Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2894

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (6):** 1499-1514 (2017)

International Journal of Pure & Applied Bioscience

Review Article

OPEN ACCESS

Chronological Review on Phytochemical, Antioxidant, Antimicrobial and Clinical studies on Biodiesel Yielding Good Luck Tree (*Thevetia peruviana)*

Ashwani Kumar*, Vani Tyagi, Beenu Rathi, Priyanka and Manisha

Department of Biotechnology & Microbiology,

Shri Ram College Muzaffarnagar, UP-251001, India

*Corresponding Author E-mail: ashwani_biotech@yahoo.co.in

Received: 24.04.2017 | Revised: 29.05.2017 | Accepted: 6.06.2017

ABSTRACT

Thevetia peruviana belongs to the Apocynaceae family. Thevetia peruviana is commonly found in Asian countries, especially in India, Sri Lanka. That has been used as an anti-inflammatory, anti-microbial, and an anti-oxidant. The paper has made an attempt in presenting a comprehensive review of the fifteen years of extensive research conducted on this plant with respect to its clinical significance. A wide-ranging account of its phytoconstituents, Antioxidant, Antimicrobial and the clinical aspect are presented in this paper, In view of the many recent findings of importance with regards to this plant. A wide range of secondary metabolites have been isolated from this plant, exhibiting various and excessive array of biological activities. Extracts from the various parts of Thevetia peruviana possess useful pharmacological activities. In conclusion, Thevetia peruviana is a well studied plant of medicinal value. It has scientifically confirmed to show anti-microbial action from the oil of the plant that contains flavonoids and thevefolin isolated from seeds showed anti-cancer activity and cardiotonic activity. Plants also bearing non-edible seeds have the potentials of reclaiming wasteland and do not compete with food crops and using up of these non-conventional and non-edible feed stocks can be sustainable for biodiesel production.

Key words: *Thevetia peruviana, Good luck tree, Phytochemical, Antioxidant, Antimicrobial.*

INTRODUCTION

Thevetia peruviana belongs to the family Apocynaceae & it commonly known as Yellow oleander & Lucky nut. *Thevetia peruviana*, called Manjarali in Tamil Nadu, is a small evergreen tree (3-4 m high) cultivated as an ornamental plant in tropical & subtropical regions of the world, including India, Australia and China. Fruit contains 2-4 flat gray seeds, which yields about half a litre of oil from 1 kg of dry kernel. This plant can be cultivated in wastelands. It requires minimum water when it 30 is in growing stage. It starts flowering after 1 & a half year. After that, it blooms thrice every year. It has also been regarded as a rich source of biologically active compounds such as insecticides, fungicides & bactercides, which shows *Thevetia peruviana* plant extract, have also been reported have Anti-microbial properties[1].

Cite this article: Kumar, A., Tyagi, V., Rathi, B., Priyanka and Manisha, Chronological Review on Phytochemical, Antioxidant, Antimicrobial and Clinical Studies on Biodiesel Yielding Good Luck Tree (*Thevetia peruviana), Int. J. Pure App. Biosci.* **5(6):** 1499-1514 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2894

DESCRIPTION OF PLANT PHARMACOLOGICAL CLASSIFICATION

Botanical name	*Thevetia peruviana*
Kingdom	Plantae
Family	Apocynaceae
Order	Gentianales
Genus	*Thevetia*
Species	*peruviana*

Due to rapid population growth and economic development, the worldwide energy demand is constantly increasing. The energy demand is fulfilled mainly from the conventional energy resources like coal, petroleum and natural gas. Recently, due to the shortage of fossil fuels throughout the world, crude oil price increase and contribution of these fuels to pollute the environment, biodiesel is being attracting increasing attention worldwide as a potential alternative and renewable fuel for diesel engines.[2-3] Biodiesel, an alternative and renewable fuel for diesel engines, consists of mono-alkyl esters of long chain fatty acids, more commonly methyl esters and is typically made from nontoxic, biological resources such as edible and non-edible vegetable oils, animal fats, waste cooking oils and oil from algae by transesterification with methanol[4-5]. The concept of biodiesel as an engine fuel dates back to 1895 when Dr. Rudolf Diesel (1858-1913) developed the first diesel engine with the intention to run on vegetable oils[6]. He used peanut vegetable oil to demonstrate first its invention at the World Exhibition in Paris in the year 1900. In 1912, Diesel said, “The use of vegetable oils as engine fuel may seem insignificant today. But such oils may, in the course of time, become as important as petroleum and coal tar products of the present time.” This prophetic statement of Rudolf Diesel is a reality now. It is known that petroleum is a finite resource and that its price tends to increase exponentially, as its reserves decrease[7].

