg/kg showed 68.7% efficacy against *Haemonchus contortus*. Destructive and inhibitive effect on acetylcholinesterase causing paralysis. *Artemisia absinthium* L. (Warm wood): Crude ethanol extract of the plant at a dose of 2 g/kg shows 90.47% efficacy ovine nematodes inhibit vital metabolic enzymes, disrupt mitochondrial membrane potential, the release of cytochrome C into cytoplasm and activation of caspase-3-mediated apoptosis.
5.	Infections	*M. azedarach* L. (Ghora-neem): Aqueous methanol extract of leaves and seeds of the plant at a dose of 4000 mg/kg showed 85.24% efficacy against *Haemonchus contortus*. Inhibit secretion of key enzymes, intracellular instability, neuromuscular disorganization, paralysis, and death. *Calotropis procera* (Aiton) (Rubber Bush): Aqueous methanol extract of leaves and seeds of the plant at a dose of 0.003 mg/kg showed 88.4% efficacy on sheep. *Corymbia citriodora* (Hook.) (lemon-scented gum): Essential oil of leaves and fruits of the plant at different doses of 0.125, 0.25, and 0.5 mg/kg show 100% efficacy on sheep. Formation of vacuoles, muscular disorganization, and changes in mitochondrial profile. *Ocimum tenuiflorum* (Tulsi): Aqueous ethanol extract of *O. tenuiflorum* at a dose of 0.5–1000 µg/M had antibacterial effects against Gram-positive bacteria including *Staphylococcus aureus*, CNS, and *S. agalactiae* but not Gram-negative bacteria. *Argemone mexicana* Linn. (kateli ka phool): The aqueous extracts from leaves (100 g) and fruits (100 g), are applied over foots suffering from infections.
6.	Fever	*Bambusa arundinacea* (Bamboo): Equal amount of rhizome and the fresh leaf of bamboo is made into a paste and given twice a day for 7 days to the cattle suffering from diarrhea. *Delonix regia* Linn. (Gulmohar): Ethanolic extract of the bark is given with black pepper and garlic twice daily until cured for the treatment of fever.

Table 1. Continues.

		Vigna radiata (L.) R. Wilczek (Jungli Mung): About 250 g seed powder is mixed with 100 mL oil of *Arachis hypogea* and given twice daily for 7 d to cattle suffering from cough and cold. One liter decoction of fresh leaves of *Psidium guajava* Linn. is given twice daily till recovery to cure fever and about 100 g flower paste of *Madhuca indica* with 250 g jaggery and 50 mL water is mixed and given twice daily for seven days to cure fever of cattle.
7.	Foot and mouth ulcers	Allowing animals to walk in hot sand or applying sand to wounds externally; applying linseed oil and turmeric externally; applying kerosene if the wounds are infested with maggots.
8.	Removal of ectoparasites	The mixture of leaf and bulb of *Allium cepa* Linn is externally applied on the skin for removal of the ecto-parasites.
9.	Rheumatism	The juice, extracted from leaves (100 g) and fruits (100 g) of *Argemone mexicana* Linn., is applied over foots suffering from infections. The same juice is also applied over the body parts of cattle for relieving pain from rheumatism.
10.	Intestinal worm	Fresh leaves of *Feronia elephantum* Linn. are ground well and mixed with 500 L of water and given to cattle once daily for 10-20 d in case of intestinal worms.

(Balakrishnan et al., 2009; Verma, 2014; Tu et al., 2021; Catherine et al., 2020; Hasnaoui et al., 2020; Olaifa et al., 2020; Cardoso Oliveira et al., 2020).

COMMON DISEASES IN DAIRY ANIMALS

Diseases are defined as conditions in which there is a deviation from the health or normal functioning of any or all the tissues and organs of the human and animal body. Diseases are a major threat to dairy cattle production. Most diseases are caused by parasites, pathogenic bacteria and viruses. A pathogenic organism is defined as one which will always produce disease in the animal body under natural or experimental conditions. The most common animal disease in livestock are foot and mouth disease (Kitching, 2002), anthrax (Rushton, 2009; Devrim et al., 2009), black quarter (black-leg) (Rashid and Shank, 1994), blue tongue (Mertens and Diprose, 2004; Patel and Roy 2014; Ranjan et al., 2015), rabies (mad dog disease) (Hanlin et al., 2013), pox (King et al., 2012), brucellosis of sheep (Radostits et al., 2006; Anonymous, 2016), campylobacter abortion (vibriosis), Johne`s disease (Clarke, 1997), bovine ephemeral fever (Nadi and Negi, 1999; Kahrs, 2001), mastitis (Natzke, 1981; Ott, 1999; Wellenberg et al., 2002; Zadoks et al., 2023; Coatrini-Soares et al., 2023; Pearce et al., 2023), lesions, rinderpest (Roelke-Parker et al., 1996; Kock et al., 1998), foot rot (Dewhirst et al., 1990), piglet diarrhea or scour, bovine rhinotracheitis (Straub, 1975; Bosco Cowley et al., 2011; Gould et al., 2013), peste des petits ruminants (PPR, goat plague) (Kinne et al., 2010), theileriosis, tetanus (Radostits et al., 2007), bovine babesiosis (tick fever) (Walker and Edward, 1927), east coast fever (Bruce et al., 1910), milk fever (Mulligan et al., 2006; Radostits et al., 2007), listeriosis (Low and Donachie, 1997; George, 2002; Kahn, 2005; Wesley 2007), ringworm, calf diarrhea or scour (Trefz et al., 2012; Meganck et al., 2015; Gezmu et al., 2017), lumpy skin disease (Buller et al., 2005), etc. Diseases affect dairy production in many ways such as low milk production, reduced body weight, reduced growth rate and reproductive performance, mortality and high treatment cost.

Anthrax

Anthrax is a zoonotic bacterial disease caused by *Bacillus anthracis* (Rushton, 2009). *B. anthracis* rapidly sporulates to form very persistent spores when exposed to air (Kitching, 2002). The spores may persist and remain viable in the soil for several years because there is no effect of heat and chemical disinfectants on them (i.e., dormant stage) (Kitching, 2002; Alexandersen et al., 2003). Wild herbivorous mammals are generally affected by groups of spores through ingestion or inhalation while grazing. Carnivores living in the same vicinity may be infected by consuming infected animals (Yang et al., 1999). Even some of the diseases are transmitted to humans via direct or indirect contact with infected animals and their products, like hides or wool and by the ingestion and inhalation of spores (Gibbens and Wilesmith, 2002; Chikerema et al., 2013). Human cases often develop after exposure to infected animals and their tissues. Farmers, butchers, veterinarians, shepherds and farm workers are at great risk of exposure to infected materials (Figure 1)

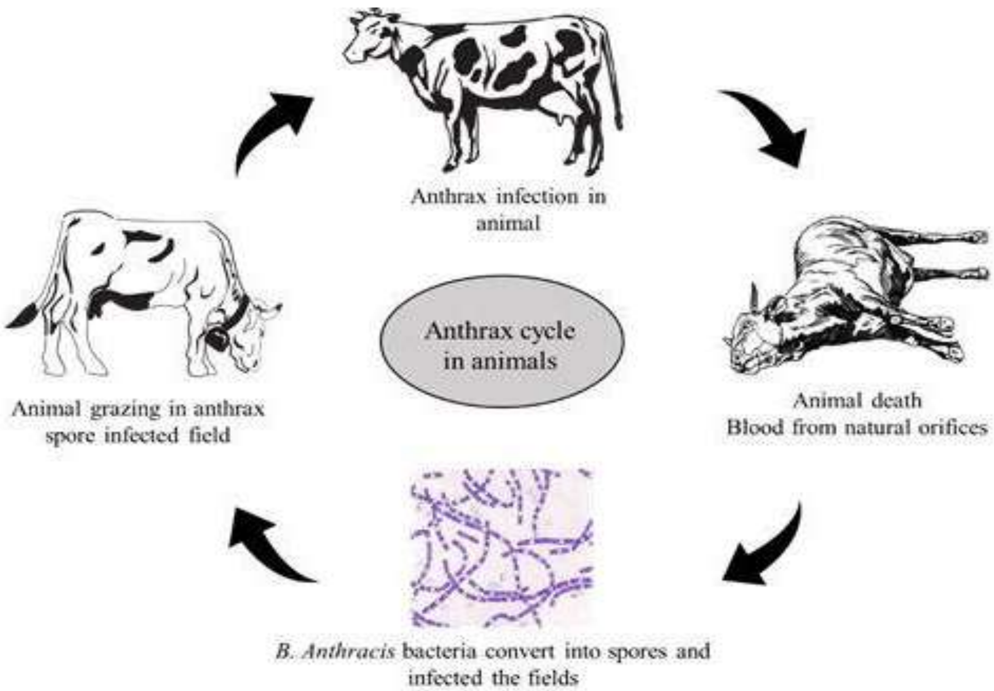

Figure 1. Life cycle of *B. Anthracis* in animals (https://textbookofbacteriology.net/Anthrax.html).

