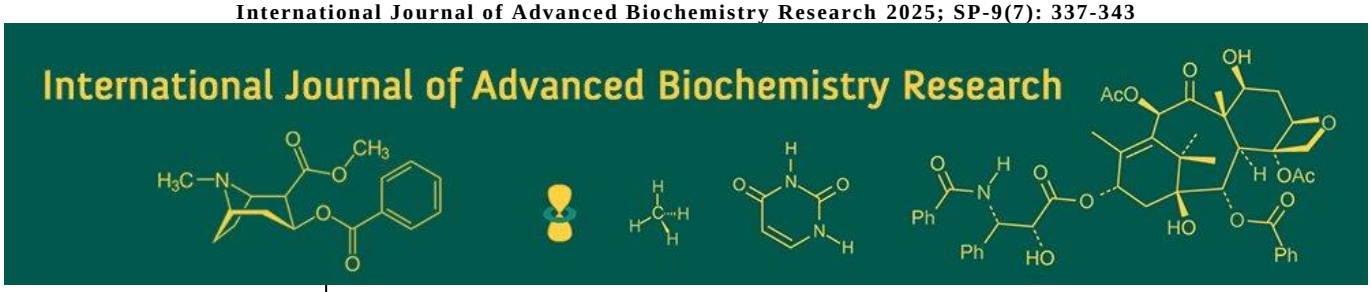

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Ethnoveterinary medicine: Role of medicinal plants in modern veterinary pharmacology

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Abstract
Ethnoveterinary medicine (EVM) has emerged as a promising field combining indigenous knowledge systems with modern veterinary pharmacology. It involves the use of medicinal plants and traditional practices for the diagnosis, treatment, and prevention of diseases in livestock and companion animals. As the global livestock industry faces mounting challenges including antimicrobial resistance, chemical residues in animal products, high treatment costs, and lack of accessible healthcare in rural areas, ethnoveterinary approaches offer viable and sustainable alternatives. This review examines the theoretical foundation of EVM, evaluates the pharmacological actions of selected medicinal plants, and presents scientific studies validating their efficacy in animal health. The focus is placed upon their modes of action, therapeutic uses, integration problems, and future prospect. Based on a combination of conventional wisdom and contemporary evidence, ethnoveterinary treatments have the ability to transform veterinary care in developing and developed countries alike.

Keywords: Ethnoveterinary, medicinal plants, veterinary pharmacology, treatment

Introduction
Livestock constitute the backbone of farm economies worldwide, and more so in developing countries, where they contribute significantly towards food security, household income generation, and cultural and socio-economic coherence. In nations of Asia, Africa, and Latin America, livestock play not only a role in the availability of dietary protein from milk, meat, and eggs, but also in supplying draft power, fertilizer for crops, and a vehicle for savings and investment. The Food and Agriculture Organization (FAO, 2021) [9] states that more than one billion people worldwide rely on livestock for their livelihood. Animals in rural and tribal societies are frequently valued as assets that have economic as well as social worth, being markers of wealth, tradition, and status.

Though livestock play a key role in the survival of rural economies, veterinary healthcare provision in remote and underserved communities is a significant challenge. These include the excessive price of industrially produced drugs, inadequate infrastructure, inadequate numbers of trained veterinary experts, and a lack of awareness about diseases among farmers that prevent early diagnosis and treatment of diseases in animals. In most areas, the per capita number of veterinarians is much lower than prescribed, resulting in a reliance on traditional or unofficial healers and home-based remedies (Rangnekar, 1998) [29]. Moreover, the increasing expenditure of traditional medicines and growing resistance of pathogens against synthetic antimicrobials have prompted an emergent demand for alternative and more sustainable livestock healthcare solutions.

Under such a challenging situation, ethnoveterinary medicine (EVM) has come forth as an indispensable and affordable healthcare option, particularly for marginalized groups. EVM refers to a system of indigenous knowledge and practices developed over generations, usually transmitted orally. This indigenous system of veterinary medicine encompasses the employment of locally used medicinal plants, ethnodiagnostic methods, religious rituals, herbal preparations, and region-specific animal husbandry practices. The applicability of EVM is extremely high in areas where modern veterinary services are poor, unaffordable, or culture-incongruent (Mathias-Mundy & McCorkle, 1989) [20].

