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REVIEW ARTICLE

Ancient Wisdom of *Ayurveda*: The Anti-inflammatory Benefits of Herbs for Managing Mastitis in Dairy Animals in South Asia

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Abstract

Mastitis, characterized by mammary gland inflammation due to microorganisms, significantly reduces dairy animal productivity by up to 70%. Clinical mastitis prevalence stands at 11%, with sub-clinical cases at a staggering 77%, highlighting its substantial impact on milk yield. Given the escalating concern of antibiotic resistance, exploring alternative therapies for mastitis treatment, particularly herbal remedies from *Ayurveda* and Ethno-veterinary practices, is imperative. Literature on herbs used in bovine mastitis within South Asian countries was meticulously gathered from diverse sources, including books and electronic databases like Web of Science, PubMed, ScienceDirect, Google Scholar and domestic literature. A comprehensive review identified 83 herbs with documented anti-inflammatory properties, assessing their potential in treating mastitis in dairy animals. Constituents such as flavonoids, polyphenols, terpenoids, alkaloids, vitamins, and minerals were scrutinised for their anti-inflammatory effects. Additionally, formulations mentioned in the ancient Indian veterinary *Sanskrit* manuscript *'Ashvavaidyakam'* have been revealed to verify their ability to mitigate inflammation associated with mastitis in the future. This review synthesizes traditional wisdom with contemporary scientific evidence to advocate for further research and dialogue. It underscores the potential of herbal therapies to develop effective and sustainable mastitis control strategies in South Asian dairy practices. Plant-based remedies are highlighted for their ability to reduce production losses and veterinary costs, thereby proving their therapeutic significance for dairy farmers. The integration of ancient knowledge with modern scientific findings presents promising avenues for addressing mastitis in dairy animals. Embracing herbal remedies offers not only economic benefits but also contributes to the sustainability of dairy farming practices in South Asia. Further research in this area is crucial to harness the full potential of alternative therapies in mastitis management.

Major Findings: A total of 83 herbs with documented anti-inflammatory properties were identified for mastitis treatment. Active constituents such as flavonoids, polyphenols, terpenoids and alkaloids exhibit significant therapeutic potential. Herbal formulations from *Ashvavaidyakam* offer promising leads for mastitis management in dairy animals.

Keywords: *Ayurveda*, Dairy, Herbs, Mastitis, Veterinary

1. Introduction

South Asia is a southern sub-region of the Asian continent, defined both geographically and ethnically-culturally. As commonly conceptualized, the modern states of South Asia (Figure 1) include Afghanistan, Pakistan, Maldives, India, Bangladesh, Bhutan, Nepal and Sri Lanka[1]. In South Asia, the worship of certain plants and animals as sacred has likely been practiced for a very long time[2]. For example, a group of six plants commonly worshipped by Asian people has also been noted for their wound-healing, antimicrobial and

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anti-inflammatory properties in *Ayurveda*[3]. *Ayurveda* is an alternative medicine system with historical roots extending back to ancient times in South Asia.



Figure 1. Map of South Asia.

Ancient Indian literature on *Ayurveda* delves deeply into the realm of *Pashu Ayurveda*, offering invaluable insights into dairy animals. Moving to the 21st century, dairy farming is now India's foremost self-sustaining industry, constituting the major rural employment division and contributing significantly to rural income, with one-third of this income originating from dairy farming. During the White Revolution era, India saw impressive daily processing of approximately 1.41 million kilograms of milk, generating revenue of Rs. 2,458.7 billion in the fiscal year 2023. However, alongside technological advancements, modern dairy farming faces substantial health challenges for dairy animals. One of the most economically burdensome diseases affecting dairy animals today is Mastitis, known as *Stana Shotha* or *Stana Vidradhi* in *Ayurveda*, characterized by the inflammation of the mammary gland. Mastitis can lead to a staggering reduction in milk yield, up to 70%. Studies reveal a prevalence rate of 11% for clinical mastitis and 77% for subclinical mastitis. The economic impact is profound, with India experiencing an annual loss of Rs. 3,000 crores due to clinical mastitis and Rs. 4,000 crores due to subclinical mastitis, totalling approximately Rs. 7,000 crores per year[4].

Mastitis, an inflammation of the mammary gland, can arise from various microorganisms, including bacteria, fungi, and algae. This condition is associated with a wide array of pathogens, which are epidemiologically classified into two main groups: contagious and environmental. Contagious pathogens, such as *Staphylococcus aureus*, *Streptococcus agalactiae*, *Staphylococcus epidermidis*, *Mycoplasma* spp., and *Corynebacterium bovis*, often cause persistent subclinical infections that may occasionally develop into clinical cases. On the other hand, environmental mastitis, triggered by pathogens such as *Escherichia coli*, *Klebsiella* spp., *Streptococcus dysgalactiae*, and *Streptococcus uberis*, typically leads to clinical episodes that are generally shorter in duration.

In ancient *Ayurveda* texts, *Stanya* (breast milk) is described as an *Upadhatu*, or secondary tissue, of *Rasa* (the lymphatic system). The structure of the *Stana* (breast) is primarily composed of *Twaka* (skin), *Kandara* (connective tissues), *Mamsa* (muscle tissue), *Rasavahini* (lactiferous ducts), and *Granthi* (glandular lobes or acini), along with a significant network of *Rakthavahini* (blood vessels). Diseases affecting these components result in *Stanyajavikara* (breast disease), known as *Stana Vidradhi* (mastitis). In addition to *Shotha* (inflammation), the breast can also develop *Vrana* (ulcers), *Granthi* (benign tumours), and *Arbuda* (malignant tumours)[5]. The causes, symptoms, and treatments for these breast conditions are comparable to those found in other parts of the body. Although *Stana Vidradhi* (breast abscess/mastitis) shares similarities with other types of *Vidradhi* (abscesses), its treatment approach may have some variations. Consequently, *Acharya Sushruta*, *Madhava*, and *Bhavaprakasha* have described these disorders under *Stana Roga* (breast/udder diseases). *Vagbhata* also provides a brief description of *Stana Vidradhi* alongside general abscesses. *Kashyapa* describes a condition called *Stana-Vajra* or *Stana-Keelaka* (thread-like appearance in the breast) instead of *Stana Vidradhi*. Traditional herbal remedies and formulations rooted in *Ethno-Veterinary practices* and *Ayurveda* were widely utilized in ancient India. Thus, it is crucial to validate and bring these proven remedies and herbs back into use for improving animal health[6].