(Hudson, 2006; Hudson et al., 2008; Hugh-Jones and Blackburn, 2009; Woods et al., 2004).

Diseases, often considered occupational in developing countries (Sumption et al., 2008; Muroga et al., 2012), are associated with rural areas or agricultural production (Knight-Jones and Rushton, 2013). Globally, 10,000 to 100,000 human anthrax incidences occur annually with a significant number of cases from developing countries, including India. Currently, anthrax is the second disease after rabies among the zoonotic diseases which are dealt with by one health approach (Pieracci et al., 2016).

Black quarter (black-leg)

Black quarter is one of the major bacterial infections causing huge economic losses to cattle herders in many parts of the country mainly due to deaths in affected animals (Rashid and Shank, 1994). The disease results in losses in milk production and a reduction in the working capacity of farm animals. The causative agent, *Clostridium chauvoei*, is a Gram-positive, motile, rod-shaped anaerobic bacterium and it can produce environmentally persistent spores when conditions are not ideal for growth (Sarah, 2013). In turn, the spores can remain in the soil for many years in an inactive form but return to their infectious form when consumed by grazing livestock (Radostits et al., 1995; Merck, 2005; Sarah, 2013). The maximum losses due to blackleg occur when cattle are between the ages of 6 months and 2 years (Merck, 2005; Sarah, 2013). Normally, cattle that have a high feed intake and are well-conditioned tend to be the most susceptible. Lesions develop without any history of wounds but excessive exercise and bruising may precipitate disease in some cases (Merck, 2005). Blackleg seldom affects cattle older than 2 years of age, most likely due to induced or naturally enhanced immunity. However, in cattle older than 2 years, sporadic cases do occur which are often associated with the reuse of needles for multiple injections. Blackleg is sometimes a problem in cattle less than 4 months old when they do not receive adequate passive immunity through colostrums (Figure 2) (Alabama Cooperative Extension, 2013).

Foot and mouth disease

Foot and mouth disease (FMD) is a viral condition of ruminants characterised by initial pyrexia through the development of vesicles on the interdigital region, tongue, hard palate, coronary band, etc. Lesions are also common on the teats in lactating cows where a sudden milk drop is typically seen (Kitching, 2002). Death may also occur in young calves secondary to acute myocarditis (Figure 3) (Alexanderson et al., 2003, Villagomez et al., 2022). This viral disease is well known for being highly transmissible. This is evident by the widespread outbreaks when introduced to disease-free susceptible populations (Yang et al., 1999; Gibbens and Wilesmith, 2002; Muroga et al., 2012). The virus is widely distributed throughout Asia, Africa and South America (Sumption et al., 2008). The annual global adverse economic impact of this disease has recently been estimated at US$11 billion (90% range US$ 6.5 to 21

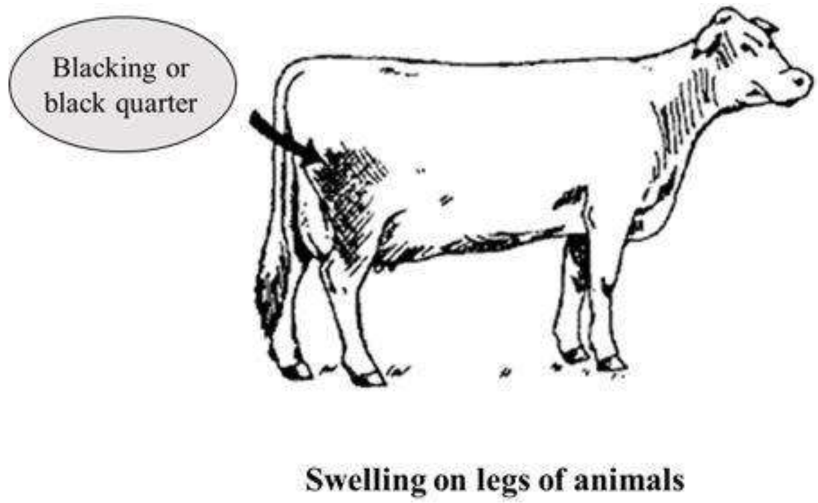

Figure 2. Black quarter in animals. (https://www.standardmedia.co.ke/farmkenya/livestock/article/2001434418/black-quarter-killer-disease-confuses-many)

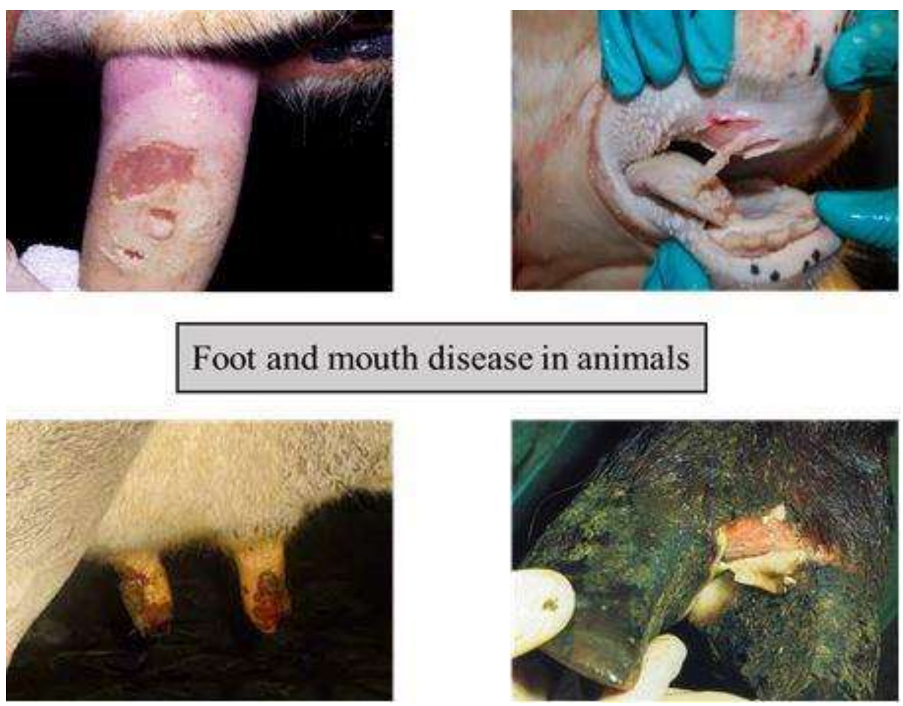

Figure 3. Foot and mouth disease in animals. (https://www.cfsph.iastate.edu/DiseaseInfo/ImageDB/imagesFMD.htm)

billion) in endemic settings and an additional minimum of US$ 1.5 billion has been ascribed to virus incursions into FMD-free countries (Knight-Jones and Rushton, 2013).

Rabies (Mad dog disease)

It is a very serious disease and has been known to humans for more than two centuries back which is evident by the following statement: “A bite from a mad dog is more dreaded than anything I know; which arises from the horribleness of the disease, the uncertainty of the animal’s being mad, or of the infection being received: The not knowing at what period to expect the effects, or to feel confident of having escaped it, keeps the person in a state of cruel suspense (sic) for months, or even years."

