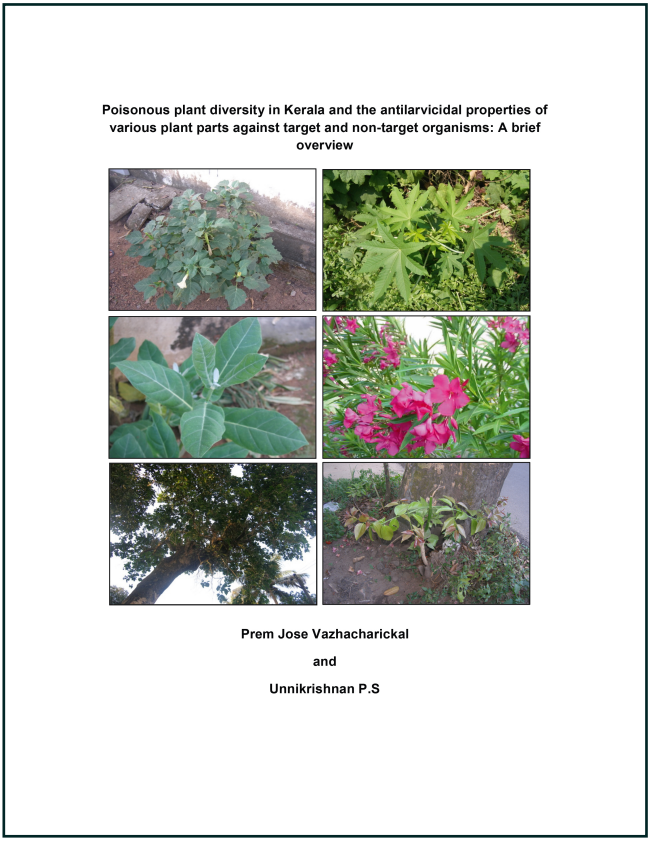
Unnikrishnan P.S (Autor)
Prem Jose Vazhacharickal (Autor)

Poisonous plant diversity in Kerala and the antilarvicidal properties of various plant parts against target and non-target organisms

A brief overview



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1. Introduction

A poison is defined as “any substance that when taken into the system acts in a noxious manner by means not mechanical, tending to cause death or serious determents to health” (Pammel, 1911).Poisonous plants are those plants that contain chemical constituents that are harmful for humans and other animals (James, 1999; Lewis and Elvin-Lewis, 2003; Cheeke, 1998;Van Wyk, et al., 2002). Poisonous plant developed a strategy to avoid the feeding from herbivores animals as a part of defensive system (Feeny, 1976; Price et al., 1980; Wink, 1988; Laycock, 1978; Wittstock and Gershenzon, 2002).Some have sharp spines, prickles, or stings that make them painful and difficult to eat (Rhoades, 1985; Feeny, 1976; Cooper and Owen-Smith, 1986; Lev-Yadun and Ne'eman, 2006; Gowda, 1996). Other defense mechanisms include presence ofalkaloids, tannins, and other secondary metabolites that taste horrid and can make the animal ill or even die (Keddy, 2007; Swain, 1977; McArthur et al., 1991; Bernays et al., 1989; Rhoades and Cates, 1976; Feeny, 1976).

Over millennia, through the process of natural selection, plants have adapted the means of producing vast and complicated forms of chemical compounds in order to defense against herbivores (Keddy, 2007; Swain, 1977; McArthur et al., 1991; Bernays et al., 1989; Rhoades and Cates, 1976; Feeny, 1976). Different toxic chemicals produced by plants are tannins, alkaloids, polyacetylenes, terpenes, phenolics (Keddy, 2007; Swain, 1977; McArthur et al., 1991; Bernays et al., 1989; Rhoades and Cates, 1976; Feeny, 1976; Wink, 1988; Levin, 1976; Fox, 1981; Antony and Josephine, 2014). In some plants toxic substance may present throughout the plant body whereas in some plants only a single or few parts of the plant are poisonous such as seeds, leaves, barks, root and flower (Antony and Josephine, 2014; Priya and Gopalan, 2015; Neuwinger, 2004; Watt and Breyer-Brandwijk, 1932; Feeny, 1976). Poison from plant can occur by injection, inhalation, or direct contact (Chopra and Badhwar, 1940; Tokarnia et al., 2002; Botha and Penrith, 2008; McLean, 1970; Schweigert et al., 2001). The effects of poisonous plants can range from mild skin irritation to death (Botha and Penrith, 2008; McLean, 1970; Schweigert et al., 2001).The poisonous effect varies depending on dose (Panter et al., 1988; Vetter, 2004). Some plants are capable of causing serious illness or death with a small amount of exposure (Panter et al., 1988; Vetter, 2004; McLean,