2. Aim of the Study

The article aimed to identify the species of plants studied for anti-inflammatory activity in bovine mastitis across South Asian countries by reviewing available online and offline research data. South Asian countries such as India, Pakistan, Bangladesh, Nepal, and Sri Lanka share similar geographical areas and medicinal flora. These plants could collectively be used by farmers as a low-cost, effective treatment for mastitis, which is a major veterinary disease in the dairy industry.

3. Methods

Literature on herbs used in bovine mastitis in South Asian countries was searched from numerous sources, including books, and electronic databases such as PubMed, Web of Science, ScienceDirect, Google Scholar, and other domestic sources. The Latin names of all plants adhere to the nomenclature specified in the 'World Flora Online'[7].

4. Single Herbs

4.1 *Ardraka* / Ginger / *Zingiber officinale* Roscoe

The extracts of *Zingiber officinale*, from the family *Zingiberaceae*, have antimicrobial and anti-inflammatory properties effective in inhibiting the growth of three prominent mastitis-causing bacteria: *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Streptococcus agalactiae*. As the concentration of red ginger extracts increased, their antimicrobial effectiveness became more evident, resulting in larger inhibition zones for bacterial growth. Among the three bacteria tested, *S. epidermidis* exhibited the highest sensitivity to the red ginger extracts, followed by *S. aureus* and *Streptococcus agalactiae*, across all concentrations[8]. The compounds responsible for the effects of ginger oleoresin are likely Gingerol and Shogaol, which are known for their pungent properties. Along with Gingerol and Shogaol, Hexadecanoic acid and Tuberonic acid are also responsible for the anti-inflammatory activity of *Z. officinale*[9]. Additionally, it was observed that the Zingibain enzyme, derived from the phenolic compounds in *Z. officinale* extract, led to the precipitation of outer protein membranes, disruption of the cell wall, and leakage of cellular contents and energy in *S. aureus*, *S. epidermidis*, and *Streptococcus agalactiae*. Thus, *Z. officinale* is worth considering as an alternative treatment for mastitis in dairy animals[10].

4.2 *Tulasi* / Holy Basil / *Ocimum tenuiflorum* Linn

One of the studies revealed that the intra-mammary infusion of *Ocimum tenuiflorum*, a member of the family *Lamiaceae*, shows an enhancement in the activity of polymorphonuclear cells (PMN) in the bovine mammary gland. The administration of *O. tenuiflorum* extract to cows notably increased the concentration of myeloperoxidase, an enzyme found in leukocytes that plays a crucial role in the cell's oxygen-dependent antimicrobial defenses[11]. When combined with H_2O_2 and halides, it forms a highly effective antibacterial system targeting pathogens[12]. The rise in enzyme levels coincided with indicators of acute inflammation, suggesting that these enzymes play a crucial role in the leukocyte inflammatory response[13]. The principal constituents of *O. tenuiflorum*, eugenol (71.3%) and linolenic acid (43-64 %), help reduce oedema, which is responsible for its anti-inflammatory activity[14]. The anti-inflammatory action has been observed in both acute and chronic inflammation by the inhibition of both the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism[15]. This reinforces the potential of *Tulasi* as an herbal option for managing bovine mastitis.

4.3 *Haritaki* / Chebulic Myrobalan / *Terminalia chebula* Retz

Terminalia chebula, belonging to the family *Combretaceae*, is called the '*Mata*' (mother) in *Ayurveda* and the 'King of Medicine' in Tibet. It is always listed at the top of the list in the subject of *Dravyaguna Vigyana*, i.e., *Ayurveda Materia Medica*, due to its extraordinary healing power[16]. A study has indicated that crossbred cows (*Bos taurus* x *Bos indicus*) exhibit a higher susceptibility to bovine subclinical mastitis compared to Kankrej (*Bos indicus*) and Gir (*Bos indicus*) cows. Using 16S rDNA PCR techniques, researchers identified *E. coli*, *S. aureus, P. aeruginosa* and *B. megaterium* as the

bacterial pathogens responsible for subclinical mastitis. Additionally, *in vitro* research suggests that *T. chebula* could serve as an effective alternative herbal treatment for bovine mastitis, offering various beneficial phyto-constituents[17]. In *T. chebula*, most of the phyto-constituents are hydrolysable tannins containing phenolic carboxylic acids, namely gallic acid, ellagic acid, chebulic acid and gallotannins. The phenolic compounds possess anti-inflammatory properties and are responsible for its pharmacological activity[18].

4.4 *Shatavari* / Asparagus / *Asparagus racemosus* Willd

Asparagus racemosus, of the family *Liliaceae*, is well-documented for its immunomodulatory, antioxidant, and anti-inflammatory properties in *Ayurveda* (API), Indian (IP), and British (BP) Pharmacopoeias. It contains sarsasapogenin and oligospirostanoside glycosides, which are responsible for its immunomodulatory properties[19]. The presence of saponins (shatavarin), racemosol, liposomes[20], steroids, and triterpenoids[21] likely contribute to its anti-inflammatory activity. Kumar et al. explain how the supplementation of *A. racemosus* reduced milk somatic cell counts and the prevalence of sub-clinical and clinical mastitis. None of the cows screened had clinical mastitis during the experimental period, whereas two cows in the control group developed clinical mastitis. *Shatavari* reduced the somatic cell count in milk, indicating a low level of intra-mammary infection[22]. Additionally, it was reported that the peripartum supplementation of a *Shatavari*-based polyherbal formulation at 250mg/kg body weight for 60 days significantly reduced the incidence of mastitis, sub-clinical mastitis, and milk somatic cell counts in crossbred cows, either by enhancing the phagocytic and bactericidal capacity of neutrophils and immunoglobulin-G levels or by reducing peri-parturient stress[23].

5. Polyherbal Formulations

5.1 Ointment *'Mastilep'*

In one of the single case studies on clinical mastitis, Ointment *Mastilep* was used along with allopathic medicines in crossbred cattle[24]. Ointment *Mastilep* was applied locally to the udder twice a day for 5 days, and the cow recovered completely. The contents of *Mastilep* produce anti-inflammatory (Table 1), antibacterial, analgesic, antihistaminic and immunomodulatory effect[25].