It has the highest mortality rate of all known infectious agents, with nearly all individuals who develop clinical symptoms, eventually dying (Figure 4) (Hanlon and Childs, 2013). India has the dubious distinction of bearing the largest burden of about a dozen of neglected tropical diseases (NTDs) (Hotez and Damania, 2018; Anonymous, 2020). This list includes rabies, a viral infection caused mainly by the bite of infected mammals or by the deposition of saliva on wounds or mucous membranes. Rabies is historically absent in western Europe and several island nations such as Japan, Australia and New Zealand. In North America, domestic animal rabies in dogs and cats occurs mainly through exposure to infected wildlife reservoir hosts (Anonymous, 2018). However, in several rabies-endemic countries in Africa and Asia especially, India, domestic dogs are the main rabies reservoir and source of human exposure (Sudarshan et al., 2007; Anonymous, 2018).

It is estimated that about 35% of global annual human deaths occur in India due to dog-mediated rabies (Anonymous, 2018). About three-quarters of cases in India occur in rural communities that have poor access to diagnostic facilities and post-exposure prophylaxis which are key to preventing the spread of disease (Sudarshan et al., 2007). More than 95% of cases are caused by dog bites because there happen to be approximately 60 million stray dogs in the country (Gompper, 2014) wherein human rabies goes undetected (Mani et al., 2017). A significant proportion of cases are in children. Despite the availability of safe and effective vaccines, awareness of and access to post-exposure prophylaxis (PEP), including rabies immunoglobulin, continue to be unpopular (Mani et al., 2016).

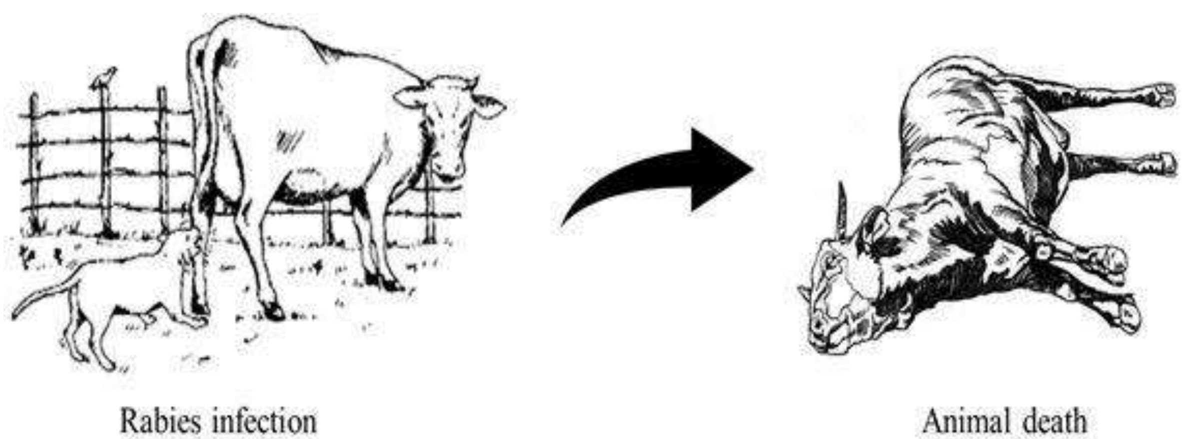

Figure 4. Death of animals due to rabies infection. (http://www.nzdl.org/cgi-bin/library.cgi?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-1l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-00&cl=CL3.33&d=HASH0173b8ba971d4ea75c7de167&gt=2)

Blue tongue

Belonging to the genus *Orbivirus* Blue tongue (BT) is an infectious, non-contagious and arthropod-transmitted viral disease of domestic and wild ruminants (Mertens and Diprose, 2004; Patel and Roy 2014; Ranjan et al., 2015). BTV is a double-stranded RNA (dsRNA) genome surrounded by a triple-layered icosahedral capsid non-enveloped virus with 10 distinct segments (Figure 5) (Grimes et al., 1998; Ratinier et al., 2011; Patel and Roy 2014). The BTV genome encodes 5 non-structural (NS1-NS5) and 7 structural (VP1-VP7) proteins (Mertens and Diprose, 2004; Ratinier et al., 2011; Stewart et al., 2015). BT is a World Organisation for Animal Health (OIE) listed multispecies disease due to its economic impact (MacLachlan and Osburn, 2006; Gunn et al., 2008; Anonymous, 2008; Rushton and Lyons, 2015). Due to the high morbidity, mortality, stillbirths, abortions, foetal abnormalities, less birth weight in young ones, reduced milk yield and fertility rate, weight loss, early culling as well as meat and fleece losses, BTV infection causes high economic debt. Further, the indirect losses are due to trade restrictions imposed on ruminant animal movement, their germplasm and animal products, and expenditure for vaccination, diagnosis, vector control and treatment of clinically pretentious animals (MacLachlan and Osburn, 2006; Gunn et al., 2008; Rushton and Lyons, 2015; Pinior et al., 2015a; Pinior et al., 2015b; Grewar, 2016; Gethmann et al., 2020).

It was estimated that BTV outbreaks caused economic losses of approximately 3 billion US dollars in 1996 worldwide (Tabachnick, 2004). The total cost for the prevention of the incursion of BTV-8 into Scotland was estimated to be approximately 141 million euros between 2009 and 2013 (Gunn et al., 2008). Only in the US livestock industries, BTV caused losses of US $144 million annually due to trade restrictions and diagnosis for assessing BTV status (Hoar et al., 2003).

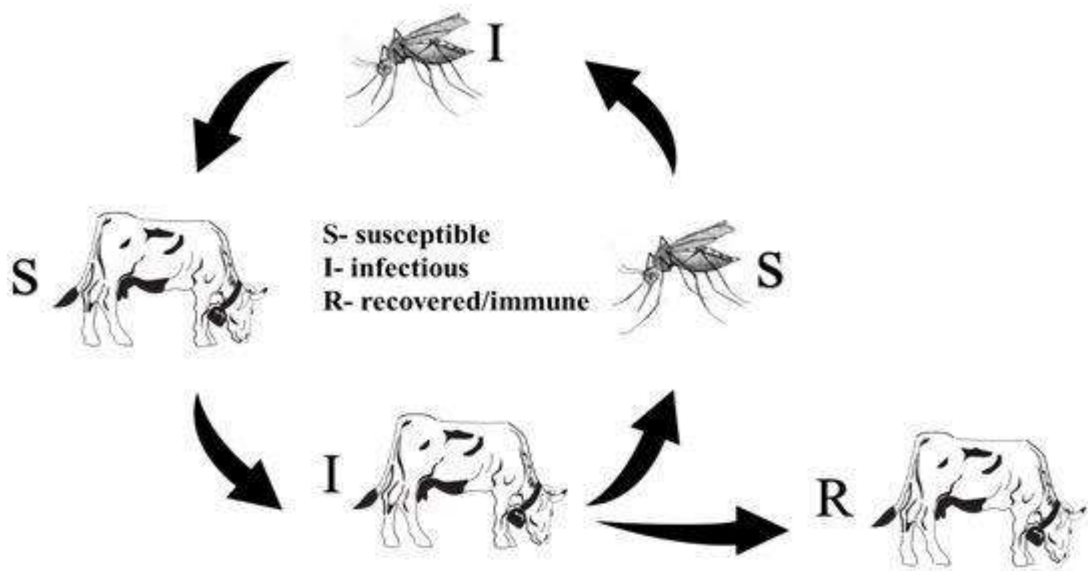

Figure 5. A simple graphical representation of the life cycle of bluetongue virus. (https://www.nc.cdc.gov/eid/article/15/12/09-0788_article)

Pox (Zewdie-2021, Characterization of sheep pox)

Sheep pox, goat pox, and lumpy skin diseases are economically important infectious illnesses of sheep, goats and cattle, respectively. They belong to the genus *Capri-pox*virus (CaPV) (King et al., 2012). Goat pox virus (GTPV) and sheep pox virus (SPPV) are intimately linked to the lumpy skin disease virus (LSDV) of cattle mainly affecting sheep and goats, respectively (Figure 6). These strains generally have transitional host specificity; however, some virus isolates may cause mild to severe disease in both species (Babiuk et al., 2008; Tuppurainen et al., 2014). SPP and GTP are economically significant viral diseases of sheep and goats. They are manifested by widespread pox lesions across the mucous membranes and skin. It generally reflects constant fever, enlargement of superficial lymph nodes, pyrexia, generalized nodules on non-wool skin, generalized pocks, and often focal viral pneumonia (Bhanuprakash et al., 2011; Şevik et al., 2016).

