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A Study On Some Indian Medicinal Plants For Ethnomedicinal And Insecticidal Properties For Sustainable Agriculture

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ABSTRACT

Plants have been a natural source of a plethora of compounds having antimicrobial, anticancer, insecticidal, and other potentially useful therapeutic applications. These compounds include various classes of phytochemicals such as alkaloids, flavonoids, saponins, tannins, sterols, etc. Plant phytochemicals have been shown to have insecticidal properties against many insect species as shown in various in-vitro and in-situ conditions. The plant extracts have been shown to be greatly effective against various stages of insect development such as egg hatching, larvae growth and metamorphosis. Due to large number of applications, plant phytochemicals have also been commercially harvested to fill the gap of a large commercial demand deficit by industrial scale chemical synthesis in modern era. However, hazardous synthetic chemical pesticides, synthesis byproducts, and waste generated have drastically affected the ecological balance by negatively affecting flora and fauna including human, animals and insects. The eco-friendly and sustainable management of insects particularly in agriculture is a must solution in present situation. In the present study, some medicinal plants have been reviewed with respect to their potential ethnomedicinal values and insecticidal properties as potential sustainable crop pest management applications.

Keywords: Sustainable Pest Management, Phytochemicals, Ethnomedicine, Insecticides, Agriculture Pests

INTRODUCTION

Modern agricultural and farming practices have exponentially increased crop yield, variety and availability almost year-round contributing to the growth of economy and country. However, over time, indiscriminate and excessive use of chemical fertilizers and pesticides, agriculture practices such as monocrop cultivation, increasing dependency on machines, etc have also led to the degradation of soil fertility, environment, human and animal health. High input and maintenance costs, crop failures, etc. further made agriculture a non-sustainable option leading to migration and even suicides of farmers mostly from low-income group/small land owners. Rural and Tribal communities, within limited facilities, have adapted and traditionally passed down a few agricultural practices such as ethnomedicines for crop pest & disease management, seed preservation and other agroecological practices having low input costs & risk, moderate yield while maintaining agrobiodiversity. Identification and validation of such indigenous practices, processes and factors could provide

a sustainable solution to present day crisis and potentially benefit wider farming communities. In this project, it is proposed to undertake a study on the ethnomedicinal and agroecological practices especially for crop pest and disease management used in rural and tribal parts of Eastern Vidarbha (Maharashtra).

In India, on an average a farmer holds a small agriculture land. Since the green revolution agriculture was on the path of fast paced modernization in India including use of machine-based sowing-to-processing processes, irrigation systems, chemical fertilizers, pesticides, herbicides, etc. This had positive impact on the growth of economy and food security of our country, however, concurrently affected the traditional farming practices negatively. Furthermore, overuse of chemical fertilizers and pesticides rendered soil & environment heavily polluted creating numerous health hazards to plants, humans & animals, alike (Alvanza and Bonner, 2012). Modern agricultural practices, having high maintenance cost cumulated with crop damage due to pests and diseases, emergence of resistance, became non-sustainable overtime especially to small scale farmers leading to migration to other jobs and even to extremes such as suicides.

The rural and tribal farmers, still practicing traditional agriculture, have potentially sustained with some locally adapted ingenious low input low risk agricultural practices not only addressing agro-biodiversity but the food security of local community. Further, such practices may include but not limited to seed varieties preservation and use of various ethnomedicinal formulations against agricultural pests and diseases. Eastern Vidarbha in Maharashtra especially Gondia, Bhandara, Chandrapur & Gadchiroli districts with its rich and largely unexplored flora and fauna along with traditional ethnomedicinal knowledge of local tribal communities would be a potentially rich source of valuable information for sustainable agriculture. The identification and evaluation of such ingenious practices could potentially benefit a large section of farmers especially the small land holders. Also, this could potentially add new climate specific, soil specific crop varieties (seed/gene pool) to existing knowledge. Furthermore, the validation of these practices could bring more confidence of rural and tribal farmer and benefit economically.