5.2 Mastitis *Lepa*

The National Dairy Development Board (NDDB) of District Anand in the state of Gujarat, India, has promoted the use of Ayurveda Veterinary Medicine (AVM) for more than 20 ailments. NDDB has created a robust database on the cure rates of each formulation, which may be used as a tool to further popularize the same. They performed a study at the field level to assess the effectiveness of Ethno-Veterinary Herbal Preparations (EVHP) as a viable alternative for managing mastitis in dairy cattle. Their findings indicated that EVHP achieved an overall clinical success rate of 92.09% in treating mastitis cases. To cure bovine mastitis, they have used *Aloe vera* (250 gm), turmeric powder (50 gm), calcium hydroxide/lime/*Chuna* (15 gm), and mustard oil (150 ml) to prepare a *Lepa*, i.e., paste. Along with the application of *Lepa* over the affected part, lemon fruits were fed to the affected cattle[33]. Furthermore, *the* University of Transdisciplinary Health Sciences and Technology (TDU) in the Bengaluru district of Karnataka state has also mentioned an Ethno-Veterinary Practice (EVP) treatment protocol for chronic mastitis. Along with *Aloe vera*, turmeric powder, calcium hydroxide, and mustard oil, they have mentioned adding two pieces of *Cissus quadrangularis*, i.e., *Asthishrinkhala*, blending it to form a reddish paste to apply in chronic mastitis[34]. The anti-inflammatory activity of the contents of this preparation is mentioned in Table 2.

6. Survey Study

6.1 India

In India, a study was conducted to document Ethno-Veterinary Practices (EVPs) followed in dairy animals' common diseases across rural Punjab of India, divided into three zones: the Sub-mountainous region, Central Plains, and South-Western Plains. Plants reported to be used by the surveyed people included *Azadirachta indica*, *Piper nigrum*, *Citrus limon* and *Allium sativum*[41]. Additionally, another

Table 1. Anti-inflammatory activity of the contents of '*Mastilep*' ointment

Sr.no.	Latin Name	*Sanskrit* Name	English Name	Family	Vernacular name	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
1	*Curcuma longa* Linn	*Haridra*	Turmeric	Zingiberaceae	Haldi	Polyphenol - Curcumin I, Curcumin II (monodemethoxycurcumin), Curcumin III (bisdemethoxycurcumin), Volatile oil	26
2	*Glycyrrhiza glabra* Linn.	*Yashtimadhu*	Licorice / Liquorice	Fabaceae	Mulethi	Flavonoids, Licoflavanone, Dihydrostilbenes, Glycyrrhetic acid, Glycyrrhizic acid, Glycyrrhizin Glycyrrhetinic acid, Licochalcone A and E, Isoliquiritigenin, Licocoumarone	27
3	*Paederia foetida* Linn.	*Gandhaprasarini*	Skunkvine, Chinese fever vine	Rubiaceae	Gandhabhaaduli	Iridoids like Paederioside A, B, C, Nepetin, 3,4-seco-lup-20(29)-ene-3-oic acid	28
4	*Cedrus deodara* (Roxb. ex. D. Don) G. Don	*Devdaru*	Himalayan Cedar	Pinaceae	Deodaar	Deodarone, Cedrol, β-Caryophyllene, α-Pinene, Flavonoids	29
5	*Eucalyptus globulus* Labill.	*Tailaparna*	Blue-gum tree, Australian Gum tree	Myrtaceae	Neelgiri	Eucalyptol (1,8-cineole), α-pinene, β-pinene, Limonene	30
6	*Sulfurium*	*Shuddha Gandhaka*	Purified Sulphur	-	Gandhara	Cyclic octatomic molecules S_8[31]	32

survey explored the ethno-veterinary herbs used by the Chiru tribes in Manipur, Northeast India, and found that this tribe mainly used *Curcuma longa* and *Zingiber officinale* to treat mastitis in bovines[42]. Furthermore, a survey was conducted to collect ethno-veterinary data on medicinal herbs from local animal keepers, Traditional Healers (THs), and inhabitants of different age groups from seven rural villages in the East Khasi Hills district of Meghalaya in Northeast India. This survey revealed that these people used *Musa paradisiaca*, *Cynodon dactylon*, and *Curcuma longa* to treat mastitis in animals[43]. Similarly, a field survey documented ethno-veterinary medicinal herbs in the South and North Andaman districts of the Andaman and Nicobar Islands, identifying a total of 41 plants of ethno-veterinary importance. Among them, *Dhatura* and Tamarind were reported to be used for treating mastitis[44].

On reviewing the scope of the traditional system of Indian medicine (AYUSH), it was found that a book, 'Review of Medicinal Plants Used in Veterinary Practices', published by the Central Council for Research in Ayurvedic Sciences (C.C.R.A.S.), Ministry of AYUSH, Government of India, New Delhi has mentioned various herbs used in bovine mastitis[45]. After surveying the ethno-veterinary practices in India, information regarding the plants viz. *Albizia amara*, *Allium sativum*, *Aloe vera*, *Andrographis serpyllifolia*, *Azadirachta indica*, *Citrus aurantifolia*, *Coccinia grandis*, *Curcuma longa*, *Euphorbia tirucalli*, *Fumaria officinalis*, *Leucas aspera*, *Litsea glutinosa*, *Mimosa pudica*, *Musa paradisiaca*, *Ocimum tenuiflorum*, *Piper nigrum*, *Psidium guajava*, *Salvadora persica*, *Tamarindus indica*, *Terminalia arjuna* is mentioned in this book.

Similarly, a list of various herbs was found upon reviewing the special edition of the *Pashudhan Praharee Traimasika* (Quarterly) *Research Journal*, published in Jharkhand, India. This journal includes the documentation of the use of *Allium sativum, Aloe vera, Amomum subulatum, Andrographis serpyllifolia, Asparagus racemosus, Azadirachta indica, Brassica campestris, Capparis deciduas, Capsicum annuum, Centratherum anthelminticum, Citrullus colocynthis, Citrus limon, Commelina benghalensis, Cuminum cyminum, Curcuma longa, Emblica officinalis, Foeniculum vulgare, Galium aparine, Gossypium hirsutum, Lepidium sativum, Leptadenia reticulata,*

Table 2. Anti-inflammatory activity of the contents of Mastitis *Lepa*

Sr.no.	Latin Name	*Sanskrit* Name	English Name	Family	Vernacular name	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
1	*Aloe vera* (L.) Burm.f.	*Kumari / Ghrita-Kumari*	Aloe vera	*Asphodelaceae*	Ghee Kunwar	Acemannan, Campesterol, Lupeol, β-sitosterol, Bradykinase, Anthraquinones, Salicylic acid	35
2	*Curcuma longa* Linn	*Haridra*	Turmeric	*Zingiberaceae*	Haldi	Curcumin, Volatile oil	36
3	Calcium oxide	*Chuna*	Slaked lime / Hydrated lime / Quicklime	-	Chuna	$CaO + H_2O \rightarrow Ca(OH)_2$	37
4	*Brassica rapa* L.	*Sarshapa / Siddhartha*	Field Mustard, Turnip Rape	*Brassicaceae*	Sarson	Glucosinolates, Isothiocyanates, Hydroxycinnamic acids, Flavonols, Anthocyanins	38
5	*Citrus limon* (L.) Osbeck	*Nimbu / Jambira*	Lemon	*Rutaceae*	Nimbu, Kaghzi Nimbu	Flavonoids, Citric acid, Ascorbic acid, Minerals, Phenols	39
6	*Cissus quadrangularis* L.	*Asthishrinkhala*		*Vitaceae*	Hadjor	Ketosteroids (phytosterols, β-sitosterol), luteolin, Flavonoid (Quercetin), Terpenoids, Calcium salts	40