Lumpy skin disease

The virus (LSDV) belongs to the genus *Capripoxvirus* (Buller et al., 2005). Infected animals typically show poor general body conditions, reduced feed, fever and water uptake, enlarged lymph nodes characteristic skin nodules with lowered milk production. In severely infected individuals, the number of lesions may vary from a few in mild cases to multiple lesions mostly covering the entire body. In addition, in the mucous membranes of the oral and nasal cavities, necrotic plaques may appear. They may cause purulent or mucopurulent nasal discharge and excessive salivation. Sometimes, ulcerative lesions may appear in the cornea of one or both eyes. This leads to restricted vision including blindness. Severe cases may show characteristic lesions on the surface of almost any internal organ throughout the entire digestive and respiratory tract (Weiss, 1968; Prozesky and Barnard, 1982).

Recent reports in India reveal that more than 7,000 cattle have died due to lumpy skin disease in eight states and a union territory. It is under alarming situation and the vaccination drive has been stepped up to contain the infection. This disease is transmitted by blood-feeding insects, such as certain species of flies and mosquitoes or ticks. Following outbreaks in the Middle East and Europe, it has recently spread to Asia. The disease emerged in Bangladesh and India in 2019 spreading to eastern states including West Bengal and Odisha. But this year, the disease has been reported in western and northern states as well as in Andaman Nicobar of India. It has also been stated that the Haryana government has directed the officials to work on a mission mode similar to the covid-19 pandemic. Senior government officials have been asked to procure available vaccination and inoculate all cows and cattle on a war footing, besides monitoring the situation daily. The Haryana government has also contacted the Union Ministry for Fisheries, Animal Husbandry and Dairying to seek more vaccine doses to the states at the earliest (Anonymous, 2022; 2022, online).

Brucellosis of sheep

Bovine brucellosis is considered to be predominantly

Figure 6. A simple representation of pox disease in dairy animals. (https://www.frontiersin.org/articles/10.3389/fvets.2020.00008/full).

caused by *Brucella abortus* and sometimes by *B. melitensis*, where cattle are kept together with infected goats or sheep. It is characterized clinically by metritis, orchitis and epididymitis, abortion at first gestation, and retained fetal membrane (RFM) (Radostits et al., 2006; Anonymous, 2016). The common sources of infection for the transmission of bovine brucellosis are milk from infected animals, aborted fetuses, retained fetal membranes and vaginal discharges. Indirect contact with contaminated fomites and direct contact with an aborting cow and the aborted fetus is the most common means of transmission of the disease in cattle. Grazing on contaminated pasture, and ingestion of contaminated feed, fodder, water, etc. may also play a secondary role in disease transmission (Figure 7) (Radostits et al., 2006; Debassa et al., 2013). The disease remains a major public and animal health problem in many developing countries where rural income relies mainly on livestock and dairy products. Though it has been eradicated in many developed countries (Roth et al., 2003). Though the disease has been eradicated from many developed countries (Roth et al., 2003), consumption of raw milk and milk products and close contact with infected animals allows Brucellosis to originate from a domestic animal reservoir (Musa et al., 2008; Bechtol et al., 2011). Bovine brucellosis is also a zoonotic disease with economic and public health impacts, particularly for human and animal populations in developing countries (Schelling et al., 2003). The disease can generally cause significant economic loss due to abortion, stillbirth, low herd fertility, and low milk production (Diaz Aparicio et al., 2013).

Tetanus

Tetanus is a highly fatal disease of all species of domestic animals and is caused by the neurotoxin of *Clostridium tetani.* It is characterized by tremors, lockjaw prolapse of the third eyelid and a general increase in muscle stiffness. In general, the *C. tetani* organisms are commonly present in the feces of animals, especially horses and in contaminated soil (Figure 8). The disease starts when the spores enter wounded or damaged tissues. In the absence of oxygen, the bacterial spores of *C. tetani* germinate, multiply and produce very potent neurotoxins spreading along the nerves to the brain and causing the clinical signs of tetanus. The time between infection and disease ranges from 2 days to 4 weeks. The surveys in different areas of the world demonstrated it to be present in 30 to 40% of soil samples (Radostits et

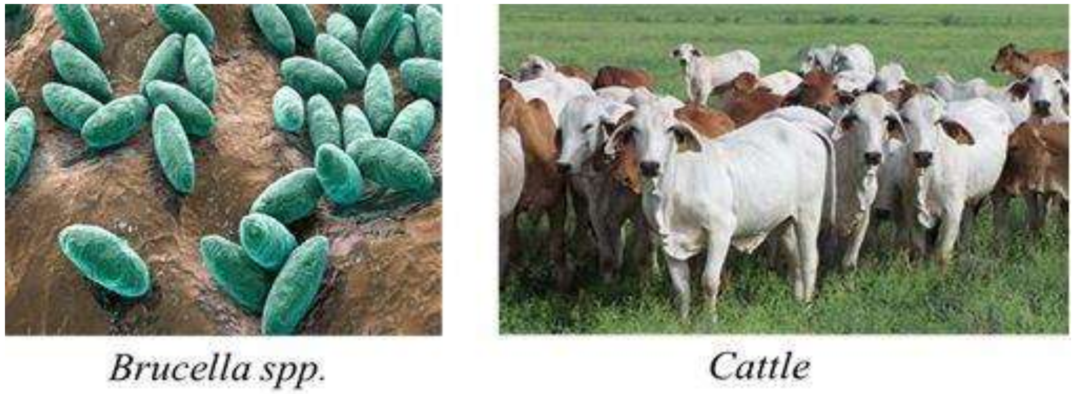

Figure 7. Brucellosis in dairy animals. (https://depositphotos.com/stock-photos/brucella-abortus.html)

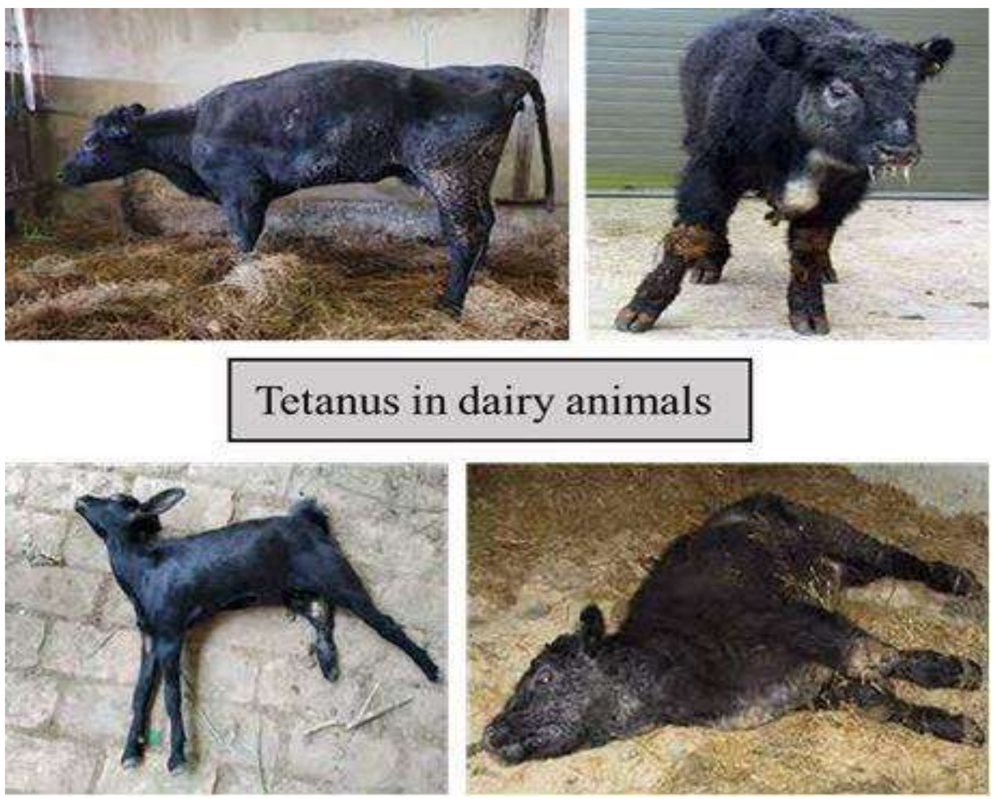

Figure 8. Tetanus in dairy animals. (https://www.boergoatprofitsguidde.com/tetanus-in-goats/)

al., 2007).