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1970; Schweigert et al., 2001). While in some plants, large quantities are required to be consumed before even mild symptoms to occur (Antony and Josephine, 2014; Rumack, 1973; Eddleston and Persson, 2003). Different symptoms include vomiting, respiratory problems, cardiac problems, abdomen pain skin rashes and burring sensations (Wilson et al., 2001; Antony and Josephine, 2014; Rumack, 1973; Eddleston and Persson, 2003).

Many of these poisonous plants also have important medicinal benefits (Lewis and Elvin-Lewis, 1977; Cowan, 1999; Rabe and Van Staden, 1997; Kelmanson et al., 2000). There are many poisonous pant reported in ancient scriptures of Ayurveda which are being still practiced widely in a number of disease after proper shodhana (purification/detoxification). It is reported that aconite (Vatsanabha) purified by cow's urine is converted to cardiac stimulant, whereas raw aconite is cardiac depressant (Singh et al., 1985).Likewise the plant Kupeelu (Strychnosnux-vomica Linn.) known as nux-vomica, is described under the 'UpavisaVargas' (poisonous group) (Sharma, 2000). It is cited in many Ayurvedic books and palm-leaf manuscript that the 'Visha' (poison) becomes 'Amrita' (nectar) after logical administration (Sharma, 2004).

The objective of this work is to identify the different verities of poisonous plant seen throughout Kerala and study its morphological variations, toxic principle, symptoms and medicinal values if there is any. The toxic effects of these plants as an effective bio-control agent against various target and non-target organisms were also included. This work is based on primary as well as secondary data collected from various scientific journals, literatures, information's from Ayurvedic doctors and folk medicine practitioners (local vaidyans).

1.1 Hypothesis

The current research work is based on the following hypothesis: (1) poisonous plant diversity is very high in Kerala; (2) most of the poisonous plant remain underutilized or neglected for its various futuristic potentials; and (3) poison extracts have a significant role in bio-control agents and their mode of action vary with the extract concentration, solvents and tested organisms (target and non-target).

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2. Materials and Methods

2.1 Study area

Kerala state covers an area of 38,863 km^2 with a population density of 859 per km^2 and spread across 14 districts. The climate is characterized by tropical wet and dry with average annual rainfall amounts to 2,817 ± 406 mm and mean annual temperature is 26.8°C (averages from 1871-2005; Krishnakumar et al., 2009).

2.2 Interview

Personal Interview with local vaidyans and Ayurvedic doctors were conducted and information's about various toxic plants, medicinal uses and its locations in Kerala were collected. Secondary data was collected from related journals and other literature.

2.3 Morphological characterization

The field study was conducted from December 2015 to February 2016. The samples were identified with the help of subject experts including local people, local vaidyans and Ayurvedic doctors. The plants were identified and the photos were taken by following non-destructive methods. Morphological characters of identified plants where studied such as habit, habitat, height, size and arrangement of leaves, inflorescence, flower characters and size, fruit size and shape, no of seeds etc. were observed and recorded and unidentified ones were studied from other journals and literatures. The instruments used to collect data were, measuring scale (30 cm), tape (160 cm), weighing machine, camera, field book and shovel. Locations of the sample collection areas were recorded using a Trimble Geoexplorer II (Trimble Navigation Ltd, Sunnyvale, California) and data were transferred using GPS Pathfinder Office software (Trimble Navigation Ltd, Sunnyvale, California).