Linum usitatissimum, Moringa oleifera, Nigella sativa, Oryza sativa, Peganum harmala, Piper betle, Piper nigrum Polygonum bistorta, Ricinus communis, Rosa indica, Saccharum officinarum, Sesamum indicum, Thuja occidentalis, Tinospora cordifolia, Trigonella foenumgraceum, Triticum aestivum, Wattakaka volubilis, Withania sonifera, Zingiber officinale in mastitis[46]. All the above-mentioned plants documented in India for the treatment of mastitis are explored in Table 3 for their anti-inflammatory activity.

6.2 Pakistan

In the Sargodha district of Pakistan, a survey was carried out to record the Ethno-Veterinary Practices (EVPs) employed for managing and treating mastitis in cattle and buffaloes. Data were gathered through interviews and focus group discussions with 217 Traditional Veterinary Healers (TVHs), utilizing rapid and participatory rural appraisal methods[96]. Another study was conducted in the district of Dera Ismail Khan (D. I. Khan) within Khyber Pakhtunkhwa province. This relatively isolated area is located near the Indus River and is bordered by several remote districts such as South and North Waziristan, Tank, Bannu, and Lakki Marwat[97]. Additionally, a survey was performed to document medicinal plants used in the Pashto-speaking regions of Southwest Pakistan, focusing on practices among the Saraiki and Punjabi communities. It was reported that these communities have long used *Acorus calamus*, *Calotropis procera*, *Asparagus capitatus*,

Table 3. Anti-inflammatory activity of the medicinal herbs used in the treatment of mastitis, collected by surveys in India

Sr.no.	Latin Name	*Sanskrit* Name	English Name	Family	Vernacular name	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
1	*Albizia amara* (Roxb.) Biovin	*Krishna Shirisha*	Bitter Albizia, Oil cake tree, Black Siris	*Fabaceae*	Siras	Alkaloids, Saponins, Phenols, Tannins, Terpenoids, Flavonoids, Quinones	47
2	*Allium sativum* L.	*Rason/ Lasuna*	Garlic	*Amaryllidaceae*	Lasan, Lehsun, Thoom	Phenol, Flavonoid, Catechin	48
3	*Amomum subulatum* Roxb.	*Shula Ela*	Greater or Nepal Cardamom	*Zingiberaceae*	Badi Elaichi	Glycosides, Carbohydrates, Flavonoids, Steroids, Resin	49
4	*Andrographis serpyllifolia* (Rottler ex Vahl) Wight	-	Roundleaf Chiretta	*Acanthaceae*	-	Andrographolides, Flavanoid, Alkaloid, Phenols, Glycosides, Saponins, Tannins	50
5	*Azadirachta indica* A.Juss.	*Nimba*	Margosa	*Meliaceae*	Neem	Nimbin, Nimbidin, Azadirachtin, Quercetin, Beta-sitosterol	51
6	*Capparis deciduas* Edgew.	*Karira*	Caper Berry, Desert or Indian caper	*Capparaceae*	Ker	β-Sitosterol, Flavonoids, Terpenolides,	52
7	*Capsicum annuum* Linn	*Lanka*	Chilli, Red Pepper	*Solanaceae*	Lal mirch	Capsaicin Phenols, Flavonoids	53
8	*Centratherum anthelminticum* (L.) Moench	*Aranya-Jiraka*	Purple Fleabane, Achenes, Black Cumin	*Asteraceae*	Kaali Jeeri	Flavonoids, Sterol, Brassicastero, Stigmasterol, Alkaloid, Vernolic acid	54
9	*Citrullus colocynthis* (L.) Schrad.	*Indravaruni*	Colocynth Bitter Apple	*Cucurbitaceae*	Indrayan, Kor tuma	*Cucurbitacins, Cucurbitacins,* Phenols, Flavonoids, Fatty acids, Tannins, Saponins, Anthranol	55
10	*Citrus aurantifolia* (Christm.) Swingle	*Nimbuka*	Acid or Sour Lime, Country Lime, Mexican lime	*Rutaceae*	Kaghzi Nimbu	Flavonoids – Hesperidin, Naringenin Alkaloids, Phenols, Saponins, Tannins, Triterpenoids	56
11	*Coccinia grandis* (L.) Voigt	*Bimbi*	Ivy gourd, scarlet gourd	*Cucurbitaceae*	Katduriki-Bel	Flavonoids, Proteins, Amino acids, Alkaloids, Carbohydrates, Phytosterols, Tannins	57
12	*Commelina benghalensis* Linn.	*Kanchata, Karnamorata, Karnasphota*	Bengal dayflower, Tropical spiderwort, Wandering Jew,	*Commelinaceae*	Kankau	Flavonoid – Quercetin, Aalkaloid, Volatile oil, Vitamin C and A, β-Carotene, Resins, Balsams, Tannins	58
13	*Cuminum cyminum* Linn.	*Sweta Jiraka*	Cumin	*Apiaceae*	Safaid zeera	Cuminaldehyde, 3-caren-10-al, β-pinene	59
14	*Cynodon dactylon* (L.) Pers.	*Durva*	Bermuda Grass, Bahama Grass, Couch Grass	*Poaceae*	Duub, Hariyali	Flavonoid, Cyanidin, β-carotene	60
15	*Datura metel* L.	*Dhatura*	Thorn apple	*Solanaceae*	Dhatura	Triterpene, Withanolide, Alkaloids Hyoscine, Scopolamine	61,62
16	*Phyllanthus emblica* L.	*Amalaki*	Indian gooseberry	*Phyllanthaceae*	Amla	Vitamin C, Flavonoids, Tannins, Polyphenols, Minerals, Amino acids	63