Listeriosis

Listeriosis, also called meningoencephalitis, silage disease, or circling disease, is caused by *Listeria monocytogenes*. This infection is a fatal disease of animals, birds, fish, crustaceans and humans where encephalitis and septicaemia are predominantly observed (Low and Donachie, 1997; George, 2002; Kahn, 2005; Wesley 2007; Barbuddhe and Chakraborty, 2009; Dhama et al., 2013; Anonymous, 2014). Listeriosis occurs in a sporadic or epidemic form throughout the world (Mitchell, 1996; Barbuddhe et al., 2008; Dhama et al., 2013). Most of the time, infection in animals is subclinical (Anonymous, 2014). The disease is characterized by abortion, stillbirth, perinatal infections, septicaemia, encephalitis, meningitis, meningoencephalitis, rhombencephalitis and gastroenteritis (Brugere-Picoux, 2008; Barbuddhe and Chakraborty, 2009; Okada et al., 2011; Barbuddhe et al., 2012; Disson and Lecuit, 2013;

Limmahakhun and Chayakulkeeree, 2013; Mateus et al., 2013; Anonymous, 2014). Since the organism has an intracellular life cycle that can pass from cell to cell without a release from the cell, it exhibits the ability to cross the placental barrier and blood-brain barrier, explaining its pathogenesis and clinical signs (Janakiraman, 2008). The organism can survive at varying temperatures ranging from 4 to 37°C (Janakiraman, 2008). Due to poor measures of quality control during food processing/handling and packaging, contamination of *L. monocytogenes* may continue (Carpentier and Cerf, 2011), raising concerns for public health (Kaufmann, 1988; Rocourt and Bille, 1997; Schelch and Acheson, 2000; Oliver et al., 2005; Dhama et al., 2013; Dhama et al., 2013). In humans, ready-to-eat food-mediated listeriosis infection has been documented by several workers from different parts of the globe (Lianou and Sofos, 2007; Meloni et al., 2009; Mengesha et al., 2009).

Johne's disease

Johne's disease (JD) is a chronic disease caused by intestinal infection with the pathogen *Mycobacterium avium* ssp. *paratuberculosis* (MAP) which is pervasive on dairy farms. Infection with MAP typically occurs in calves (Clarke, 1997). After a period of transient shedding (van Roermund et al., 2007), it passes through a latent, non-shedding stage of varying length with no obvious clinical symptoms (Whitlock et al., 2000). If left unchecked, clinical JD may develop, with a high level of MAP shedding (Whitlock et al., 2000). Animals infected with JD should be culled at the onset of clinical signs such as diarrhea or wasting (Collins, 2003; Smith et al., 2009). Raizman et al. (2007) found that infected animals are less likely to conceive. It is now a globally prevalent contagious disease with major economic and welfare implications for the cattle industry.

Bovine ephemeral fever

Bovine ephemeral fever (BEF, three days sickness, stiff sickness, bovine epizootic fever) is an Ephemerovirus. It is an arthropod-borne viral disease of cattle and water buffaloes characterized by a fever of short duration, stiffness, lameness, depression, respiratory signs and sometimes paralysis (Nadi and Negi, 1999; Kahrs, 2001) occurring mainly in Australia, Africa and Asia (Burgess, 1971). Fall in milk production by 50 to 80%, and great economic losses were attributed to the disease. Most cows do not achieve the pre-illness production level, or decrease in body weight (St. George, 1998). In addition, it may be followed by various complications such as hindquarter paralysis, pulmonary pneumonia, mastitis and subcutaneous emphysema, abortion and sometimes temporary sterility in bulls (Theodoridis et al., 1973; Hill and Schultz, 1977; Sharma, 1992).

Rinderpest

Also known as cattle plague, it is the most destructive of the virus diseases of cloven animals, such as cattle, buffaloes, sheep, goats, pigs and wild ruminants. Rinderpest is caused by a morbillivirus which causes diseases affecting mammals and humans. Rinderpest virus affects mainly ungulates both wild and domestic animals. It is most closely related to the measles virus. The canine distemper virus also affects a number of other carnivorous animals with epidemics reported in African lions and pinnipeds (Roelke-Parker et al., 1996; Kock et al., 1998; Di Guardo et al., 2005; Munson et al., 2008). Similarly, phocid distemper virus (Baumgartner et al., 2003); cetacean morbillivirus (Di Guardo et al., 2005); measles in humans (Furuse et al., 2010) and a newly discovered felid morbillivirus (Woo et al., 2012) fall in the same line. Rinderpest in cattle and buffaloes is marked by fever with ocular and nasal discharges and is capable of causing high morbidity and mortality rates.

Mastitis

Bovine mastitis is an inflammatory condition of the mammary gland, mostly caused by bacterial intramammary infection. The economic losses associated with mastitis can be attributed to culling, medication, discarded milk and reduced milk quality (Natzke, 1981; Ott, 1999; Wellenberg et al., 2002; Zadoks et al., 2023; Coatrini-Soares et al., 2023; Pearce et al., 2023). Mastitis can be classified into (i) contagious and (ii) environmental mastitis based on the bacteriological etiologic agent. The infected quarter is the source of contagious pathogens such as *Staphylococcus aureus* and *Streptococcus agalactiae*, whereas environmental pathogens such as *Escherichia coli*, *Streptococcus dysgalactiae,* and *Streptococcus uberis* originate from a variety of sources e.g., bedding, manure, pastures, and pond water. During and after the milking process, the bacteria gain access to a healthy gland most frequently when vacuum fluctuations, liner slips, and relaxed teat canal sphincter muscle tone often give an opportunity for invasion.

Footrot

Ovine footrot is a contagious foot disease of sheep caused by the Gram-negative anaerobic bacterium *Dichelobacter nodosus* (Dewhirst et al., 1990). It has been described to occur in sheep-producing countries worldwide. Besides sheep, other domesticated animals such as cattle, goats and South American camelids, as well as wild ruminants, may harbor *D. nodosus*. (Bennett et al., 2009). The considerable economic and welfare impact of the disease on sheep farming and affected animals is tremendous. The identification of the molecular mechanisms was the understanding factor of influencing disease outcomes (Kennan et al., 2014; Stauble et al., 2014). Foot rot is a common cause of lameness in cattle and occurs commonly when cattle are forced to walk through mud to obtain water and feed. It is also caused when a cut or scratch in the skin allows the infection to penetrate around the top of the hoof or between the claws. Sick animals should be kept in a dry place and treated with medication by a veterinarian.

Bovine rhinotracheitis

Infectious bovine rhinotracheitis (IBR) is responsible for the significant huge economic loss in the dairy industry worldwide which is caused by bovine herpesvirus Type 1 (BHV1). It represents a high-risk for bovine respiratory disease complex infection with BHV-1 and is associated with mild to severe respiratory disease. It can also show gastrointestinal, ocular, neonatal and neurologic disease as well as reproductive failure due to abortion and other genital symptoms (Infectious pustular balanoposthitis (IPB) and Infectious pustular vulvovaginitis (IPV) (Straub, 2001; Bosco Cowley et al., 2011; Gould et al., 2013). The disease popularly occurs in animals over 6 months of age by contact with infected animals, aerosol route and virus-contaminated semen from bovine herpesvirus-1 (BHV-1) infected bulls. A complication associated with IBR infection is its ability to establish latency unless stress conditions favour its reactivation (Fulton et al., 2013). Throughout the world, indirect enzyme-linked immunosorbent assay (ELISA) has been extensively used for the assessment of seroepidemiological investigation of IBR antibodies among the cattle population (Bosco Cowley et al., 2011; Shirvani et al., 2011; Cabonero et al., 2011; Iscan and Duman, 2011; Roshtkhari et al., 2012).