ETHNOMEDICINAL USE OF MEDICINAL PLANTS

A large number of studies have been carried out on the medicinal uses of various plants by ethnic groups worldwide, as evident from publications, however, there is dearth of literature on use of such plants or other formulations against agriculture pests and diseases. Kamanula et. al., (2010) report on pesticidal plants against stored maize and beans (Southern Africa), Nyahangare et. al. (2015) report on ethnoveterinary plants against ecto-parasites (Zimbabwe) and Guimaraes et. al., (2006) report on control of pests by peasant farmers in Brazil, are some of the recent studies linking ethnomedicinal and agroecological approaches to pest and disease control by rural and tribal communities. Hikal et. al. (2017), reviewed various botanical extracts as insecticides and their physiological effects against several pests (Table 1).

Table 1. Ethnomedicinal plants used for human diseases in eastern region of Maharashtra.

Sr. No.	Study	Area	Use
1	Koche et. al., (2008), Cherian & Ramteke (2009), Lilhare et. al., (2017)	Gondia District	Ethnomedicinal use by rural and tribal community
2	Gupta et. al (2010), Gadpayale et. al., 2014	Bhandara District	Ethnomedicinal and Ethnoveterinary use
3	Harney (2013), Bakare (2014)	Chandrapur District	Ethnomedicinal use
4	Tiwari (2017), Shambharkar & Gogle (2017), Mishra et. al., (2021)	Gadchiroli District	Ethnomedicinal use in

In India, large number of research studies on ethnomedicinal plants, especially those used by rural and tribal communities, were published. However, most of the publications were concerned with the phytotaxonomic evaluation of plants and/or treatment of ailments or diseases of mankind. There have been very few reports on plants or their formulations used against crop pests and diseases by ethnic communities in india. (Kumar, et. al., 2009; Narayanasami, 2006). While from Maharashtra, Dhale (2013), Gupta, et. al., (2010), Kamble et. al., (2010) have reported the tribal (Gond and Bhill) communities using ethnomedicinal formulations against crop pests.

The Eastern parts of Vidarbha, Maharashtra including Districts Gondia, Bhandara, Chandrapur & Gadchiroli have dense forest & hills, National Parks, Tiger Reserve, Lakes and Rivers with rich flora and fauna while several tribal communities reside by. However, there is very little information available for ethnomedicinal and agroecological practices by these tribal communities against crop pest and disease management particularly from eastern Vidarbha. However, there is very limited information available in public domain regarding ethnomedicinal and agroecological practices by rural and tribal communities particularly from the Eastern Vidarbha region of Maharashtra against crop pest and disease management. In the wake of non-sustainability of modern farming practices for small landholding farmers owing to high input cost, crop failures, emergence of disease resistance leading to economic distress and even suicides, it is important to identify and evaluate low cost, low risk, sustainable farming practices, including alternatives such as use of plant formulations against crop pests and disease, passed on through generations in tribal communities (Figure 1).

