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REVIEW

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Intensification of Ethnoveterinary Practices for Better Animal Health and to Prevent Antimicrobial Resistance

Vaidya Tanmay[1] | Chitnis Swarali[1] | Umap Swati*[1] | Somkuwar Arju[1]

[1]Department of Veterinary Pharmacology and Toxicology, Nagpur Veterinary College, Maharashtra Animal and Fishery Sciences University, Nagpur.

Correspondence
Umap Swati, Department of Veterinary Pharmacology and Toxicology, Nagpur Veterinary College, Maharashtra Animal and Fishery Sciences University, Nagpur.
Email: swatiumap@mafsu.in

Conflict of Interest

The authors declare that the manuscript was formulated in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors Contribution

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Abstract

Ethnoveterinary medicine is booming in the subcontinent due to the emergence of anti-microbial resistance amongst microorganisms and its trifling side effects. Common livestock diseases like Foot and Mouth Disease (FMD), mastitis, mange, Black Quarter (BQ) are difficult to cure because of AMR. Various plant parts like leaves, roots, and flower extract have anti-bacterial properties, which can be used effectively in treating diseases and combat AMR. Herbal preparations such as extracts, decoctions, paste, and mixtures are used widely. Ethnopharmacology involves the active components of plant extracts, their action, composition and effect on various health conditions. Plants like *Cocos nucifera*, *Aloe barbadensis* and *Musa paradisiaca* are widely used in India to treat bacterial, viral, parasitic, as well as fungal infections. These therapies are cost-effective and have high reliability. This review is about the usage of ethnoveterinary practice in diverse parts of India by using their active components with respect to antimicrobial properties

KEYWORDS

Anti-microbial resistance, Ethnoveterinary medicine, livestock diseases, herbal preparations, active components.

INTRODUCTION

India is an Agro-based Nation where the primary Industries include agriculture, livestock husbandry, and Management. Dairy and Agriculture are important contributions to the country's economy, and maintaining animal health is a crucial part of it. India is a developing country, and animal husbandry is its backbone (Phondani et al., 2010). Most of the rural people have a deep connection with their livestock. Millions of years ago, before the establishment of modern Western drugs, the tribal people realized the use of plants and herbs for curing livestock diseases. Ethnoveterinary medicine is the traditional understanding of people's beliefs and practices around the use of floras and their products in animal therapy. This traditional knowledge has built a sustainable relationship between human animals and nature. The advantage India has over other countries is its vast biodiversity, which accounts for 8% of global plant resources. (Balaji et al., 2010) Amongst the old literature, Rigveda mentions cattle management. (Kulkarni et al., 2014). Ayurveda and Yajurveda include herbal remedies for various veterinary diseases. From the Vedic period (3500 to 200 BC), Indian physicians (Vaidya) such as Dhanvantari, Atreya, and Nagarjuna derived knowledge about the healing process of plants as veterinary medicine from pioneering texts of the Atharva Veda Rigveda and Ayurveda. Legendary individuals like Patanjali, Bhaga Bhatta, Sushruta and Hindu Hippocrate Charak practiced National Indian Medicine. (Shrivastava et al., 2017). Sahilhotra wrote the first book on veterinary care in Sanskrit, which described specialized techniques such as using local herbs to heal livestock. (Rath et al., 2020).

STEADFASTNESS AND RELEVANCE OF ETHNOVETERINARY MEDICINE IN CURRENT TIMES

Around 80% of individuals in under-developed nations manage livestock diseases primarily with traditional approaches, according to World Health Organization. These traditional practices of curing diseases are entitled as ethnoveterinary medicine. It is efficient and also intense. (Warren, 1991). Farmers may easily obtain, produce and deliver ethnoveterinary remedies at little or no cost. These traditional methods apply to all cattle species and every area of maternal specialization. (Sri Balaji et al., 2010). Throughout the ages people have created methods for maintaining the health of animals through home cures, surgery, manipulation, husbandry tactics and related mystical religious rituals. Combined for ages this creates, today recognized as ethnoveterinary medicine. (Mc Corkle, 1995). Ethnoveterinary medicine is "comprehensive, multidisciplinary study of traditional knowledge, skills, and social structures related to the well-being and healthy husbandry of food producing animals, and other income generating animals, with an eye towards developing applications for livestock production and livelihood systems and ultimately enhancing human well-being through stock raising benefits. (Mc Corkle, 1998. The inability to afford the traditional western health care system and its negative repercussions have made it necessary to rely on such extra rural wisdom in these areas on a continual basis. (Kumar, 2002).