A new manifestation of BoHV-1 infection, the IPV was described in cows and bulls in the 1950s. Due to the inflammatory processes, it affects the respiratory, genital and other organ systems besides a wide range of clinical signs including abortion, infertility, respiratory problems, encephalitis, conjunctivitis, enteritis, and dermatitis (Straub, 2001). BoHV-1 virus can be shed intermittently and may also establish latency (Turin et al., 1999). The triggering factors for shedding in latent infection may include cattle movement, unfavourable weather conditions, and poor husbandry or diet (Thiry et al., 1987; Turin et al., 1999; Raaperi and Orro, 2014). By vaccination, the virus shedding at reactivation can be reduced but not completely eliminated (Bosch et al., 1997). Big differences in seroprevalence and disease incidence have also been observed (Ackermann and Engels, 2006; Raaperi and Orro, 2014). Since the 1980s, Veterinarians and farmers in Europe recognized the danger of BoHV-1 infection in cattle farms and implemented control programs to eradicate IBR/IPV in several countries. Some European countries or regions have already been declared IBR-free, and many others have introduced control programs (Raaperi and Orro, 2014).

PPR (goat plague)

Peste des petits ruminants (PPR) is caused by a morbillivirus that is closely related to the rinderpest virus mainly affecting goats, sheep and some wild relatives of domesticated small ruminants and camels. PPR was first reported in Ivory Coast in 1942 and now more than 70 countries have confirmed PPR within their borders and many countries are at risk of the disease being introduced. Domestic small ruminants get infected by wild ruminants as an epidemiological virus source (Figure 9) (Kinne et al., 2010). The Food and Agriculture Organization reported that PPR across 70 countries around the world, affects 30 million animals. Forty percent of countries fall in the Middle East and Asia while sixty percent of them are in the African continent. (Anonymous, 2015). PPR is dangerously characterized by high morbidity and mortality rates of up to 90% (Kumar et al., 2014). Affected animals suffer from high fever, depression, eye and nose discharges, along with severe pneumonia and diarrhoea. Fortunately, the PPR virus (PPRV) hardly crosses from animals to infect humans (Anonymous, 2015). Due to the availability of effective and safe live attenuated PPR vaccines for sheep and goats, the control program in some developing countries has been boosted. As a result, many countries are recognized by the OIE as being free from this disease. The rest of the developing countries are currently unable to develop and apply an effective strategy to control and eradicate the PPR virus.

The disease causes annual economic losses of billions of dollars each year affecting nearly 300 million families at risk of losing their livelihoods, food security and employment opportunities.

Bovine babesiosis (tick fever)

Bovine babesiosis is caused by intraerythrocytic hemoprotozoa *Babesia bigemina*. It is a tick-borne disease affecting the bovines in subtropical and tropical parts of Africa, Australia, America, and Asia. It was for the first time reported in India by Walker and Edward, in 1927. An annual economic loss to livestock in India due to babesiosis was estimated to be about 57.2 million US dollars (McLeod and Kristjanson, 1999). The climatic conditions of Punjab state are conducive for tick vector

Figure 9. Clinical signs of PPR in goats. (https://www.researchgate.net/figure/Clinical-signs-of-peste-des-petits-ruminants-in-goats-of-Ngorongoro-Tanzania-The_fig1_309313124)

survival. This disease has clinically been characterized by anaemia, fever, haemoglobinuria and sometimes death (Sharma et al., 2013). The zebu and buffaloes mainly act as a carrier but the crossbred cattle exhibited a higher rate of susceptibility (Jithendran, 1997). Typically, in buffaloes, the clinical symptoms reported are haemoglobinuria, anorexia, suspended rumination, reduced milk yield and depression (Singla et al., 2002; Rani et al., 2010; Patel et al., 2011). Due to the inverse age resistance, calves up to 9-12 months of age are generally resistant however the clinical symptoms of babesiosis in neonatal calves were inability to suckle, high fever, coffee colour urine, jaundice, and deep shallow respiration (Figure 10) (Karunakaran et al., 2011; Ven et al., 2013).

East coast fever

East coast fever (ECF), also known as theileriosis, is tick-borne and indigenous to the region, originally a parasite of the Cape buffalo (*Syncerus caffer*). It was first described in eastern Africa as Amakebe by Bruce et al., in 1910. It had been endemic and apparently recognised for centuries as a relatively mild disease of calves (Lawrence et al., 1992). As a result of rinderpest and the effects of the Boer war, the cattle populations of southern Africa depleted, resulting in an inadequacy to meet the multiple needs of the region (Figure 11) (Lawrence et al., 1992; Matiwos et al., 2022). Therefore, the cattle were

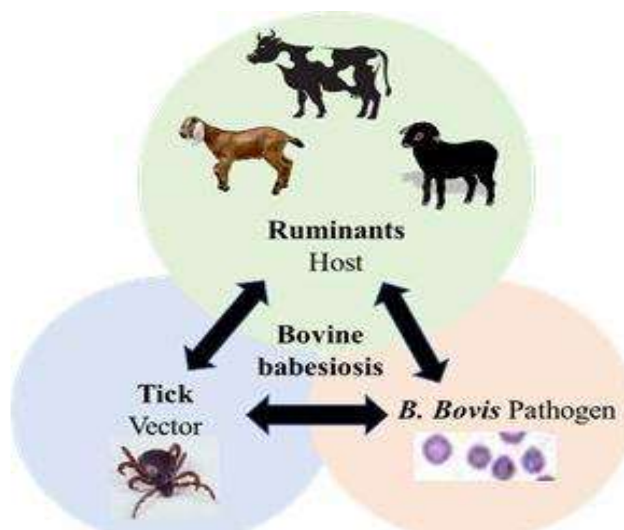

Figure 10. Bovine babesiosis in dairy animals. (https://link.springer.com/chapter/10.1007/978-3-319-70132-5_9)

imported from many sources where ECF had been existing almost unnoticed for generations in its milder form in the resistant indigenous animals of the region. It was only when the early European settlers when started to arrive in eastern Africa, and imported exotic cattle breeds. It was then that the disease was recognised and realized that the endemic disease in eastern Africa and the epidemic highly fatal disease in southern Africa were

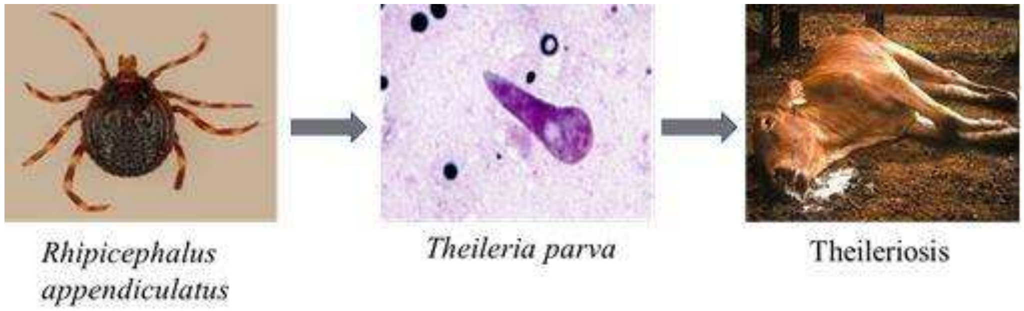

Figure 11. East coast fever in dairy animals. (https://m.facebook.com/Africanfarmresourcecentre/photos/how-to-control-east-coast-fever-cattle-diseaseeast-coast-fever-is-one-of-the-dea/2454384514830103/)

found to be the same (Kolakowski et al., 2022).

Ringworm

Affecting both animals and humans that mainly damage the superficial layer of skin, hair, nails and claw, ringworm, also known as dermatophytosis, is a contagious fungal disease caused by dermatophytes species (Aala et al., 2010). *Trichophyton, Microsporum* and *Epidermophyton*, these three genera are known to be pathogenic for both humans and animals (Figure 12) (Weitzman and Summerbell, 1995). The high incidence of fungal infection is mainly attributed to the intensive use of immunosuppression drugs in man and poor maintenance conditions around animals (Woodfolk, 2005).

Generally, the contaminated environment, diseased animals and infected fomites act as main source for infection among susceptible hosts through direct or indirect contact (Murray et al., 2005). The disease spreads more predominantly in poorly housed animals which helps in disease dissemination (Shams-Ghahfarokhii et al., 2009). Dermatophytosis is a significant public health problem worldwide, impacting millions of individuals, annually (Dalis et al., 2018; Ashwathanarayana and Naika, 2016).