Table 3. Continued…

17	*Euphorbia tirucalli* L.	*Trikantaka/ Saptalaa*	Indian tree purge, Milk bush, Pencil tree	*Euphorbiaceae*	Konpal	Phorbol ester, Flavanoids, Alkaloid, Steroid, Tannins, Phenols	64
18	*Foeniculum vulgare* Mill.	*Mishreyaa*	Fennel	*Apiaceae*	Saunf	α-pinene, β-pinene, Limonene	65
19	*Fumaria officinalis* L.	*Parpata*	Common fumitory, Drug fumitory, Earth smoke	*Papaveraceae*	Pit-Papara	Alkaloids - Protopine, Fumariline, Flavonoids - Quercetin, Tannins, Saponins, Essential oils	66
20	*Galium aparine* Linn.	-	Goosegrass, Cleavers	*Rubiaceae*	Banafsha	Iridoid glycosides (Asperu-glycosidic acid, 10-deacetylasperulosidic)	67
21	*Gossypium hirsutum* L.	*Karpasa*	Cotton or Mexican cotton	*Malvaceae*	Paiway, Baraiwain	Terpenoids, Saponins, Flavonoids, Alkaloids, Tannins	68
22	*Lepidium sativum* Linn.	*Chandrashura*	Garden Cress/Water Cress	*Brassicaceae*	Halia	Flavonoids, Alkaloids, Cyanogenic Glycosides, Tannins, Glucosinolates, Sterols, Triterpenes	69
23	*Leptadenia reticulata* (Retz.) Wight and Arn.	*Jivanti*	Cork Swallow Wort	*Apocynaceae*	Dori, Dodishaak	Triterpenoid – Lupeol, Phenols, Flavonoids – Quercetin, Rutin, P-Coumaric acid	70
24	*Leucas aspera* Link	*Dronpushpi*	Common Leucas, Thumb, Thumbnail	*Lamiaceae*	Chotahalkusa	Alkaloids, Triterpenoids, Steroids, Glycosides	71
25	*Linum usitatissimum* Linn	*Atasi*	Linseed, Flax	*Linaceae*	Alsi	Flavonoids, Tannins, Saponins, Alkaloids,	72
26	*Litsea glutinosa* (Lour.) C.B.Rob.	*Medasaka / Adhavara*	Indian laurel, Soft bollygum, Bolly beech	*Lauraceae*	Maeda Lakari	Linalool, Flavone Glycosides, Reducing sugars, Amino acids, Tannins, Saponins	73
27	*Mimosa pudica* L.	*Lajjalu*	Sensitive plant, Shameplant, Touch-me-not plant.	*Fabaceae*	Chuimui	Flavonoids – Quercetin, Alkaloids	74
28	*Moringa oleifera* Lam.	*Shigru*	Drumstick, Horse-Radish	*Moringaceae*	Sahajan	Flavonoids - Quercetin, Kaempferol, and Rutin, Isothiocyanates - Moringin, Glucosinolates, Polyphenols - Chlorogenic acid and Catechins	75
29	*Musa paradisiaca* L.	*Kadali, Rambhaa*	Banana	*Musaceae*	Kela	Glycoside, Flavonoids, Phytosterols, Tannins, Apigenin, Vitamins A, C, E, B-complex, Magnesium, Zinc, Calcium, Selenium	76
30	*Nigella sativa* Linn.	*Kalajaji*	Black Cumin, Small Fennel	*Ranunculaceae*	Kaoolnji	Thymoquinone, p-cymene, α-thujene, Longifolene, α-pinene, β-pinene, Carvacrol	77
31	*Oryza sativa* Linn.	*Shali*	*Rice*	*Poaceae*	Chawal, Moonji	Carbohydrates, Terpenoids, Glycosides, Proteins, Phenols, Saponins, Alkaloids, Flavonoids, Tannins	78
32	*Peganum harmala* Linn.	*Harmala*	Wild Rue; Foreign Henna, Syrian Rue	*Nitrariaceae*	Harmal	Quinic acid, Harmaline, Harmol, Harmine, Pegamine	79
33	*Piper betle* L.	*Tambula, Nagavallari*	Betel pepper	*Piperaceae*	Paan, Tambool	Phenols – Hydroxychavicol,	80

Table 3. Continued…

34	*Piper nigrum* Linn.	*Maricha*	Black Pepper	*Piperaceae*	Kali Mirch	Alkaloid - Piperine	81
35	*Polygonum bistorta* Samp.	-	Snake Weed, Bistort, Dragon Wort	*Polygonaceae*	Anjbar	5-glutinen-3-one and Friedelanol	82
36	*Psidium guajava* L.	*Peruka*	Common Guava	*Myrtaceae*	Amrud	Flavonoids - Quercetin, Kaempferol, Myricetin, Carotenoids - β carotene, Lycopene Vitamin C, Tannins	83
37	*Ricinus communis* Linn.	*Eranda*	Castor oil plant	*Euphorbiaceae*	Arand, Erandi	Ricinoleic acid, Polyphenols, Flavonoids	84
38	*Rosa indica* L.	*Taruna*	Damask Rose	*Rosaceae*	Gulab	Linoleic acid, α-linolenic, Palmitic, Oleic, Stearic, Octadecenoic, Eicosenoic, Eicosadienoic and Erucic acid	85
39	*Saccharum officinarum* Linn.	*Ikshu*	Sugarcane, Noble Cane	*Poaceae*	Kamad, Ganna	Flavonoids, Glycosides, Steroids, Quinone, Coumarin, Tannins, Terpenoids	86
40	*Salvadora persica* L.	*Pilu*	Miswak, Toothbrush tree	*Salvadoraceae*	Jhak	Salvadorine, Flavonoids, Alkaloids, Saponins, Tannins	87
41	*Sesamum indicum* L.	*Tila*	Sesame, Gingelly	*Pedaliaceae*	Meetha til	Sesamin, Sesamol	88
42	*Tamarindus indica* Linn.	*Amlika, Chincha*	Tamarind	*Fabaceae*	Imli	Tannins, Saponins, Glycosides, Flavonoids, Polyphenols	89
43	*Terminalia arjuna* (Roxb. ex DC.) Wight and Arn.	*Arjuna*	Arjuna, Arjun tree	*Combretaceae*	Arjuna	Flavonoids - Quercetin, Kaempferol, Rutin, Tannins, Phenols	90
44	*Thuja occidentalis* L.	-	Arborvitae, Northern white cedar	*Cupressaceae*	Morepankhi	Thujone, Borneol, Terpenoids, Flavonoids, Polyphenols	91
45	*Tinospora cordifolia* (Willd.) Miers ex Hook.f. and Thomson	*Guduchi*	Heart-leaved moonseed	*Menispermaceae*	Geloy	Alkaloids - Berberine, β-sitosterol, Stigmasterol, Glycosides, Polysaccharides, Tinosporaside, Cordifolioside A, Syringin	92
46	*Trigonella foenum-graecum* Linn.	*Methika*	Fenugreek	*Fabaceae*	Matheray, Methi	Linolenic, Linoleic acids	93
47	*Triticum aestivum* Linn.	*Godhuma*	Wheat	*Poaceae*	Gandam, Kanak	Flavone, Flavonolignans	94
48	*Wattakaka volubilis* Stapf	*Suparnikaa, Madhumaalati*	Green Milkweed Climber Sneeze Wort	*Apocynaceae*	Akad Bel	Saponins, Alkaloids, Flavonoids, Terpenoids	95