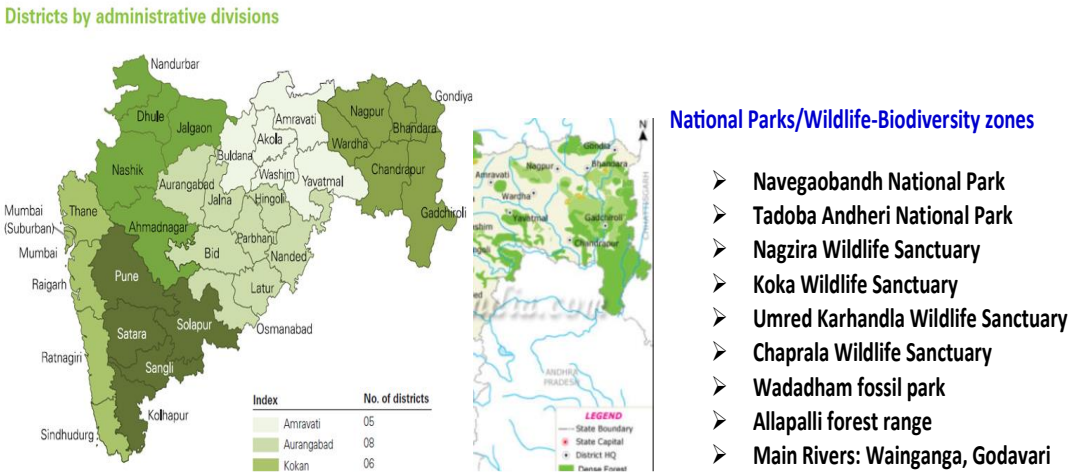

Figure 1. Map of Maharashtra with forest cover in region of Eastern Maharashtra (Vidarbha)

The Eastern parts of Vidarbha region of Maharashtra including Gondia, Bhandara, Gadchiroli, and Chandrapur is hotspot of biodiversity having huge forest cover, national parks, wildlife sanctuaries, rivers, ponds, natural dams and diverse wildlife flora and fauna, with various indigenous communities carrying a wealth of traditional knowledge. Several ethnobotanical surveys have been conducted in this Eastern part of Maharashtra to explore the vast reserve of flora and fauna as well as to extract the ethnomedicinal information from the rural and tribal communities (Gond, Madia, Gowari, Rajgond, Halba, Gawali, Pradhan, etc.).

INSECTICIDAL USE OF MEDICINAL PLANTS

Several studies have documented the insecticidal potential of Indian plants against agricultural pests and disease vectors. Extracts of *Lantana camara* have shown bio-insecticidal properties, indicating their efficacy in controlling pest populations (*Roy & Chatterjee, 2015*). Similarly, *Citrullus colocynthis* exhibits strong antifeedant and fertility-reducing activities against *Spodoptera litura*, a major agricultural pest (*Ramasamy et al., 2019*). Plants such as *Neem* (*Azadirachta indica*) and *Calotropis procera* have been traditionally employed for pest control in North Maharashtra and North-East India (*Sharma & Gautam, 2014*). These plants are valued for their phytochemicals, such as alkaloids, flavonoids, and terpenoids, which disrupt insect growth, feeding, and reproduction. (Figure 2)

Mechanisms of Action

The medicinal plant contains variety of phytochemicals that exhibit a distinct of biological-chemical interactions at cellular-molecular level leading to effective control of pests (Khan et. al., 2021)

The insecticidal action of plant compounds can be attributed to various mechanisms, including listed as below:

1. **Neurotoxicity:**
   - Disruption of neurotransmitter function
   - Interference with nerve impulse transmission
2. **Antifeedant Activity:**
   - Deterrence of feeding by insects
   - Reduction of food intake
3. **Growth Inhibition:**
   - Inhibition of insect growth and development
   - Disruption of molting and metamorphosis
4. **Reproductive Toxicity:**
   - Impairment of reproductive processes
   - Reduced fertility and fecundity
5. **Ovicidal Activity:**
   - Killing of insect eggs
   - Prevention of egg hatching

