

Medicinal and aromatic plants farming

Prospective intervention for fluorosis in livestock

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Fluorosis is a debilitating condition caused by excessive fluoride intake in food and water. It is a pervasive health issue in India, particularly in regions where fluoride levels in water and soil exceed safe limits of 1.5 mg/L. This condition affects millions of humans and livestock, leading to severe dental and skeletal deformities that compromise animal health, reduce productivity, and cause significant economic losses for farmers. The livestock population in endemic regions (Rajasthan, Andhra Pradesh, Bihar, Gujarat, Punjab etc.) of India is at risk. The cultivation of MAPs not only offers a natural remedy for managing fluorosis in livestock but also presents a viable economic opportunity for Indian farmers. As the global demand for organic products and natural remedies grows, integrating MAPs into Indian farming systems can increase farm income while improving livestock health. This dual benefit makes MAPs a sustainable and economically advantageous solution to the fluorosis problem.

Keywords: Environmental contaminants, Fluorosis, Medicinal and Aromatic plants, Sustainable farming

Environmental contaminants are a burning challenge for researchers and activists globally. Fluoride contamination considerably impacts human and animal health, and is responsible for many undesirable impacts on health and production. Indian subcontinents lie within a fluoride-rich zone. In 18 out of 32 states, it represents a significant public health concern. Approximately 177 districts experience high fluoride concentrations in their water supplies. This issue arises when high fluoride levels accrue as throughput inside the body after excretion via urine and feces, leading to multiple health complications. Livestock are particularly affected, experiencing various detrimental effects, including dental and skeletal problems. These health issues cause suffering for the animals and negatively impact their productivity and overall vitality. Dental issues caused by fluorosis can lead to

difficulties in mastication, affecting their growth and milk production. Skeletal problems can result in joint deformities and reduced mobility, further compromising their overall health and productivity. These issues can ultimately reduce farming operations' economic viability and increase farmers' financial strain. Farmers dependent on livestock for their livelihoods face considerable challenges due to these health problems.

In response to this growing problem, there has been an increasing interest in exploring sustainable and natural solutions. One promising area of investigation is the use of Medicinal and Aromatic Plants (MAPs). These plants have a long history of use in traditional Indian medicine. They have been used to treat various ailments and improve overall health since time immemorial. MAPs are known for their therapeutic properties and are often considered to offer

natural remedies for various health conditions. Recent research is focusing on how MAPs might help mitigate the effects of fluoride toxicity. In addition to their potential health benefits, MAPs offer another significant advantage—they can serve as an additional income source for farmers. India holds the second position globally in agricultural production. About 60% of the Indian population is involved in farming activities, with roughly 80% of farmers classified as marginal (less than 1 hectare) or small-scale (1–2 hectares) cultivators. Cultivating and selling these plants can provide farmers with an alternative revenue stream, which can be especially valuable in regions where traditional farming methods face environmental and economic challenges. This approach supports the broader goal of promoting sustainable farming practices and improving the resilience of agricultural systems.

Fluorosis in livestock

Fluoride is a naturally occurring element present in various environmental sources such as groundwater, soil, and plants. While it is essential in small amounts for dental and bone health, excessive fluoride bioaccumulates in the body. It is responsible for causing serious health issues in livestock and humans alike. Government mitigation plans and personal efforts of humans to consume purified water have significantly reduced the incidence of fluorosis in humans. However, livestock populations in these areas are affected due to farmers' unawareness of its ill effect on the health and production of livestock, and the unavailability of sufficient decontaminated water.

The primary source of fluoride exposure in livestock is often contaminated water or forage. In areas with high natural geogenic fluoride levels or where industrial activities release fluoride into the environment, livestock can ingest significant quantities of fluoride through drinking water or grazing on pastures contaminated with fluoride-fortified fertilizers.

Fluorosis in livestock manifests in acute and chronic forms depending on the burden of fluoride ingested and the length of exposure. Acute fluorosis, though rare in natural exposure, occurs when animals ingest a large amount of fluoride

in a very short period. The acute form clinically manifested as gastrointestinal disturbances (diarrhoea, inappetence, etc), salivation and death in severe cases. Chronic fluorosis is more prevalent in natural situations and develops over time as fluoride accumulates in the body. Manifestation is clinically characterized as dental and skeletal forms, apart from other non-specific symptoms. In dental fluorosis, the enamel of teeth becomes discoloured, pitted, and weakened, causing difficulty in chewing, salivation, and damaging aesthetic look. The long-term impact is loss of body condition and decreased production.