Ethnoveterinary practices have an intimate association with the cultural, ecological, and spiritual life of local populations.

For instance, in India and Africa, decoctions, pastes, or infusions from medicinal plants like neem (*Azadirachta indica*), turmeric (*Curcuma longa*), tulsi (*Ocimum sanctum*), and ashwagandha (*Withania somnifera*) are prepared by traditional healers to treat diseases from gastrointestinal infections and parasitic infestations to wounds, mastitis, and respiratory infections (Kala *et al.*, 2004; Yineger *et al.*, 2007) [14, 41]. These treatments are frequently grounded in generations of empirical experience and community confirmation, providing a low-cost, culturally suitable, and environmentally friendly means to animal health.

Increased international concern about issues like antimicrobial resistance (AMR), lingering drug residue contamination in animal-based food commodities, and the environmental toxicity of chemical inputs has further stimulated interest in ethnoveterinary methodology. The World Health Organization (WHO, 2015) [39] and World Organisation for Animal Health (OIE) have called attention to the judicious use of antibiotics in animals, leading to the development of natural and plant-based alternatives. Within this context, EVM is being seen increasingly not just as a system of folklore or subsistence-level medicine, but as a complementary and integrative system that can effectively augment or even replace standard veterinary therapies in certain circumstances.

Recent ethnoveterinary knowledge validation by science has given added evidence to traditional practices. Many pharmacological and phytochemical studies have validated the antimicrobial, antiparasitic, anti-inflammatory, and immunomodulatory activities of medicinal plants employed in EVM (Lans *et al.*, 2007; Katiki *et al.*, 2013) [19, 15]. For example, Allium sativum (garlic) has exhibited broad-spectrum antibacterial activity, whereas Emblica officinalis (amla) has exhibited potent antioxidant and hepatoprotective activity. In addition, as opposed to synthetic drugs, herbal medicines tend to have fewer and milder side effects and less likelihood of developing resistance, hence a more sustainable long-term solution for animal healthcare systems.

Additionally, ethnoveterinary knowledge application does not conflict with the concept of One Health—a multiprofessional approach that acknowledges interdependence between human, animal, and environmental health. By keeping chemical residues in food chains to a minimum, minimizing dependence on antimicrobials, and enhancing biodiversity by conserving medicinal plant species, EVM addresses integrative and sustainable management of livestock health. A number of international development organizations and research centers have begun documenting and incorporating EVM practices into animal health policy and extension programs (Martin *et al.*, 2001; FAO, 2021) [25, 9].

Theoretical Framework of Ethnoveterinary Medicine

Definition and Scope

Ethnoveterinary medicine (EVM) is the total body of traditional knowledge, beliefs, skills, practices, and cultural understanding developed by rural and indigenous societies over many centuries, specifically to address animal health and disease treatment. It is an oral system of veterinary healthcare firmly rooted in local ecological and cultural contexts. The domain of EVM is wide, covering:

- The application of certain herbs in the treatment of everyday infections like mastitis, foot rot, diarrhea, and parasitic infections. For example, *Azadirachta indica* (neem) is used for ectoparasites as well as skin conditions, while *Curcuma longa* (turmeric) is used for wound healing and inflammatory conditions (Lans *et al.*, 2007) [19].
- Detailed information on local floras and faunas, which allows healers to recognize and collect medicinal plants by habitat, season, and plant maturity. Such ecological information is frequently region-specific and suited to local biodiversity.
- Traditional methods of preparation, such as decoctions (boiling plant materials in water), pastes (powdered herbs with oil or water), tinctures (extracts in alcohol), and local treatments (ointments and poultices). These preparations are aimed at maintaining the effectiveness of bioactive constituents and maximizing their therapeutic action (McCorkle *et al.*, 1996) [22].
- Spiritual and cultural aspects, comprising healing rituals, chanting, animal sacrifice, and observance of taboos, usually under the intervention of local healers or shamans. These elements demonstrate an integrated understanding of health comprising both the physical and metaphysical aspects (Mathias & McCorkle, 2004) [21].
- EVM also converges with a number of existing systems of conventional medicine like Ayurveda, Siddha, Unani, and Traditional Chinese Veterinary Medicine (TCVM). What, however, makes EVM unique is its animal-focused practice, with the goal of promoting low-cost, community-oriented, and sustainable health options. These systems exist alongside and sometimes inform one another, which creates a continuum between animal and human healthcare wisdom (Moyo & Masika, 2009) [24].