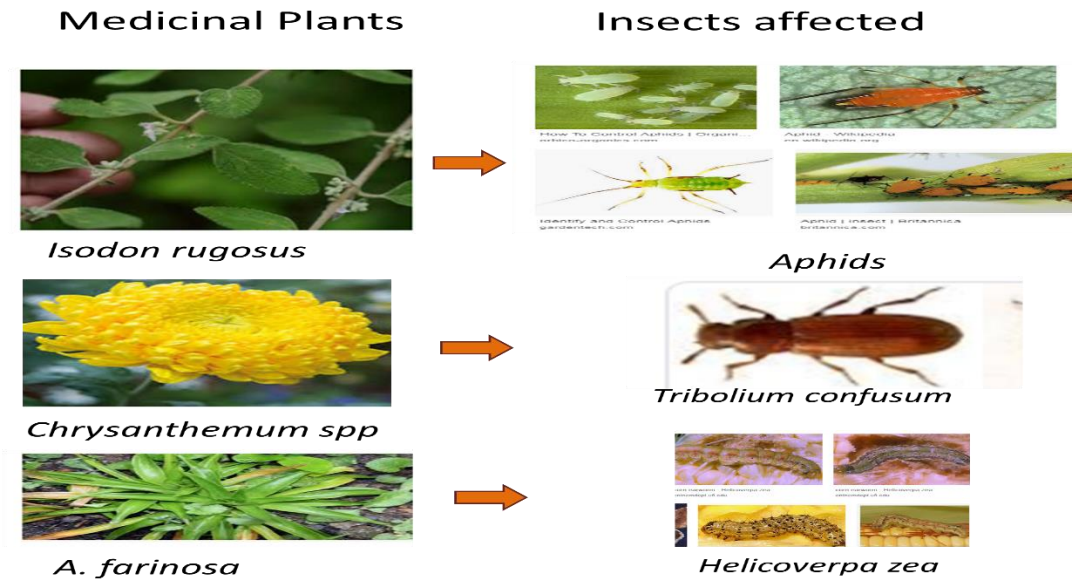

Figure 2. Some medicinal plants and insects affected

PLANT-DERIVED INSECTICIDES: A PROMISING FUTURE

The use of plant-based insecticides offers several advantages over synthetic chemical pesticides:

- Environmental Friendliness: Plant-derived insecticides are generally biodegradable and less harmful to the environment.
- Reduced Pesticide Resistance: The diverse modes of action of plant compounds make it less likely for insects to develop resistance.
- Selective Toxicity: Many plant-based insecticides target specific pests while minimizing harm to beneficial insects and other organisms.
- Availability and Cost-Effectiveness: Many plants with insecticidal properties are readily available and can be cultivated or extracted at a lower cost than synthetic pesticides.

DISCUSSION

Plants have long been utilized in traditional medicine and agriculture for their therapeutic and pest control properties. Recent studies have highlighted the potential of various Indian plants in ethnomedicine and as natural insecticides, demonstrating their utility in sustainable agricultural practices and eco-friendly pest management. Indian ethnomedicine is rich in plant-based remedies, as reviewed in above literature, and are being widely widely used for their antimicrobial, anti-inflammatory, and therapeutic properties. For instance, *Ocimum sanctum* has shown significant anti-mosquito properties against *Anopheles stephensi*, highlighting its dual role in healthcare and vector control (*Kumar et al., 2011*). These plants often form the backbone of rural healthcare systems, providing cost-effective alternatives to modern pharmaceuticals.

While plant-based insecticides offer a promising solution to pest management, several challenges remain like the potency and efficacy of plant-derived insecticides can vary depending on factors such as plant variety, growing conditions, and extraction methods, formulations where developing effective formulations and delivery systems for plant-based insecticides is crucial to optimize their performance as well as regulatory hurdles in which the process of regulatory approval for plant-based pesticides can be time-consuming and costly. Future research should focus on identifying novel plant sources, understanding the molecular mechanisms of action, and developing sustainable and cost-effective production methods. By addressing these challenges, we can harness the power of plant-based insecticides to protect crops and the environment.

CONCLUSION

The dual roles of medicinal plants as ethnomedicine use and pest control underscore their significance in sustainable development. Continued research and integration of indigenous knowledge can lead to novel, eco-friendly solutions for global challenges in healthcare and agriculture. Several of the medicinal plants have shown properties as a promising candidate for insecticidal applications. It is the need of the hour to further explore medicinal plants as potential pest control management strategy for sustainable agriculture.

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