Osteal-fluorosis affecting bones contributes to lameness, stiffness, and deformities of joints due to fluoride-induced calcification and degeneration of bone tissues. Non-skeletal fluorosis poses undesirable effects on several internal organs, manifested as inappetence, sporadic diarrhoea, polyuria, paralysis, reduced fertility and sometimes nervous disorders. Proper management and monitoring are essential to mitigate its effects and ensure the well-being of livestock.

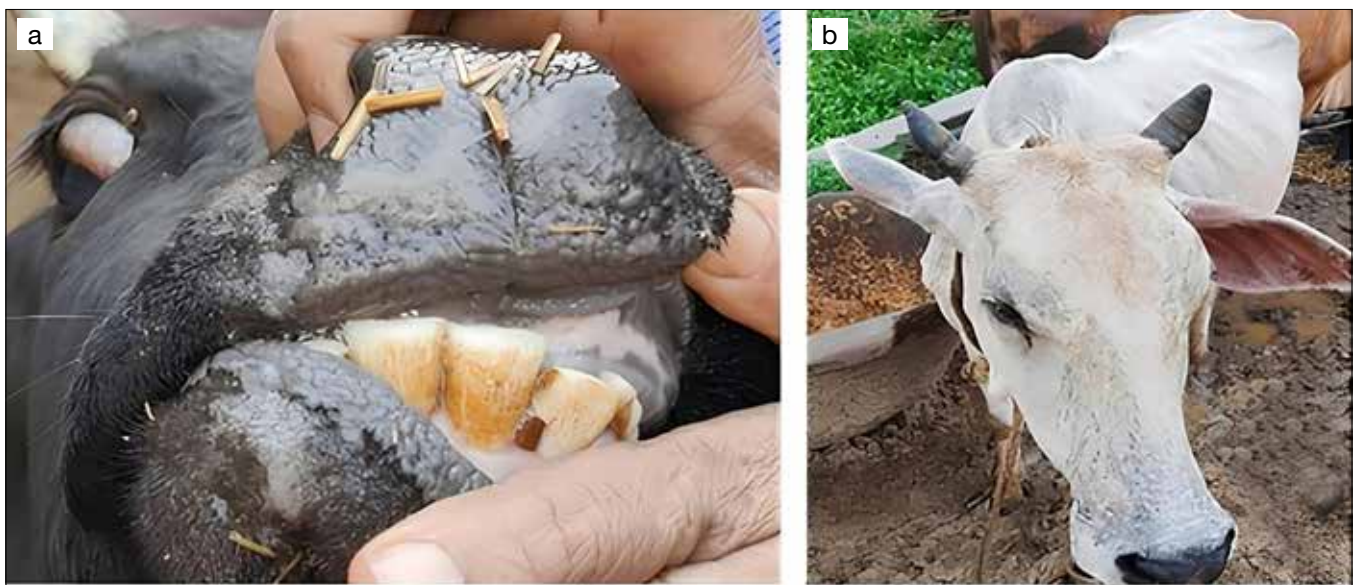
MAPs in ameliorating fluorosis

Medicinal and Aromatic Plants are a diverse group of plants that have been used for centuries for

their unique ability to produce compounds that offer medicinal benefits or have pleasing aromas. These plants are often rich in bioactive substances such as essential oils, alkaloids, flavonoids and glycosides, which contribute to their therapeutic effects. These plants are also characterized by their ability to produce aromatic compounds that are used in fragrances, cosmetics and culinary applications. They are integral to traditional medicine systems across the globe, including India, where they hold a significant place in both cultural practices and modern agriculture. Additionally, many MAPs exhibit antioxidant properties, which act by neutralizing harmful free radicals in the body, thereby supporting overall health.

In Indian agriculture, MAPs play a crucial role due to their versatility and economic value. They are cultivated not only for their medicinal properties but also for their potential to enhance soil health and biodiversity. Growing MAPs can contribute to sustainable farming practices by reducing the reliance on chemical inputs and supporting ecological balance. Furthermore, the demand for MAPs in both domestic and international markets provides economic opportunities for farmers, contributing to rural development and improving livelihoods.

Plants with high antioxidant content help mitigate oxidative stress



Fluorosis in cattle associated with drinking contaminated water. a. Dental manifestation; b. Skeletal manifestation with lameness, wasting of body muscles, and excessive periosteal exostoses in the rib, hip bone and horn layering



Some common MAPs. a. Amla, b. Banana, c. Curry leaves, d. Jamun, e. Lemon, f. Moringa, g. Neem, h. Tamarind, i. *Terminalia arjuna*, j. Turmeric