REWARDS AND SHORTCOMINGS OF EVM

Because plant products with acknowledged medical qualities are much more readily available to the local rural people than Western remedies and provide a more affordable and convenient substitute for

pricey pharmaceuticals, ethnoveterinary medicine is environmentally sound and sustainable. It is inexpensive, widely accessible, and simple to administer. It is typically applied topically or orally. Since certain plants that have been used traditionally to treat specific diseases are still in use today and have been for generations, certain tribal people prefer to utilize them in veterinary care because they are readily available, provide assurance that the ailment will be cured, and have few or no negative side effects. For instance, *Eucalyptus grandis* has been shown to be useful against *Haemonchus contortus* and *Aloe vera* for mastitis along with tamarind paste. EVM is already well-known to livestock owners, and the procedure is taken into consideration in the absence of a viable treatment option.

Some shortcomings related to EVM are in some instances, treating a large herd with EVM is improper. For instance, it is almost impossible to clean the wounds and treat pastoralist herds of 1000–2000 animals using warm ashes mixed with salt that are suffering from FMD. Standardizing herbal remedies is also challenging because different portions of plants have varying concentrations of active ingredients, and certain medicinal plants have seasonal availability. The majority of ethno-veterinary treatments lack scientific approval, and using and preparing them takes time and is inconvenient. These factors also limit the usage of EVM. Animal health is negatively impacted by the use of unsuitable techniques such as cauterizing cows' vulva to induce heat, relieve urinary obstructions, and tr-eat infectious infections. The importance of ethnoveterinary medicine is realized in current times not in actual practice but government also taking effort to support traditional medicine. The central government has taken an active interest in long-neglected indigenous systems of medicine in the form of Ayush. Honorable prime minister of India, Narendra Modi en-marked a minister of state to look after the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy (AYUSH). It represents a traditional form of Indian Medicine. (Prabhakar Maurya et al,.2015).

ETHNOVETERINARY MEDICINE TO COMBAT ANTIMICROBIAL RESISTANCE

High importance discriminating drug usage and their residues in milk and animal products is a major setback in India. These drug residues developed drug-registered microbes that hinder the cure of disease and lead to antimicrobial resistance. (Nair et al.,2017). Because rural people have reduced access to modern drugs, ethnoveterinary practices are gaining importance across the globe. These traditional healing practices are only passed on to the next generations by word of mouth and need better documentation. (Raikwar et al., 2015). The term "antimicrobial" or "antibacterial" drug resistance describes a microorganism's insensitivity to an antimicrobial medication, even while the host can withstand its highest dose. There are two varieties: acquired and natural. Intrinsic resistance is the term used to describe an animal's innate or genetic resistance to an antimicrobial agent or target site or the drug rapidly becoming inactive in the bacterial cell. Acquired resistance describes an organism's development of resistance to an antimicrobial agent to which it was previously susceptible. Acquired resistance may develop by mutation or gene transfer. The extensive and improper use of antimicrobial medications has been identified as the primary cause of acquired resistance in bacteria (Sandhu, 2006). Antimicrobial medications typically aid in the selection of bacteria or bacterial strains that are naturally resistant rather than creating resistance in the bacteria. Resistance in microorganisms is also mediated by biochemical processes. There are several

different biochemical mechanisms underlying bacterial resistance, including changes in drug-binding sites, drug penetration, metabolic pathways, and/or drug-inactivating enzymes. Changes in the permeation of drugs, changes in binding sites, modifications to the metabolic pathway, and drug-inactivating enzymes are some of these. (Sandhu, 2006).