Table 4. Anti-inflammatory activity of the medicinal herbs used in the treatment of mastitis, collected by a survey in Pakistan

Sr.No.	Latin name	*Sanskrit Name*	English Name	Family	Vernacular name	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
1	*Acorus calamus* Linn.	*Vachaa*	Sweet Flag, Calamus	*Acoraceae*	Bach	Eugenol, Pcymene, β-asarone	99
2	*Allium cepa* Linn.	*Palaandu*	Onion	*Amaryllidaceae*	Piyaaz	Tannin, Flavonoids - Kaempferol and Isorhamnetin, Anthocyanin, Saponin, Allicin, Quercetin	100
3	*Amomum subulatum* Roxb.	*Shula Ela*	Greater or Nepal Cardamom	*Zingiberaceae*	Badi Elaichi	Glycosides, Carbohydrates, Flavonoids, Steroids, Resin	49
4	*Artemisia scoparia* Waldst. and Kit.	-	virgate wormwood, capillary wormwood	*Asteraceae*	Gajar, Seeta-bani, Jhau, Lasaj	Flavonoids, Coumarins, Dicaffeoyl-epi-quinic acid, Sesquiterpene lactones	101
5	*Calotropis procera* (Aiton) Dryand.	*Arka (Rakta)*	Swallow-Wart, Milk Weed	*Apocynaceae*	Spalmai, Aakh, Madaar, Ashar	Cardenolides	102
6	*Capparis decidua* Edgew.	*Karira*	Caper Berry	*Capparaceae*	Karir, Dillay	Amino acids, Fatty acids, Tocopherols, Sterols, Glucosinolate, Phenolic	103
7	*Baccharoides anthelmintica* (L.) Moench	*Aranya-Jiraka, Vanajiraka*	Purple Fleabane, Achenes	*Asteraceae*	Kali Zeeri	Flavonoids, Butin, Sicasterol, Stigmasterol, Alkaloid-vernonine	54
8	*Cichorium intybus* Linn.	*Kaasani*	Chicory, Indian Endive	*Asteraceae*	Kasni, Kaasani Dashti	Fructans – Iinulin, Polyphenols, Sesquiterpene Vitamins, Lactones	104
9	*Citrus aurantium* L.	*Naarang*	Mandarin orange, Tangerine	*Rutaceae*	Malta, Sangtara	Flavonoids - Hesperidin and Nobiletin, Steroids, Polyphenols, Coumarins, Terpenes, Alkaloids	105
10	*Convolvulus arvensis* Linn.	*Bhadrabalaa, Hiranpadi*	Deer's Foot	*Convolvulaceae*	Prewaty, Lablaab	Flavonoid - Kaempferol, Alkaloids, Phenols, Sterols, Tannins, Triterpenes, Lactones	106
11	*Portulaca oleracea* Linn.	*Brihat Lonikaa, Loni*	Common Purslane	*Portulacaceae*	Loonrak	Alpha-linolenic acid (ALA), Flavonoids - Kaempferol and Quercetin, Betacyanins, Vitamins - A, C and Minerals - Mg, K	107
12	*Thymus serpyllum* Linn	*Ajagandhaa, Vana-Yavaani*	Wild Thyme, Mint	*Lamiaceae*	Jangli Podina	Flavonoids - Luteolin and Apigenin, Triterpenoids, Phenol – Thymol, Carvacrol	108
13	*Trachyspermum ammi* Sprague	*Yavaani*	Carum, Ammi, Lovage	*Apiaceae*	Ajwain	Thymol, Carvacrol, p-cymene	109
14	*Ziziphus jujuba* Mill	*Badar, Kola*	Indian Jujube	*Rhamnaceae*	Ber	Flavonoids - Quercetin, Rutin, Apigenin, Polysaccharides, Triterpenoids, Cyclopeptide Alkaloids, Saponins	110

Artemisia scoparia, *Cichorium intybus*, *Convolvulus arvensis*, and *Ziziphus jujube* to treat mastitis[98]. As a result, this documentation provides data validating the medicinal plants found in Pakistan and used in the management of mastitis in dairy animals. Due to the shared geographical areas, most of the plants were similar in both India and Pakistan. The additional plants found uniquely in Pakistan for treating bovine mastitis are listed in Table 4, along with their anti-inflammatory activity.

6.3 Nepal and Bangladesh

In western Nepal, a study was conducted to investigate and document knowledge about using various medicinal plants to treat different animal ailments. A total of 100 elderly people who rear domestic animals and possess traditional knowledge of ethnoveterinary plants were interviewed. A total of 103 plants were documented, of which 14 were noted for their use in treating mastitis: *Aloe vera, Cucurbita maxima, Solena heterophylla, Trichosanthes cucumerina, Asparagus racemosus, Linum usitatissimum, Artocarpus heterophyllus, Musa x paradisiaca, Sesamum indicum, Hordeum vulgare, Diploknema butyracea, Solanum lycopersicum, Urtica dioica*, and *Zingiber officinale*[111]. In Bangladesh, a research study was conducted to document the knowledge of ethno-veterinary medicine by surveying local practitioners in the Jessore district. It was found that these practitioners use *Nimba* and *Dhatura* to treat mastitis in animals, resulting in a reduction of swelling within 10-12 hours[112]. The anti-inflammatory activity of these plants is summarized in Table 5, except for those already discussed previously.