Figure 12. Ringworm in dairy animals. (https://www.semanticscholar.org/paper/5.-Important-Mycotic-Diseases-in-Animal-Livestock-Ahmad-Gholib/353fb8266f424f88bd7ebe4ece09e80428bd2140/figure/1)

Milk fever

Milk fever (*Parturient paresis*) is one of the very serious and quite common metabolic diseases of the transition cow (Mulligan et al., 2006; Radostits et al., 2007). Milk fever is the main subject of research for over 50 years in the dairy industry focusing on the risk factors, epidemiology and pathogenesis (DeGaris and Lean, 2008). Periparturient health disorders are not totally independent events but rather complex interrelated disorders (Drackley et al., 2005; DeGaris and Lean 2008; Mulligan and Doherty, 2008). Breed, parity, milk production levels, nutrition and genetic predisposition have been suggested as determining factors in the pathogenesis of milk fever (Figure 13) (Mulligan et al., 2006). The key to the prevention of milk fever is management during late pregnancy and a close-up dry cow (Sharma, 2015). Multiple strategies are required to be designed for the management of hypocalcaemia and to enhance calcium mobilization in dairy cows, especially

Figure 13. Milk fever in dairy animals. (https://krishijagran.com/featured/ketosis-milk-fever-management-in-lactating-cattle/)

during the peri-parturient period (Amaral-Phillips, 2017). The most important economic loss of milk fever is the reduction in milk production, loss of animals due to culling and mortality and the medical cost of treatment of the animals (Thirunavukkarasu et al., 2010).

Neonatal calf diarrhoea

All over the world, neonatal calf diarrhoea (NCD) is one of the most dangerous diseases among new-born calves (<1 month old). NCD gives rise to notable levels of morbidity and mortality through several complications, for example- dehydration, acidosis, and solution depletion (Trefz et al., 2012; Meganck et al., 2015; Golbeck et al., 2018; Falkenberg et al., 2022). Presently, NCD is the major cause of economic loss in Feral cattle herds around the world (Picco et al., 2015). The cattle industry has become very advance regarding herd management and care, animal facilities, nutrition and feeding and importantly timely use of biopharmaceuticals. This disease may be stimulated by both infectious and non-infectious factors such as the intrinsic characteristics of the calf, its organic processes, veterinary treatment, management of the herd and environmental factors (Bendali et al., 1999; González-Bautista et al., 2021). Among the numerous infectious agents causing NCD, rotavirus, coronavirus, *Escherichia coli,* enterotoxin K99/F5 and *Cryptosporidium parvum* are recognized as the most essential pathogens (Kongsted et al., 2013). When tested, *C. parvum* and rotavirus are often detected in fecal samples (Figure 14) (Meganck et al., 2015). Recent studies have urged that concurrent infection of a number of pathogens may be necessary to model the pathophysiology of gastrointestinal diseases (Jang et al., 2019). It was proved by a study that the rate of co-infection was 55% in faecal samples obtained from diarrheic calves. Interestingly, the rate of co-infection in healthy calves was only 3% (Al Mawly et al., 2015).

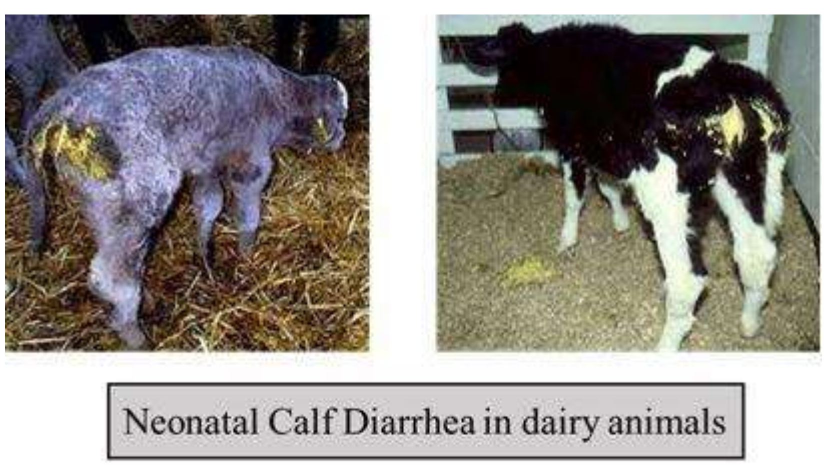

Figure 14. Neonatal calf diarrhea in dairy animals.
(https://www.sciencedirect.com/science/article/pii/S0749072008000996)

PREVENTION OF DISEASES

Anthrax

Regular annual vaccination of animals in endemic areas certainly prevents diseases from occurring. At least a month prior to expected disease occurrence in endemic areas, vaccination must be carried out. It is not recommended to open a carcass of an animal suspected to have died from anthrax.

Black quarter (black-leg)

A veterinarian must immediately be consulted for early treatment for the possible cure of the animal.

Foot and mouth disease

The external application of antiseptics contributes to the healing of ulcers and wards off attacks by flies. A mixture of coal-tar and copper sulphate in the proportion of 5:1 is recommended as a common and inexpensive dressing for the lesions in the feet of dairy animals.

Rabies (Mad dog disease)

Dogs must be vaccinated against rabies by the veterinary services of the community. If there is an outbreak of rabies, all the livestock in the community can be vaccinated.

Bluetongue

Livestock should be inspected closely with a particular focus on the lining of the mouth, nose and coronary band. In case of an animal has bluetongue, it must be brought to a veterinary hospital as quickly as possible.

Pox

Ethnoveterinary treatment suggests an external application of paste prepared by neem leaves, tulsi leaves each 100 g and turmeric powder- 50 g sprinkled with sufficient water. It should be continued for 3 to 5 days. The same mixture can be administered orally by diluting the paste with water.

Lumpy skin disease

All the viral infections, including this one, wreak havoc on the economy of animal farmers. This is a relatively new viral disease of animals and is spreading in Asian countries very fast, these days. A vaccination program is being launched in India to protect animals from such diseases.

Brucellosis of sheep

On the basis of symptoms alone, it is not possible to diagnose brucellosis. It can be suspected that humans in contact with animals suffer from undulant fever. The observation of poor breeding records in goat herds and evidence of mastitis could be an indication of the disease. Proper diagnosis can be done by serological tests on isolated organisms.

Tetanus

For proper protection, the sheep should be given 2 injections at 3 weeks intervals to develop a solid immunity. Proper hygiene and cleanliness at surgical procedures and castration should be observed.

Campylobactor abortion (vibriosis)

The rate can be reduced by antibiotics like chlortetracycline and concurrently through enhancing specific immunity. The use of inactivated vaccines may reduce the incidence of disease in a herd. The bulls can be treated by injecting antibiotic cream in the prepuce but there is no direct treatment for females.

Johne’s disease

Because the organism is more resistant to chemotherapeutics, the practical utility of treatment in clinical cases is poor. The affected animal should be segregated and their faeces properly disposed of. The vaccine reduces the incidence of disease. It consists of a non-pathogenic strain of Johne`s bacillus with an adjuvant. The calves soon after birth are inoculated with the vaccine subcutaneously and can be done in heavily infected herds as well.

Bovine ephemeral fever

Non-steroidal anti-inflammatory drugs are effective in preventing the onset of clinical signs when given daily during the incubation period and can induce rapid recovery when given after the onset of clinical disease (Uren et al., 1989).

Lesions

Recovering animals from this disease should not be stressed or worked on because relapse is likely. Complete rest is the most effective treatment. Anti-inflammatory drugs when given early in repeated doses for 2 to 3 days, are effective. Oral dosing needs to be avoided unless the swallowing reflex is functional. Rehydration with isotonic fluids and treatment with an antibiotic to control secondary infection may be warranted.

Rinderpest

Symptomatic treatment can help early cure the animals of this disease. Consultation with a veterinary doctor is essential.

Neonatal calf diarrhoea

This disease is controlled by the use of vaccines only (Maier et al., 2022).

Mastitis

Treatment success depends on the severity of the disease, nature of the aetiological agent involved and the extent of fibrosis. Complete recovery from bacterial infection can be obtained in cases of fresh infection but fibrosis has taken place, the recovery is only to a small extent. Drugs such as acriflavine, gramicidin and tyrothricin are no more in use and are placed with the more effective drugs, such as sulphonamides, penicillin and streptomycin.