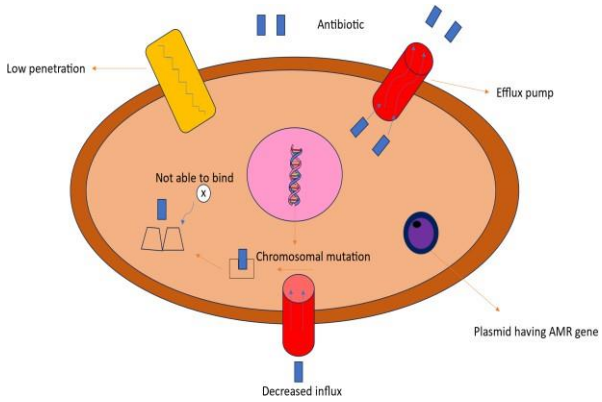

Figure 1: Mechanism of resistance development against antibiotics in microorganism

Methicillin Resistance Staphylococcus aureus (MRSA) and extended-spectrum beta-lactamase (ESBL) - producing E. coli are two primary antibiotic resistant organisms which have been procured from mastitis milk and been a great hazard to human race. (Rath 2020). The improper use of this medication may cause environmental contamination and be seen as residues in animal-origin products, especially in milk and remaining in milk it can potentially detrimental impact on human health. (Groot and Hooft, 2016) Anaphylactic shock, allergy, immuno-pathological effects, carcinogenicity, hepatotoxicity, reproductive disorders, and bone marrow toxicity are long-term effects, even the development of anti-microbial resistance in bacteria that may cause potential infections in man and animals and just a few of the toxic effects that antibiotic residues may cause. (Darwish et al., 2013) Livestock diseases like wounds, dysentery, fever, cough, skin infections, enteritis, mouth ulcers, foot lesions, stomach problems, bone fracture, conjunctivitis, poisoning, cataract, arthritis, pneumonia, hematuria are easily cured with herbal drugs. Also, FMD, HS, BQ, ephemeral fever and parasitic infestations can be treated. (Lokhande, 2021). Through the traditional knowledge system, the evaluation is 'systemic' as compared to 'atomic' or 'cellular' in western medicine. (Nair et al., 2017). Most widely in age-old system of treatment leaves and roots are used as they contain higher concentration of the bioactive compounds.

Elements of EVM include parts of plants (leaves, bark, roots and sometimes whole plant), edible earth and minerals, and parts of animal products (more commonly milk, cow urine and other parts). More than a hundred thousand biologically active secondary plant chemicals reported in plants by researchers; these are categorized into four foremost chemical classes, have been identified from higher plants thus far. These consist of nitrogen compounds (alkaloids, amines, non-protein amino acids, cyanogenetic glycosides), sulphur compounds (glycosylates, disulphides, acetylenic thiophenes), terpenoids (monoterpenes, lactones, diterpenes, saponins), and phenols (phenols, flavonoids, quinone, tannins, lignin). It is also known that several organic acids and polyacetylene exist. (Cotton, 1996). Edible earth and

minerals include edible earth from termites and anthills, along with limestone for extractions. Parts and products of animals such as skin and hide, bones, milk butter, and even urine and dung are ingredients of EVM used from ancient time. Also, in some of the preparation honey, vegetable oils, and salt are added because of their healing preservative and flavoring properties. (Balaji, 2010).

Widely used herbs in India for EVM are *Aloe vera*, *Curcuma longa*, *Azadirachta indica*, *Mimosa pudica*, *Lantana camara*, *Moringa oleifera*, *Ocimum* sp., *Papaver somniferum*, *Piper betle*, *Tamarindus indica*, *Acacia nilotica*, *Musa paradisiaca*, *Nerium oleander*, *Annona squamosa* and *Lawsonia inermis*. Bacterial illnesses are treated with herbs and spices such as coriander, bay leaves, asafoetida, and chilies fenugreek, pepper; and some fruits, vegetables, and tubers such as ginger, garlic, onion, lemon, bitter gourd, radish, lady finger, coconut, and mustard are effective constituents of several traditional curative formulations. Limestone, coconut oil, gingelly or sesame oil, salt, jaggery, ghee, and butter are additional ingredients. (Kulkarni et al., 2014). The holy 'Tulsi' is the Queen of herbs and also known as the legendary 'Incomparable one' of India, is one of the holiest and most precious of the many remedial herbs found a in terrain. (Pattanayak et al., 2010)

The following Table no. 1 depicts the use of various parts of plants and their preparations in treating common livestock diseases.