Over the last few years, EVM has come under spotlight not just as a heritage cultural practice but also as a possible source of integrative veterinary medicine—a new approach that tries to integrate traditional proven practices with conventional treatments for total care of animals (Koech *et al.*, 2021) [16].

Development from Folklore to Science

Historically, ethnoveterinary practices were marginalized by mainstream veterinary science, often labeled as anecdotal, untested, or even superstitious. However, a paradigm shift began in the late 20th century as researchers from disciplines such as ethnobotany, veterinary pharmacology, phytochemistry, and anthropology began systematic documentation and scientific evaluation of these traditional practices. The contemporary scientific world now acknowledges that numerous EVM preparations have demonstrable pharmacological activity. This shift from oral folk to scientific acceptance is motivated by:

- Phytochemical analysis, which has isolated many bioactive constituents like alkaloids, flavonoids, tannins, saponins, and essential oils in the traditionally used plants for animal health. For instance, *Withania somnifera* (ashwagandha) contains immunomodulatory and anti-inflammatory activity (Dar *et al.*, 2015) [8].
- Advanced pharmacological methods such as High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), and Nuclear Magnetic Resonance (NMR) spectroscopy that

facilitate isolation, identification, and standardization of active principles that are accountable for therapeutic action (Sasidharan *et al.*, 2011) [31].

- *In vivo* and *in vitro* confirmatory research of traditional medicines in a controlled laboratory setting. Research on Allium sativum (garlic) and Eucalyptus globulus has shown intense antibacterial and antiparasitic effects, justifying their application in traditional veterinary medicine (Katiki *et al.*, 2013; Yineger *et al.*, 2007) [15, 41].
- Clinical trials and ethnopharmacological surveys, which assess the efficacy, dosage, toxicity, and safety profiles of herbal preparations. These studies not only validate efficacy but also address concerns about potential side effects and standardization (Lans *et al.*, 2007) [19].

As a result, a new sub-discipline known as veterinary phytotherapy has emerged, focusing on the scientific study and application of medicinal plants in veterinary practice. It recommends the incorporation of proven herbal medicine into conventional animal health systems as an integrated, and in many instances, safer complementary option to chemical drugs, particularly in the age of antimicrobial resistance (WHO, 2015) [39]. In addition, global institutions like the World Organisation for Animal Health (WOAH) and Food and Agriculture Organization (FAO) have started including ethnoveterinary knowledge in their livestock improvement and animal health projects because of its ability to enhance the welfare of animals and the accessibility of healthcare in rural areas (FAO, 2021) [9].

Phytopharmacological Basis of Medicinal Plants in Veterinary Medicine

Medicinal plants yield a very broad range of secondary metabolites that act as defense compounds against predators and pathogens. Although not involved directly in plant growth, these compounds provide strong biological activity in animals and humans.

Table 1: Bioactive Phytochemical Classes and Their Actions in Veterinary Pharmacology

Class of Compound	Examples	Actions in Animals
Alkaloids	Berberine, Atropine	Antimicrobial, analgesic, antiparasitic
Flavonoids	Quercetin, Kaempferol	Antioxidant, anti-inflammatory
Terpenoids	Menthol, Azadirachtin	Antiparasitic, insecticidal
Saponins	Diosgenin, Ginsenosides	Immunomodulatory, cholesterol-lowering
Tannins	Ellagitannins, Proanthocyanidins	Antidiarrheal, antimicrobial
Glycosides	Cardiac glycosides, Anthraquinones	Laxative, cardiovascular modulation
Essential oils	Eugenol, Limonene, Thymol	Antiseptic, antifungal, insect repellent

These compounds tend to have synergistic actions that increase the therapeutic effectiveness of the plant (Table 1). In contrast to synthetic medications, which tend to attack one pathway, phytochemicals address several molecular targets and thus are extremely effective against complex pathophysiological disorders in animals.