7. Discussion

Mastitis, a prevalent inflammatory condition affecting dairy animals, poses a significant challenge to the dairy industry in South Asia. This review explores the anti-inflammatory potential of herbs mentioned in *Ayurveda* along with Ethno-Veterinary Practices (EVP) in addressing mastitis in dairy animals. Drawing upon traditional knowledge and recent scientific studies, we delve into the mechanisms through which *Ayurveda* herbs exert their anti-inflammatory effects, shedding light on their potential application

Table 5. Anti-inflammatory activity of the medicinal herbs used in the treatment of mastitis, collected by a survey in Nepal and Bangladesh

Sr. No.	Latin name	*Sanskrit Name*	English Name	Family	Vernacular name	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
1	*Artocarpus heterophyllus* Lam.	*Panasa*	Jackfruit	*Moraceae*	Katahal, Phanas	Phenols (Artocarpesin, Norartocarpetin, Oxyresveratrol), Flavonoids, Triterpenoids, Lignans, Carotenoids	113
2	*Cucurbita maxima* Duchesne	*Pita Kuushmaanda*	Red Gourd, Red Pumpkin	*Cucurbitaceae*	Kaddu	Flavonoids, Phenolic acids, β -carotene, Lutein, Zeaxanthin, Triterpenoids, Vitamins, Fatty acids, Proteins, Peptides	114
3	*Diploknema butyracea* (Roxb.) H.J.Lam	*Madhuka* (related species)	Indian butter tree	*Sapotaceae*	Chiuri, Phulwaaraa	Flavonoids, Tannins, Terpenoids, Glycosides	115
4	*Hordeum vulgare* L.	*Yava*	Barley	*Poaceae*	Jau	Flavonoids, Phenolic acid, Lignans, Tocols, Phytosterols, Folates	116
5	*Solanum lycopersicum* L.	-	Tomato	*Solanaceae*	Tamatar	Lycopene, Flavonoids, Vitamins,	117
6	*Solena heterophylla* Lour	-	Himalayan Creeping Cucumber	*Cucurbitaceae*	Bankakara, Kudri	Flavonoids, Polyphenols, Terpenoids, Alkaloids	118
7	*Trichosanthes cucumerina* L.	*Amritaphala, Vana-Patota, Tikta-Patoli*	Malabar Patola, Snake gourd	*Cucurbitaceae*	Pudel, Kadwa Parwar	Triterpenoids, Phenols, Flavonoids, Saponins, Tannins	119
8	*Urtica dioica* L	*Vrishchhiyaa-shaaka* (related species)	Stinging Nettle	*Urticaceae*	Shisuun (Kumaon)	Flavonoids, Polyphenols	120

Table 6. Formulations mentioned in the ancient Indian veterinary *Sanskrit* manuscript *'Ashvavaidyakam'*

Sr.No.	Latin name	*Sanskrit Name*	English Name	Family	Vernacular name	Part Used	Chemical Composition Probable Responsible for Anti-inflammatory Activity	References
Ingredients of Formulation – 1								
1	*Piper longum* L.	*Pippali*	Indian Long Pepper	*Piperaceae*	Pipar	Fruit	Piperine, Volatile oil, Alkaloids, Isobutylamides, Lignans, Esters	127
2	*Zingiber officinale* Roscoe	*Shunthi*	Ginger	*Zingiberaceae*	Adrakh	Rhizome	Gingerol, Shogaol, Hexadecanoic acid, Tuberonic	9
3	*Trianthema portulacastrum* L.	*Varshabhu*	Horse Purslane	*Aizoaceae*	Pathari, Bisakhaparaa	Whole plant	Steroids, Alkaloids, Terpenoids, Glycosides, Flavonoids, Phenolic compounds, Carbohydrates	128
4	*Cedrus deodara* (Roxb. ex. D.Don) G.Don	*Devdaru*	Himalayan Cedar, Deodar	*Pinaceae*	Deodaar	Heartwood/ Stem	Deodarone, Cedrol, β-Caryophyllene, α-Pinene, Flavonoids	29
5	*Calotropis procera* (Aiton) Dryand.	*Arka*	Swallow-Wart, Milk Weed	*Asclepiadaceae*	Aakh, Madaar	Root/Leaf	Cardenolides	102
6	*Moringa oleifera* Lam.	*Shigru*	Drumstick, Horse-Radish	*Moringaceae*	Sahajan	Stem bark / Leaf	Flavonoids - Quercetin, Kaempferol, and Rutin, Isothiocyanates - Moringin, Glucosinolates, Polyphenols - Chlorogenic acid and Catechins	75
Ingredients of Formulation – 2								
1	*Rubia cordifolia* L.	*Manjishtha*	Indian Madder	*Rubiaceae*	Manjeeth	Stem	Anthraquinones, Bicyclic hexapeptides, Naphthoquinones, Triterpenoids	129
2	*Woodfordia fruticosa* Kurz	*Dhataki*	Fire-flame Bush	*Lythraceae*	Dhayti	Flower	Phenolic, Flavonoid, Ascorbic acid, β-carotene, Lycopene, Octadecanoic acid, n-hexadecanoic acid, γ -Terpinene	130
3	*Symplocos racemosa* Roxb.	*Lodhra*	Lodh tree, Sapphire Berry	*Symplocaceae*	Lodh Pathaani	Stem Bark	Phenolic glycosides, Triterpenoids, Flavonoids, Anthrasinins, Tannins, Alkaloids	131
4	*Hemidesmus indicus* (L.) R. Br. ex Schult.	*Sariva (Shveta)*	Indian Sarsaparilla	*Apocynaceae*	Anantmuula	Root/Stem	Glycosides, Phytosterols, Saponins, Tannins, Phenolic compounds, Proteins, Free amino acids, Fats, Volatile oils	132
5	*Cryptolepis dubia* (Burm.f.) M.R.Almeida	*Anantamula (Krishna Sariva)*	Indian Sarsaparilla (black var.)	*Apocynaceae*	Karantaa	Root/Stem	Nicotinoyl glucoside alkaloid, Pyridine alkaloid (Buchananine)	133
6	*Prunus cerasoides* D.Don	*Padmaka*	Wild Himalayan Cherry	*Rosaceae*	Padam, Padmakashtha	Heartwood/ Stem bark	Terpenoids, Flavonoids, Flavones, Flavonoid-glycosides, Flavanone-glycoside Isoflavone, Padmakastein, Phenolics	134

in managing mastitis. This discussion aims to bridge the gap between traditional practices and modern scientific understanding, offering insights into the development of sustainable and effective strategies for mastitis control in the dairy sector. Mastitis remains a critical concern for the dairy industry, impacting milk quality, animal welfare, and economic sustainability. South Asia, with its rich history of *Ayurveda*, presents an opportunity to explore traditional remedies for combating inflammation associated with mastitis. This review evaluates the anti-inflammatory properties of various *Ayurveda* herbs, emphasizing their relevance and potential in current dairy farming practices. The anti-inflammatory potential of *Ayurveda* herbs is attributed to compounds such as polyphenols, flavonoids, and essential oils.