Table 1: Various parts of plants used in diseases along with their method of administration EVM (Lavekar et al., 2014)

S. No.	Scientifi name of plant	Common name	Parts of plant used	Illness / Disease condition	Preparation for administration
1.	*Aegle marmelos.*	Bel	Leaves	BQ	Mix the leaves with cow dung, boil and make into paste- topical application
				Metritis	Crush and mix 300gm of leaves with boiled rice starch. Orally once for 3 days
2.	*Allium sativum* L.	Garlic	Bulbs	Ephemeral fever, HS	Mix 1 garlic with pepper and Leucas leaves and grind well. Drench 2 ghottas twice daily.

				Ringworm	paste from tuber -apply on affected part daily till recovery.
3.	*Allium cepa L.*	Onion	Bulbs	Ephemeral fever	Diospyros leaves + onion + garlic + pinch of turmeric powder and mix well in 1 litre water. Drench twice daily for 2 days
4.	*Asparagus racemosus*	Shatavari	Root and leaves	Mastitis	The paste of leaves to be applied over affected udder. The animal should be milked separately.
5.	*Cynodon dactylon*	Durva	Leaves	Impetigo, vaccinia virus, aspergillus	Boil 3-4 handful of glass in water along with neem leaves. Cool and give orally.
6.	*Azadiracta indica*	Neem	Leaves, oil	Abscess	Fresh leaves into paste. Drain the pus and then apply paste topically twice a day till recovery
				BQ	Apply leaf paste topically
				Foot rot	Equal portion of neem and Annona leaves crush and prepare paste. Apply paste on wound once daily for 5-6 days and cover with moderately tight bandage.
7.	*Aloe barbadensis*	Aloe vera	Leaves	Mastitis (*Staphylococcus aureus*, *E. coli*,	Prepare a paste from 2-3 leaves of aloe, 2-3 handful of mimosa and

				pseudomonas sp.)	tamarind leaves (for mastitis with purulent discharge, yellow milk and flakes). After milking, smear the paste to affected quarter twice a day for 3 days.
8.	*Annona squamosa*	Custard apple	Leaves, Seeds	Ectoparasites	Crush seeds and leaves and boil in oil and allow to cool. Apply over body for 5 days locally twice a day.
				FMD	Leaves into fine paste. Topically over lesions.
9.	*Acacia catechu*	Khair	Bark and heart wood	Ectoparasites	Apply powder externally to affected parts
10.	*Ocimum sanctum*	Tulsi	Leaves	FMD	Decoction of 100gm ocimum leaves+ 100gm coriander leaves + 1 onion + 100gm cucumber in 1L water.
			Whole plant	Wide range of non-specific bacterial infection	Whole plant extract or powder form, drench 75-100gm daily twice a day for 3-5 days.
11.	*Bacopa monnieri*	Brahmi	Leaves	Impetigo	Crush the leaves (75-100gm) and use internally as well as externally. Whole plant can be used as infusion juice powder or paste
12.	*Cocos nucifera*	Coconut	Shell	Mange	To make a sticky paste, burn a coconut shell,