Footrot

If the disease becomes a herd problem a foot bath containing a 5% solution of copper sulphate, placed once or twice a day, will help to reduce the number of new infections. In addition, mud holes and cement areas around the water troughs must be drained where cattle are likely to pick up the infection. Proper nutrition including a balance of protein, minerals and vitamins maximizes the hoof health. The pens and areas where cattle gather must be kept as clean as possible.

Bovine rhinotracheitis

This disease is controlled by the use of vaccines only.

PPR (goat plague)

No specific treatment is recommended as it is also a viral disease. However, mortality rates can be reduced by the use of drugs controlling parasitic and bacterial complications. Specifically, to prevent secondary pulmonary infections, oxytetracycline and chlortetracycline are recommended. Using a sterile cotton swab, lesions around the mouth, eyes and nostrils should be cleaned twice daily. It is observed that during an outbreak of PPR in goats, fluid therapy and anti-microbial such as enrofloxacin or ceftiofur along with mouth wash with 5% boroglyceride, can be of benefit in reducing the mortality. Isolation of affected goats from clinically healthy goats is the most important measure in controlling the spread of infection. A nutritious, palatable, soft, moist diet should be given to the affected animals. Vaccination is the most effective way to control PPR. Proper disposal of contact fomites and decontamination is a must and the carcasses of affected goats should be burned or buried at any cost.

Bovine babesiosis (tick fever)

Acaracide dipping is commonly used to control tick fever in endemic areas. In heavily infested areas, dipping may be done at a regular interval of every 4 to 6 weeks. The occurrence of resistance of ticks, chemical residues in cattle and environmental concerns over the continued use of insecticides has led to the use of an integrated strategy for tick control. Babesiosis can be eradicated by eliminating the host tick(s) however the babesiosis vaccines are highly effective and readily available to treat animals. Treating all the cattle on a regular interval of every two to three weeks with acaricides has given positive results. In countries where eradication is not in regular practice, tick control can reduce the incidence of disease.

ALLOPATHIC MEDICINES AND THEIR DRAWBACKS

The allopathic medicine can show a wide range of side effects and in some cases, these side effects of the drug cause animal death. Due to its high cost and occasional side-effects people have started using herbal medicines (Kala, C.P. 2005). Plant remedies are well-accepted alternatives to allopathic medicines due to their easy availability and cheap therapy as compared to costly pharmaceuticals (Sandya et al., 2006). Plant-derived medicines have negligible side effects and a single ethnoveterinary medicine works for many diseases.

ETHNOVETERINARY MEDICINES

Ethnoveterinary medicine can be defined as “the holistic, interdisciplinary study of local knowledge and its associated skills, practices, beliefs, practitioners, and social structures pertaining to the healthcare of animals. It belongs to the healthful husbandry of work, food and other income-producing animals for livestock production and livelihood systems for improving human wellbeing via increased benefits from stock raising (McCorkle et al., 1998). Ethnoveterinary medicine is the scientific term for traditional animal health care providing low-cost and safer alternatives to allopathic medicines (McCorkle, 1986; Guèye, 1999). To cover this area, research is often undertaken as part of a community-focused approach which serves to improve animal health and make availability of basic veterinary services in rural areas (McGaw and Eloff, 2008; Saratini and Giogri, 2022; van der Merwe et al., 2001; Vercelli et al., 2022). Further, ethnoveterinary medicines cover methods, practices, skills, knowledge and beliefs of people about the health care of their animals (McCorkle 1986). Ethnoveterinary medicine can play an important role in livelihood development and animal production. It is often considered the only available means for farmers to treat ill animals in many poor rural areas (Akhtar et al., 2000). These medicines popularly provide important and valuable alternatives to complement the western veterinary system. In late 1930, it was noticed that cattle fed on spoiled sweet clover died from haemorrhage due to the accumulation of a chemical, dicoumarin now known under the trademark dicoumarol (Said 1998). Therefore, it is eminently necessary to compile and spread this indigenous knowledge. In order to help and share with the people who use plants for animal health care and promote different conservation measures detailed documentation was warranted.

ELEMENTS OF ETHNOVETERINARY PRACTICE

Due to being less prone to drug resistance and having fewer harmful side-effects on the animals and environment, ethnoveterinary practices have re-started growing in the current era. The use of traditional ethnoveterinary practices is based on three main elements:

(i) Application of herbal products
(ii) Appeal to spiritual forces
(iii) Manipulation and Surgery

The natural products include the following components:

(i) Medicinal plants and by-products
(ii) Edible earth and minerals
(iii) Parts and products of animals
(iv) Other natural ingredients

Medicinal plants and by-products

Plants are the maximum used ingredients in the formulation of ethnoveterinary medicines. Whole plants and the parts thereof, such as flowers, leaves, seeds, bark, and fruits, are used in the preparation of ethnoveterinary medicine. Though about 100,000 species of plants are used by humans as medicine, food, fiber, fuel, shelter, oils, poisons, ornamentals, intoxicants, etc. At present over 35,000 plants are discovered as having healing properties. Due to specialized biochemical capabilities, plants synthesize and accumulate a vast variety of primary and secondary metabolites as natural chemicals (Cotton, 1996; Ihtesham et al., 2019). Due to economic and cultural factors, about 75% population of the world depends on medicines from plants. Of the proprietary medicines in the western market, 35% are from natural origins. However, it is believed that these medicines are derived from less than 0.1% of known plant species. For this reason, more than 100,000 secondary plant compounds have been isolated and identified from higher plants showing various biological properties. Their diverse structures are categorized into five main chemical classes. (i) The phenolics (flavonoids, phenols, quinones, lignins and tannins), (ii) terpenoids (monoterpenes, diterpenes, triterpenes, lactones, saponins and others), (iii) sulphur compounds (glycosylates, acetylenic thiophenes and disulphides) and (iv) nitrogen heterocyclic compounds (alkaloids, non-protein amino acids, amines and cyanogenetic glycosides) (v) polyacetylenes and certain organic acids are also the important bioactive natural products (Cotton, 1996; Mia et al., 2022; Assih et al., 2022; Ravishankar and Sireesha, 2021).

Edible earth and minerals

In ethnoveterinary preparations, edible earth, especially from ant and termite hills, is generally used. Limestone is used in decoctions as a commonly used edible type of earth.

Parts and products of animals

Many parts and products of animals such as bones, milk, butter, skin and hides and even urine and dung are ingredients of several ethnoveterinary medicines. Other ingredients including honey, vegetable oils and butter, salt, etc. are used for their healing and preservative properties (Table 1).

CONCLUSIONS AND FUTURE PERSPECTIVES

Indian dairy farming requires serious attention and needs better veterinary research facilities, especially in the field of epidemiology and deserves liberal funding because dairy animals suffer from life-threatening diseases. For planning, prevention and control of diseases that are endemic in Indian dairy farming, especially in the field of epidemiology, valid state-wise comprehensive research data are necessary otherwise implementation of control measures and eradication will be difficult. Animal diseases are not only affecting dairy farmers' economies adversely but also significantly affecting human health. It is believed that in the recent past, some of the emerging infectious diseases affecting human health have originated from animals. Therefore, it is important to safeguard animal health even for the maintenance of human health. For successful reduction of diseases, quick and correct diagnosis, epidemiological forecasting, safer and quality vaccines, and sanitation measures are imperative. Adequate infrastructure facilities for cold storage and transport facilities to transport the vaccines to remote areas are necessary for a country like India. Advanced diagnostic assays can help to accelerate the diagnosis and differentiation of diseases from others. Door-attending veterinary services and improved extension services for awareness to farmers will significantly enhance the possibility of controlling diseases in dairy animals. In developing countries, like India, the major drawback in the control of diseases is the lack of financial support, poor vaccination coverage and insufficient infrastructure interfering with the building of herd immunity. An interdisciplinary approach like veterinarians, para-veterinary officers, animal health scientists and NGOs need to take a leadership role while implementing animal disease control programmes. This will increase livestock production and their sustainability resulting in the alleviation of poverty in the rural areas of the country. The use of ethnoveterinary medicines is the old proven traditional methodology to enhance the overall immunity in animals and control prevalent diseases. This old treasure of knowledge needs scientific standardization through standard methods for its further popularity worldwide. The main aim of this compilation is to collect information regarding diseases in dairy animals and their possible prevention and cure by Indian ethnoveterinary medicinal plants.

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