Flavonoids inhibit pro-inflammatory enzymes such as cyclooxygenase-2 (COX-2) and lipoxygenase, reducing the synthesis of inflammatory mediators. They also suppress the activation of nuclear factor kappa B (NF-κB), a transcription factor that regulates the expression of various inflammatory cytokines. By attenuating the production of pro-inflammatory cytokines and mediators, flavonoids may help reduce inflammation in mammary tissues affected by mastitis[121]. Terpenoids exhibit anti-inflammatory properties by inhibiting the production of nitric oxide and pro-inflammatory cytokines. They also modulate signalling pathways involved in inflammation, such as the Mitogen-Activated Protein Kinase (MAPK) pathway. By modulating these inflammatory pathways, terpenoids can help alleviate the inflammatory response in mastitis[122].

Furthermore, alkaloids possess anti-inflammatory effects by inhibiting the release of pro-inflammatory cytokines and reducing oxidative stress. They can modulate immune responses, thereby decreasing inflammation. Through their immunomodulatory and antioxidant activities, alkaloids can contribute to reducing inflammation in mastitis-affected tissues[123]. Various primary phenolic phytochemicals of herbs exhibit anti-inflammatory actions as well, such as gingerol. Gingerols the active components in ginger, inhibit the synthesis of pro-inflammatory cytokines and prostaglandins. They also suppress the activation of NF-κB, leading to reduced expression of inflammatory genes. The anti-inflammatory actions of gingerols can help in mitigating the inflammatory processes in mastitis[124]. Vitamin C and E act as antioxidants, scavenging reactive oxygen species and reducing oxidative stress, which is linked to inflammation. Zinc plays a role in maintaining immune function and has anti-inflammatory properties. By reducing oxidative stress and supporting immune function, these vitamins and minerals can aid in controlling inflammation associated with mastitis[125].

Collectively, these compounds target various pathways involved in inflammation, suggesting their potential utility in managing mastitis. However, further research is necessary to fully elucidate their mechanisms and efficacy in clinical settings. Moreover, an exploration of traditional veterinary practices in South Asia reveals a historical reliance on *Ayurveda* herbs for managing livestock health. Through a compilation of case studies and anecdotal evidence, we aim to highlight instances where *Ayurveda* interventions have demonstrated positive outcomes in treating mastitis, providing valuable insights for further scientific investigation. To strengthen the credibility of *Ayurveda* in mastitis management, we review contemporary scientific studies and clinical trials that have investigated the anti-inflammatory efficacy of specific herbs. This section aims to identify gaps in existing research, paving the way for future studies that rigorously assess *Ayurveda* interventions in controlled experimental settings.

On reviewing the ancient Indian veterinary *Sanskrit* language manuscript known as *'Ashvavaidyakam'*,[126] authored by *Jayadatta* in the 13th century, hailed as a distinctive contribution to equine therapeutics, several unrevealed formulations were identified within the text of *Adhyaya* (chapter) 49 entitled, '*Vatadishotha Lakshana Chikitsa* as having anti-inflammatory properties suitable for treating conditions such as mastitis, abscesses, fibrosis and more. As clinical trials have not yet explored these formulations, their significance in treating mastitis must require studying them clinically either as formulations or as individual drugs. A few examples of these ancient, yet unrevealed formulations are mentioned in Table 6.

While *Ayurveda* herbs show promise in mitigating mastitis, challenges such as standardization of herbal formulations, dosage determination, and regulatory approval must be addressed. This section explores these

challenges and highlights the need for collaborative efforts between traditional knowledge holders, *Vaidyas* (*Ayurveda* practitioners), veterinarians, and researchers to develop evidence-based guidelines for incorporating *Ayurveda* practices into modern dairy management. In the quest for sustainable mastitis management, we propose avenues for future research, including interdisciplinary collaborations, pharmacological investigations, and the integration of *Ayurveda* practices into conventional veterinary protocols. Emphasizing a holistic approach, we advocate for the preservation and adaptation of traditional knowledge to address contemporary challenges in dairy farming.

Despite advancements in modern veterinary sciences, greater emphasis should be placed on the therapeutic potential of *Ayurveda* in veterinary practices, alongside its promotion among farmers and livestock owners. Notably, the Ministry of AYUSH in India, along with the Indian Government, is taking significant steps through initiatives such as the Mastitis Control Project (MCP) under the Rashtriya Krishi Vikas Yojana (RKVY) and the Mastitis Management Program by the Ministry of Agriculture. Furthermore, the positive outcomes of the EVHP intervention led by NDDB Gujarat have been particularly encouraging. Mastitis is a significant issue, as farmers may not be fully aware of the economic losses it causes. There is an urgent need to address both clinical and subclinical cases of mastitis, improve milk quality and quantity, prevent economic losses due to reduced milk yield, minimize drug residue concerns, and lower veterinary expenses. Shifting away from the overuse of modern antibiotics is essential to mitigate the growing risk of antibiotic resistance. This review highlights the potential of *Ayurveda* herbs in reducing inflammation associated with mastitis in dairy animals. By integrating ancient knowledge with modern scientific findings, we aim to encourage further exploration and discussion, paving the way for efficient, eco-friendly solutions to mastitis management within South Asian dairy traditions.

8. Conclusion

In this review, most of the herbs used for the treatment of mastitis were found to be similar, as the countries of South Asia share comparable geographical and climatic conditions. A total of 83 herbs were reported for their role in treating mastitis across South Asian countries. Several constituents identified in these herbs exhibit potential anti-inflammatory properties, including flavonoids (such as quercetin and kaempferol), polyphenols (such as curcumin, resveratrol, and ellagic acid), terpenoids (such as carotenoids), gingerols, alkaloids, vitamins (such as vitamin C and vitamin E), and minerals (such as zinc). These bioactive compounds are likely contributors to the anti-inflammatory effects of herbs. It is important to note that the effectiveness and concentration of these constituents can vary among plant sources, and individual responses to these compounds may also differ. Further research is required to establish their precise mechanisms of action and efficacy in managing inflammation. The use of plant-based remedies holds promise for reducing production losses and veterinary costs, underscoring their therapeutic potential and importance for dairy farmers. Therefore, the mechanisms of these ancient yet underexplored remedies for mastitis need to be scientifically validated on a global scale.

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10. Author Contribution

GAA: Conceptualization, data curation, writing-Original draft preparation; RSB: Writing- reviewing and editing; BS: Writing-reviewing and editing; SM: Writing-reviewing and editing and MS: Supervision and final editing. All authors have read and agreed to the published version of the manuscript.

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