					ground it into a powder, and then add coconut oil. Once a day, apply the paste to the affected region until the infection is resolved.
13.	*Citrus limon*	Lemon	Leaves, Fruit	Abscess, Mastitis	Ripe fruit + lemon juice + calcium hydroxide. Make a fine paste and apply after draining the pus.
14.	*Curcuma longa L.*	Turmeric	Rhizome	Mastitis, FMD, abscess	Paste from fresh rhizome (30-40gm) or powder from dry rhizome to be applied over lesions after thorough cleaning. Twice a day topically till complete healing
15.	*Musa paradisiaca*	Banana	Fruit	FMD	Put one crushed *Semecarpus anacardium* seed in banana. 1 daily orally for 4 days.
			Stem	Ringworm	Water /sap oozing out from stem of freshly cut banana tree. Apply on lesions externally till recovery.
16.	*Moringa oleifera*	Drumstick	Leaves	Ephemeral fever	Moringa leaves (75-100gm) + neem leaves + 2 leaves of Betel + 1/4th quantity of jaggery and mix with 2 glasses of goat milk. Drench twice a day for 2 days.
17.	*Peganum*	Wild rue	Leaves and	Mild mastitis	Smoke of leaves or

	harmala		branches		branches for 5-7 days to affected quarter of udder.
18.	*Tetradenia reparia*	Ginger bush	Leaves and flowers	Mastitis	Leaves crushed into fine paste and applied over the affected quarter for 5 days
19.	*Withinia somnifera*	Ashwaga ndha	Roots	Acute mastitis	Paste of 200gm of freshly crushed roots to udder for 1 week.
20.	*Nerium oleander*	Rose bay	Root bark	Leprosy	Oil from root bark to be applied externally over affected parts.
21.	*Zingiber officinale*	Ginger	Rhizome	*Aspergillus sp, Pseudomonas sp.*	Make a fine paste of ginger rhizome and mix well with 1 litre water. Drench twice daily for 3 -4 days minimum.

For their antibacterial properties against methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumonia, Acinetobacter baumannii, Citrobacter freundii, Enterococcus, Streptococcus pyrogens, Bacillus subtilis, and Micrococcus sp., cocos nucifera-carp were compared with gentamicin and ciprofloxacin. The antibacterial activity was attributed to potential bio-components, which included β-sitosterol, alcohol palmitoleyl, cycloartenol, and tocopherol. Microsporum canis, M. gypseum, M. audouinii, Trichophyton mentagrophytes, T. rubrum, T. tonsurans, and T. violaceum have all been shown to be susceptible to action from coconut shell. This activity was mostly ascribed to the elevated concentration of chemicals phenolic. In a different study, virgin coconut oil stopped Candida albicans from growing. (Lima et al., 2015).

Table 2: Shows several plants used in EVM with their active principles and their proven mechanism of action for pharmacological action.

SL. NO	NAME OF PLANT	PLANT IMAGE	ACTIVE COMPONENT	MECHANISM OF ACTION	REFERENCE
1.	Acacia nilotica		Tannins (catechin gallate)	It changes the mechanical integrity and permeability of cell membrane and affect metabolism leading to cell death.	Rather et al., 2015
2.	Acacia catechu		Catechin (tannins)	It interfere in cell membrane permeability of bacteria leading to cell death. (bactericidal)	Kumari et al., 2022
3.	Allium sativum		Allicin, ajoene	The chemical interaction of with enzymes containing thiol-thioredoxine reductase, alcohol dehydrogenase by oxidation.	Bhatwalkar et al.,2021
4.	Allium cepa		Allicin	It cause non-adherence of cell wall thus interfering in cell metabolism.	Chakraborty et al., 2022

5.	Aloe barbadensis		Emodin	It inhibit extracellular protein production and increases re-epithelialization.	Sanchez et al., 2020
6.	Aegle marmelos		Aegelin /Marmelin	The saponins cause seepage of proteins and certain enzymes from the cell. Terpenoids cause dissolution of cell wall of microbes. Steroids cause leakage from lysosomes.	Mujeeb et al., 2014
7.	Asparagus racemose		Shatavarin (1-4) saponin	It inhibits oxytocin induced contractions, uterine sedative. In mastitis -reduce inflammatory response and inhibit vascular permeability.	Alok et al.,2013
8.	Annona squamosa		Annotemoyin (flavonoid)	The bacterial membrane destabilisation and is cytotoxic.	Kumar et al.,2021
9.	Azadirachta indica		Tetranortriterpenoid, limonoid	It breakdown the bacterial cell wall, inhibiting their viability.	Alzohairy et al.,2016