Table 1. MAPs and their potential use against fluorosis in livestock

MAP	Active compound(s)	Useful part	Use against fluorosis	Reference
Amla (<i>Emblica officinalis</i>)	Vitamin C, Gallic acid	Fruit	Enhances immune response and antioxidant defence, helping to counteract fluoride effects.	Ranjan and Yasmin (2015)
Banana (<i>Musa acuminata</i>)	Potassium, Vitamin C	Fruit, Leaves	Provides essential nutrients and antioxidants, aiding in detoxification and reducing fluoride effects.	Mondal (2017)
Curry leaves (<i>Murraya koenigii</i>)	Alkaloids, Flavonoids	Leaves	Offers antioxidant protection and supports overall health to counteract fluoride effects.	Handral <i>et al.</i> 2012
Jamun (<i>Syzygium cumini</i>)	Anthocyanins, Vitamin C	Fruit, Seeds	Rich in antioxidants and acts to ameliorate oxidative damage from fluoride.	Angwa <i>et al.</i> 2022
Lemon (<i>Citrus limon</i>)	Vitamin C, Citric acid	Fruit, Juice	Enhances fluoride excretion and neutralizes oxidative damage with its high vitamin C content.	Angwa <i>et al.</i> 2022
Moringa (<i>Moringa oleifera</i>)	Moringin, Quercetin	Leaves, Seeds	Reduces oxidative stress and improves antioxidant status, mitigating fluoride damage.	Angwa <i>et al.</i> 2022
Neem (<i>Azadirachta indica</i>)	Azadirachtin, Nimbin	Leaves, Bark	Provides anti-inflammatory and detoxifying effects, reducing fluoride toxicity.	Alzohairy (2016)
Tamarind (<i>Tamarindus indica</i>)	Tartaric acid, Flavonoids	Fruit, Seeds	Promotes fluoride excretion and provides digestive benefits, reducing fluoride accumulation.	Samal <i>et al.</i> 2016
Arjuna (<i>Terminalia arjuna</i>)	Arjunic acid, Flavonoids	Bark	Supports cardiovascular health and reduces oxidative stress, potentially alleviating fluoride damage.	Dwivedi and Chopra (2014)
Turmeric (<i>Curcuma longa</i>)	Curcumin	Rhizome	Exhibits potent anti-inflammatory and antioxidant properties, alleviating fluoride-induced damage.	Fujiwara <i>et al.</i> 2021

caused by excess fluoride. Some MAPs possess detoxifying effects that enhance fluoride excretion from the body. Anti-inflammatory MAPs can alleviate the symptoms of fluorosis, such as joint pain and skeletal deformities. A few valuable MAPs and their potential use in ameliorating fluorosis in livestock are given in Table 1. Integrating these plants into the diet or livestock feed can potentially reduce fluoride accumulation and ameliorate fluorosis symptoms, offering a natural and sustainable solution to this widespread issue.

Implementation of MAPs in farming practices

Implementing MAPs in farming offers significant potential for enhancing agricultural sustainability and improving farmer livelihoods in India. Incorporating MAPs into farming systems involves several key steps. First, selecting suitable MAPs based on local soil and climatic conditions is crucial. For example, moringa thrives in arid

regions, while turmeric requires a tropical climate. Farmers can cultivate these plants alongside traditional crops, benefiting from their diverse uses, including natural pesticides, soil enrichers, and health supplements for livestock.

Extension activities, including training, awareness, and education, are essential for successful implementation. Farmers should be informed about the benefits of MAPs and provided with guidance on cultivation techniques, harvesting, and processing. Extension services and agricultural universities are pivotal in offering technical support and resources. The economic benefits of MAPs include additional income from the sale of medicinal herbs and value-added products like essential oils and supplements. Additionally, MAPs can reduce dependency on chemical inputs, enhance soil health and provide a natural remedy for managing livestock health issues such as fluorosis. Overall, integrating MAPs into Indian farming systems can drive ecological stability and

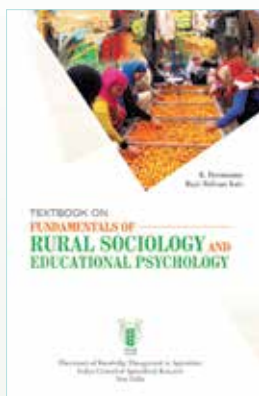
financial growth, promote climate sustainability and improve the health and productivity of crops, humans, and livestock.

CONCLUSION

The prospects of utilizing Medicinal and Aromatic Plants (MAPs) in Indian farming to combat fluorosis present a highly promising and innovative approach. The application of MAPs in managing fluorosis addresses a critical health challenge and supports broader goals of sustainable agriculture and rural development. By harnessing the potential of these plants, India can make significant strides in improving livestock health, enhancing agricultural productivity, and fostering economic growth. This approach represents a harmonious blend of traditional knowledge and modern agricultural practices, paving the way for a healthier and more prosperous future in farming.

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TECHNICAL SPECIFICATIONS

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