Overview of Outstanding Medicinal Plants Utilized in Veterinary Practice

Ethnoveterinary medicine has increased in popularity over the past decade or so as a sustainable and culturally appropriate intervention in animal health. Different medicinal plants have been scientifically proved to contain therapeutic agents and are now widely used in livestock and poultry management for both preventive and curative applications. The following is a comprehensive review of some of the most notable plant species used in ethnoveterinary medicine, their pharmacological actions, traditional uses, and existing evidence.

***Azadirachta indica* (Neem)**

Neem is among the most sacred medicinal plants of Indian traditional systems, such as Ayurveda and EVM. It is found extensively throughout South Asia and tropical regions and is regarded as a natural pharmacy due to its numerous therapeutic properties.

Active Phytochemicals: Azadirachtin, Nimbin, Salannin, Quercetin, and other limonoids.

Pharmacological Actions: Antibacterial, antifungal, antiviral, insecticidal, immunostimulant, antiparasitic.

Veterinary Applications:

- For external use as an antiseptic and in the treatment of skin infections and wounds.
- As a strong acaricide against ticks, lice, and mites.
- Neem leaf oil or neem leaf extract is applied in sprays or washes for the control of ectoparasites on cattle, goats, and poultry.
- Internally as a liver stimulant and bitter tonic**.**

Scientific Evidence

Biswas *et al.* (2002) [6] showed the inhibitory action of neem against Staphylococcus aureus, a causative agent of bovine mastitis. Sharma *et al.* (2014) [33] noted neem oil's efficacy in controlling tick infestations and healing wounds in cattle.

***Curcuma longa* (Turmeric)**

Turmeric, or Haldi, is a golden yellow rhizome popularly grown in India and Southeast Asia. In veterinary medicine, it is prized for its anti-inflammatory, antioxidant, and hepatoprotective effects.

Bioactive Compound: Curcumin

Mechanism of Action: Suppresses pro-inflammatory cytokines, free radical scavenging, and induction of bile flow.

Veterinary Uses

- Used topically for wound healing and infection.
- Feed-administered orally to maintain liver function, alleviate mastitis, and fight arthritis.
- Antioxidant used to decrease hepatotoxicity caused by aflatoxin in poultry.

Scientific Evidence

Yarru *et al.* (2009) [40] found that turmeric supplementation enhanced performance and alleviated aflatoxin residues in poultry liver. Chattopadhyay *et al.* (2004) [7] recorded

curcumin's function in modulating inflammation and oxidative stress in animal models.

Aloe vera

Aloe vera, locally referred to as Ghritkumari in India, is a succulent plant widely famed for its calming, cooling, and healing properties. The gel of its leaf is a combination of mucopolysaccharides, vitamins, and anthraquinones.

Therapeutic Properties: Anti-inflammatory, immunostimulatory, wound healing, laxative.

Veterinary Uses

- Topically applied in the case of burns, wounds, and skin infections in cattle and goats.
- Orally used for digestive upsets, ulcers, and colic.
- Mixed with other herbs for mastitis and udder injury treatment.

Scientific Evidence

Kumar *et al.* (2014) [17] noted enhanced healing of cutaneous wounds in goats treated with *Aloe vera* gel. Chandegara and Varshney (2013) noted aloe's impact on preventing inflammatory reactions and promoting epithelial recovery.

***Allium sativum* (Garlic)**

Garlic, a key culinary herb, is also a long-established medicinally used plant in human and veterinary practice. Its sulphur-containing compounds are largely responsible for its pharmaceutical action.

Bioactive Constituents: Allicin, Ajoene, Diallyl disulfide, S-allyl cysteine.

Actions: Anthelmintic, antimicrobial, antiviral, cholesterol-lowering, immune-modulating.

Veterinary Uses

- Treated gastrointestinal parasites in goats and sheep.
- Added to poultry diets to minimize microbial load and enhance gut health.
- Boosts immunity in stressed or ill animals.