2.4 Sample collection and processing

Four plants were selected as sample for further experiment, Ummam (P1), Avannaku (P2), Errukke (P3), Aralli (P4). Fresh Leaf (L), Stem (S), Fruit (Fr), Flower (F) of each plant was collected using sharp surgical knife. Total of 12 samples were collected. The samples were covered with clean plastic cover and brought to laboratory. The samples were cleaned using distilled water and dried in room temperature. Fresh weight (FW) where take for each sample. The samples were chopped in to small pieces and dried in

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hot air oven (KOA4, KEMI lab equipments, Ernakulam, India) for 48 h at 80°C. The dried sample were weighted and the dry weight were noted (DW).

The percentage of moisture content were determined using the formula given below

$$\% \text{ of moisture (wt/wt)} = \frac{\text{Wet weight-Dry weight}}{\text{Wet weight}} \text{x } 100$$

The oven dried samples were powered using a waring blender (Magic V2, Preethi Kitchen Appliances Pvt Ltd, Chennai, India) and stored in polyethylene (PE) bottles until further analysis. The powdered samples were dissolved in three solvents; chloroform (C), methanol (M) and distilled water (D) with the two different concentrations. The dissolved extracts were transferred in PE bottles and stored in a refrigerator at 4 ºC.

2.5 Target/non target organisms

Three organisms (target/non target) were selected for conducting experiments. Non-targeted organisms include Guppy fish (*Poecilia reticulate*; O1), tropical snail (*Pila globosa*; O2), and targeted organism was Mosquito larva (O3). The Guppy fish (O1) was collected from aquarium and local pounds with the help of local peoples. It was collected in air tight plastic bags and brought to laboratory. The collected fishes were stored in medium size aquarium in laboratory. Snail (O2) was collected from muddy areas, pound sides and stored in wide bottles of size (1000 ml). For mosquito larva (O3) small amount water where taken in cut open bottles and placed near garbage area, garden, messy areas and in rubber (*Hevea brasiliensis*) plantations. After 2-3 days mosquito larva were observed and was collected in glass jar which is brought to laboratory. They were stored in wide plastic bottles of size (1000 ml). The larvae were reared 27 ± 1 (°C) and 60 % relative humidity and a 12:12 h light and dark photoperiods (Nikkon et al., 2011).

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2.6 Experiment design

The experiment were conducted in a factorial manner, with four types of poisonous plants (P1, P2, P3 and P4); three different plant parts (leaf, stem, fruit/flower) two concentrations (2 and 5%); and three solvents (methanol, chloroform and distilled water). The entire experiment was replicated three times with a total size of 216 experiments (4 x 3 x 2 x 3 x 3) for a single target/non target organism. Crude extract of twelve samples where made using three solvents; chloroform (C), methanol (M) and distilled water (D), with two concentration (2 and 5%); chloroform 2% (C2) and chloroform 5% (C5), methanol 2% (M2) and methanol 5% (M5), distilled water 2% (D2) and distilled water 5% (D5).

2.7 Anti-inhibitory assay

2.7.1 Fish

Two average sized fishes were taken each in 6 sterile glass jar of size 250 ml with 100 ml distilled water. Total of 12 fishes per sample and 144 fish for twelve samples were taken in 72 glass jars. The extract (200µl) where added to each jar respectively using a sterile micro-pipette. The number of mortals within 24 h were observed. A control was also set using three solvents and same was observed.

2.7.2 Snail

Two snails where taken each in 6 sterile petri-dish for a single experiment. Total of 12 snails per sample and 144 snails for twelve samples were taken in 72 petri-dishes. 200 µl of extract where added to each petri-dish respectively using a sterile micro-pipette. The numbers of mortals within 24 h were observed. A control was also set using three solvents and same was observed.

2.7.3 Mosquito larvae

Two larva were taken each in 6 sterile petri-dish for a single experiment. Total of 12 larva per sample and 144 fish for twelve samples were taken in 72 glass jars. 200µl of extract where added to each jar respect using a sterile micro-pipette. The number of mortals within 24 h were observed. A control was also set using three solvents and same was observed.

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