10.	Bacopa monneirri		Betulinic acid, Wogonin (flavonoids)	Have a bactericidal activity.	Chaudhari et al., 2004
11.	Boerhevia diffusa		Qiundizidine	Have broad spectrum anti-bacterial activity of root powder.	Mishra et al.,2014
12.	Citrus limon		Limocitrin, orientin, vitexin (flavanones, flavanol)	It impede the growth of fungal hyphae, gram negative and positive bacteria, and both .	Klimek et al.,2020
13.	Cocos nucifera		tannins (anthelmintics) Phenols (antifungal) Tocopherol (antibacterial)	It bind to parts present in cuticle, oral cavity, cloaca of nematode	Lima et al.,2015
14.	Coriandrum sativum		Linalool (essential oil)	It inhibits growth of bacteria	Laribi et al., 2015

15.	Curcuma longa domestica		Curcumin	It alter mitochondrial membrane potential and decreases concentration of calcium ions	Amalraj et al.,2016
16.	Cynodon dactylon		Luteolin, apigenin	cytotoxic activity.	Al-snafi, Ali 2016
17.	Moringa oleifera		Ethanolic extract	It inhibit the growth of pseudomonas sp. And staphylococcus aureus.	Paikra et al.,2017
18.	Musa paradisiaca		Rutin (flavonoid)	It scavenges free radicals and inhibit growth of gram-negative bacteria.	Karuppiah et al 2013
19.	Nerium oleander		Methanolic extract	It inhibits NO production in concentration dependent manner.	Atay et al., 2018
20.	Ocimum sanctum		Linoleic acid, alkaloids (fixed oils)	It inhibits growth of bacteria.	Pattanayak et al., 2010

21.	Peganum harmala		Beta - carboline, harmine (alkaloid)	Have monoamine oxidase inhibitor action.	Iranshahy et al.,2019
22.	Tetradenia reparia		Diterpenes	It is more sensitive towards Staphylococcus aureus, Listeria sp., Bacillus cereus. Active against biofilm of staphylococcus - disruption of organised structure	Panda et al.,2022
23.	Withinia somnifera		Withanolide D, methanol	Its activity is comparable to chloramphenicol. Cytotoxic reduction (bactericidal).	Saleem et al., 2022
24.	Zingiber officinale		6-/8-/10-gingerols	It affects membrane integrity and inhibit biofilm formation. Decreases guanosine monophosphate and inhibit ergosterol production.	Mao et al.,2019

CONCLUSION

In order to ensure that the benefits of this information are adequately documented for future generations, further scientific evaluation of herbal treatment is necessary for phytochemical, biological, preclinical and clinical investigations to maximize livestock benefits. In recent eras, AMR has been a major hindrance in curing common livestock diseases. Ruminant diseases like mastitis, FMD, and BQ are not cured due to the emergence of AMR, and this leads to economic setbacks for India. Prolonged, irrational use of antibiotics, higher doses of drugs, and use of newer-generation antibiotics are causing AMR in microbes. This renders useful drugs ineffective. Because of this, it has become the need of the hour to reduce the use of antibiotics but use similarly potent and effective methods. This can be achieved by increasing the usage of medicinal plants. EVM is lagging behind due to limited research and documentation, lack of standardization, and quality control. The use of plants and herbal drugs with the same anti-bacterial effect and the added advantage of easy availability and administration has encouraged upcoming generations to take EVM to avoid AMR. Bacterial, viral, fungal, parasitic, and mycoplasmal diseases can be efficiently cured without any side effects of these herbs. Closing the knowledge breach between traditional and scientific fields is crucial in current time. Awareness among people is necessary to use herbal medicine effectively with synthetic drugs to synergize its effects to decrease the cost of treatment as well as to neutralize the toxic effects and reduce excessive use of antimicrobials.

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