Scientific Evidence

Aydin *et al.* (2011) [5] established a significant coccidial oocyst shedding reduction in broilers that were treated with garlic powder. Reuter *et al.* (1996) [30] documented garlic's antimicrobial activity against a wide range of pathogens.

***Ocimum sanctum* (Tulsi)**

Popularly known as Holy Basil, *Ocimum sanctum* holds a special place in Indian homes as a spiritual and healing plant. It is one of the powerful adaptogens and stress-reducing agents.

Key Phytochemicals: Eugenol, Carvacrol, Ursolic acid, Rosmarinic acid.

Therapeutic Benefits

Antiviral, antibacterial, antipyretic, immunomodulatory. Administered to alleviate respiratory ailments and promote resistance to stress.

Veterinary Applications

- Tulsi leaves or extracts are incorporated in feed or drinking water while in transit for stress reduction.
- Administered in respiratory infections and coughs during changing seasons in poultry and ruminants.

Scientific Evidence

Mondal *et al.* (2009) [23] showed that tulsi supplementation in poultry alleviated transportation stress and strengthened immunity. Singh *et al.* (2018) [35] documented increased phagocytic activity and antibody titers in animals treated with tulsi extract.

Andrographis paniculata

Also referred to in Ayurveda as Kalmegh and across the world as the "King of Bitters," this herb possesses bitter flavor but very effective therapeutic activity, particularly in hepatic and inflammatory disorders.

Active Phytoconstituent: Andrographolide

Actions: Hepatoprotective, anti-inflammatory, antioxidant, immunostimulant.

Veterinary Applications

- Administered in the treatment of subclinical mastitis in dairy cows.
- Improves liver function in animals with toxicities.
- Maintains gastrointestinal health in ruminants and poultry.

Scientific Evidence

Akbar (2011) [4] discussed more than 30 clinical and experimental studies affirming its hepatoprotective and anti-inflammatory potential in animals. Misra *et al.* (2011) [18] described that Andrographis extract enhanced milk production and decreased somatic cell count in mastitis-infected cows.

Clinical Uses of Ethnoveterinary Plants

Ethnoveterinary medicinal plants provide a promising, environmentally friendly, and affordable option for conventional veterinary medicines. They are employed extensively in preventive and curative situations on a variety of livestock, such as cattle, buffalo, sheep, goats, pigs, and poultry. The efficacy of these plants is due to their antimicrobial, antiparasitic, anti-inflammatory, immunostimulatory, hepatoprotective, and adaptogenic activities. These drugs are gaining more and more evidence through pharmacology and clinical trials to become relevant to being incorporated into official animal health schemes. The next table provides an overview of some major ethnoveterinary medicinal plants and their use in various disease conditions and species.

Table 2: Clinical Applications of Notable Ethnoveterinary Medicinal Plants

Disease Condition	Medicinal Plant(s)	Target Species	Mode of Administration	References
Mastitis	*Curcuma longa*, *Azadirachta indica*, *Andrographis paniculata*	Cattle, Buffalo	Topical paste, decoction, feed additive	Yarru *et al.*, 2009 [40]; Biswas *et al.*, 2002 [6]; Akbar, 2011 [4]
Internal Parasites	*Allium sativum*, *Azadirachta indica*, *Carica papaya* (seeds)	Goats, Sheep, Poultry	Crushed bulbs/seeds mixed in feed	Aydin *et al.*, 2011 [5]; Lans *et al.*, 2007 [19]
Skin Diseases	*Aloe vera*, *Azadirachta indica*	Cattle, Canines	Topical gel, neem oil bath or spray	Kumar *et al.*, 2014 [17]; Sharma *et al.*, 2014 [33]
Respiratory Disorders	*Ocimum sanctum*, *Eucalyptus globulus*, *Cinnamomum camphora* (Camphor)	Poultry, Calves	Steam inhalation, extract in drinking water	Mondal *et al.*, 2009 [23]; Lans *et al.*, 2007 [19]
Stress/Transport Shock	*Ocimum sanctum*, *Withania somnifera* (Ashwagandha)	Poultry, Small Ruminants	Powder mixed in feed or drinking water	Mondal *et al.*, 2009 [23]; Singh *et al.*, 2018 [35]
Liver Dysfunction	*Andrographis paniculata*, *Aloe vera*	Ruminants, Pigs	Decoction, feed supplement, oral extract	Akbar, 2011 [4]; Kumar *et al.*, 2014 [17]

Medicinal plants may be applied in different forms (Table 2): infusions, decoctions, pastes, powders, oils, or as a feed additive. The complex action of medicinal plants makes them suitable for both prophylaxis and treatment in animal husbandry**.**

Scientific Validation and Modern Research Trends

In the last few decades, ethnoveterinary medicine (EVM) developed from anecdotal folklore to an organized science. Contemporary pharmacology, phytochemistry, toxicology, and molecular biology have all played important roles in substantiating many of the traditional assertions. EVM is now recognized more and more as a source of useful therapeutics for dealing with the issues such as drug resistance, environmental pollution, and food safety in animal production systems.

Key Areas of Research in EVM

- **Molecular Mechanism of Action:** Active plant constituents (e.g., alkaloids, flavonoids, terpenoids) are under investigation for their action on cellular receptors, enzymes, and signaling pathways in animals. Curcumin, for example, inhibits the NF-κB pathway, suppressing inflammation at the molecular level (Aggarwal & Harikumar, 2009) [2].
- **Pharmacokinetics and Bioavailability:** The absorption, distribution, metabolism, and excretion (ADME) of plant-based bioactives are being profiled in livestock. Challenges such as poor bioavailability of curcumin and allicin are being addressed through nanoencapsulation and phytosome technologies (Siviero *et al.*, 2015) [36].
- **Toxicological Safety and LD_{50} Testing:** Toxicology tests are applied to the plants utilized in EVM for ascertaining safe dosages. Sub-acute and chronic toxicity tests aid in determining the therapeutic index, particularly for known-risk substances (e.g., Ricinus communis, Datura stramonium).
- **Comparative Efficacy with Synthetic Drugs:** Clinical trials are conducted to compare herbal preparations with synthetic antibiotics, anti-inflammatories, and antiparasitics. Several herbal supplements have similar or synergistic effects with less side effect.

Prominent Case Studies and Results

- **Neem-Based Tick Control:** Islam *et al.* (2020) [13] illustrated that *Azadirachta indica*-based topical sprays efficiently suppressed tick infestation in cattle and performed better than deltamethrin, with fewer environmental effects.
- **Curcumin for Mastitis:** Aggarwal *et al.* (2007) [3] illustrated that curcumin-based topical ointments helped in alleviating mastitis symptoms sooner than cloxacillin creams, with enhanced udder health and lowered somatic cell count.
- **Garlic in Poultry Production:** Addition of Allium sativum (garlic) powder to layer diets increased egg production, yolk coloration, and shell resistance. Better gut health and nutrient utilization were major factors (Onibi *et al.*, 2009) [27].

Institutional Research Initiatives

A number of international and national bodies are encouraging research on phytotherapeutics for veterinary applications

- **IVRI (Indian Veterinary Research Institute):** Working to standardize herbal therapy for mastitis, parasitism, and metabolic disorders.
- **ILRI (International Livestock Research Institute, Kenya):** Examines ethnoveterinary knowledge for livestock diseases in African pastoral systems.
- **Universities in Europe and North America:** Research at institutions such as Wageningen University (Netherlands), University of Guelph (Canada), and University of Reading (UK) are at the forefront of herbal feed additive research and regulation modeling.

Plant-Based Veterinary Therapeutics' Advantages

The resurgence of interest in ethnoveterinary remedies is due to their multifaceted benefits, especially in organic and low-input livestock systems. Some key advantages include:

- **Safety:** Plant-based remedies generally have lower toxicity and minimal drug residues, making them suitable for use in lactating and meat-producing animals. Their shorter or negligible withdrawal periods align with food safety regulations (Patil *et al.*, 2015) [28].
- **Cost-Effective:** The majority of medicinal plants are locally sourced and can be processed on-farm, thus minimizing the economic load on smallholder farmers.
- **Sustainability and Environmental Safety:** Herbal products are biodegradable and non-polluting, as opposed to most synthetic drugs that pollute water and soil (Lans *et al.*, 2007) [19].
- **Cultural Relevance:** Rural farmers tend to have deep belief in traditional practices, making it easier to achieve greater acceptance and adherence when using herbal remedies.
- **Multifunctionality:** Most herbs have actions on more than one physiological system—providing

antimicrobial, anti-inflammatory, and immunomodulatory effects at the same time. This integrated efficacy is consistent with traditional medicine philosophy and promotes long-term animal health.

These characteristics make EVM particularly relevant in organic farm systems, where synthetic drugs are prohibited or limited.

Challenges in Adoption and Commercialization

Although promising, ethnoveterinary practices have a number of challenges to their mainstream veterinary integration:

- **Dosage and Quality Standardization:** Climatic variations, type of soil, time of harvest, and method of preparation lead to varying constituents of plants, producing different therapeutic effects. Inadequate Good Agricultural Practices (GAP) for medicinal plants worsens the situation (WHO, 2004) [37].
- **Regulatory Holes:** There are few countries with standard guidelines for sanctioning herbal veterinary drugs. This gap in regulation hinders commercialization as well as restricts farmers' access to standardized products (OECD, 2012) [26].
- **Safety and Toxicity Issues:** Certain ethnoveterinary plants, though effective, are hazardous at higher concentrations. Datura stramonium, for instance, has tropane alkaloids that impair the central nervous system. This requires scientific regulation of dosage and vigilance (Savo *et al.*, 2012) [32].
- **Professional Gap in Veterinarians:** Formal education on ethnoveterinary systems is not covered in most veterinary programs, and hence they remain underutilized and in doubt among the professional fraternity.
- **Industrial and Commercial Neglect:** Inadequate funding, lack of intellectual property rights for indigenous knowledge, and low profitability discourage investment by pharmaceutical firms.

Savo *et al.* (2012) [32] report that fewer than 10% of ethnoveterinary knowledge documented all over the world have been formally scientifically tested or commercialized.

Future Scope and Integration into Modern Veterinary Practice

To achieve its full potential, ethnoveterinary medicine requires a multidisciplinary and multi-dimensional approach. The destiny of EVM is to be integrated with contemporary veterinary science with emphasis on safety, efficacy, and sustainability.

Integrated Strategies

- **Pharmacovigilance Networks:** Develop national and regional structures to evaluate the safety, efficacy, and side effects of herbal veterinary medicines in real-time (WHO, 2013) [38].
- **Reforms in Veterinary Curriculum:** Integration of EVM modules into undergraduate and postgraduate veterinary education can empower future veterinarians with knowledge of effective and safe plant therapies.
- **Public-Private Partnerships (PPP):** Partnerships among governments, NGOs, research bodies, and herbal product industries can facilitate product development, validation, and dissemination.
- **Medicinal Plant Cultivation:** Encouraging contract farming of medicinal species guarantees quality raw material and offers an economic alternative for rural farmers.
- **Documentation and Digitalization:** Community-based projects for documenting indigenous veterinary practices through digital means and local languages can help preserve and standardize valuable knowledge.

The Role of One Health Approach

The One Health approach, which incorporates human, animal, and environmental health, offers a strong platform to promote the application of ethnoveterinary medicines. Low environmental impact and potential cross-species utility of herbal remedies favor alignment with One Health objectives—particularly in zoonotic disease management, antimicrobial resistance, and environmental contamination.

Conclusion

Ethnoveterinary medicine is a rich and untapped resource situated between ancient wisdom and contemporary science. Usage of medicinal plants in animal healthcare offers a cost-effective, sustainable, and acceptable mode of therapy compared to synthetic medication. As there is increasing scientific evidence and institutional endorsement, phytotherapeutics are likely to be a central feature in veterinary pharmacology. A judicious blend of preserving traditional know-how through modern research instruments shall ensure safe, efficacious, and extensive usage of these age-old medicines. Veterinary Uses:

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