Fig. 1: Yellow oleander fruits, seeds and kernels

The Sanskrit names for *Thevetia peruviana*, found in the encyclopaedia of medicinal plants are Ashvaghna (अश्वाघना), Divyapusha (दिव्यपूषा), and Haripriya (हरिप्रिया) [8]. (Encyclopaedia of World of Medicinal Plants). The medicinal value of this plant ranges from the being an extreme cardiotonic agent [9].

Fig. 2: Parts of Thevetia peruviana having fruits, flowers, mature fruits, buds and branches having fruits and flowers

CONSTITUENTS OF LEAF

Leaf extracts studied consisted of cardiac glycosides, sterols, iridoid glucosides, pentayclic triterpenes and a cardenolide. 7 known compounds that are known from fresh uncrushed leaves they are, 1) neolupenyl acetate, 2) 11-oxours- 12-en-28-oic acid, 3) lupeol acetate, 4) oleanolic acid, 5) ursolic acid, 6) stigmast-5-en-7- one, and 7) β-sitosterol.

CONSTITUENTS OF SEED

Seeds extract's studied consisted of cardenolide triglycosides of neriifolin, acetylneriifolin and thevetin.

CONSTITUENTS OF FLOWER

Its flowers showed presence of quercetin, kaempferol and quercetin-7-o-galactoside.

CONSTITUENTS OF BARK

Bark extract showed presence of four cardenolide glycosides, neriifolin, thevefolin, peruvoside, and (20S) – 18, 20-epoxydigitoxigenin α-L-thevetoside.

CONSTITUENTS OF ROOT

Root extract showed presence of iridoids, theveside, theviridoside, and two new glucosides theviridoside identified by Chinese researchers namely 10-O-β- D-Glucopyranosyl theviridoside and 3-O-β-D-Glucopyranosyl theviridoside.

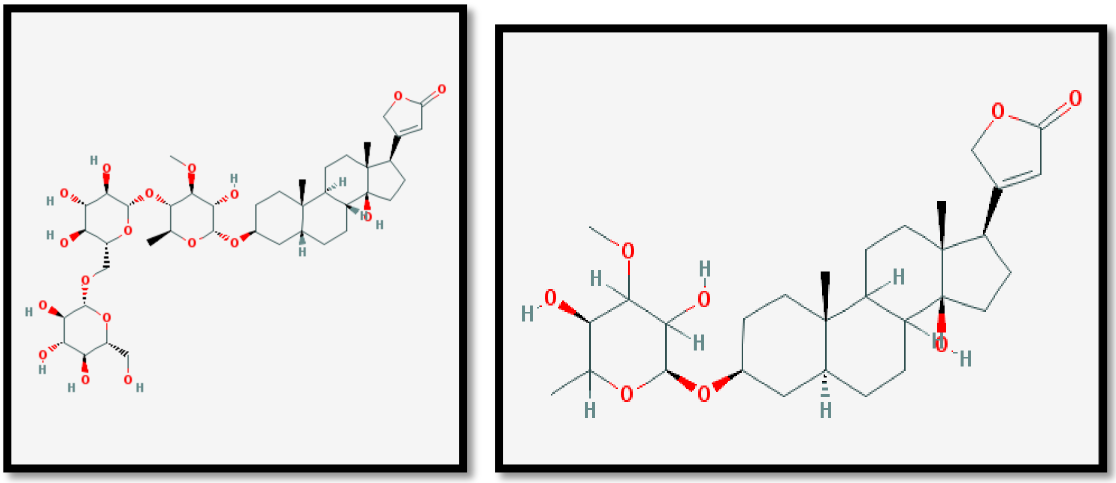

Fig. 3: Thevetin B and Thevefolin

PLANT DISTRIBUTION

This plant is grown up in Central& South America as well as Asian countries; India, Sri Lanka and tropical region also. It is a small tree, leaves are green, flowers colour is yellow or orange yellow it shows like trumpet structure. Flowers have odourless; fruits are deep green or black colour. Fruit size is largely it contains milky sap substance which is called *Thevetin. Thevetin* is a glycoside which presents cardiac stimulant property. But it is poisonous material. Leaves are present waxy coating to reduce the water loss of the plant. When plant turned to aged condition stem change colour greenish to gray[10, 11, 12, 13].

HABITAT

A large, evergreen shrub 450-600 cm tall with scented bright yellow flower in terminal cymes bears triangular fleshy drupes, containing 2-4 seeds. Leaves about 10-15 cm in length linear & acute[14, 15, 16].

CULTIVATION & PROPAGATION

CULTIVATION

The cultivation of *Thevetia peruviana* is not much hard. This plant is large flowering shrub; it plants in field, gardens in a normal temperature. It does not need much maintenance. It tolerates all types of soil. Warmer condition is prone to grown of this plant. Green house may be used in winter season[17, 18, 19, 20].

PROPAGATION

Generally seeds are propagated in spring condition or early summer when spring is just turned off with hard wood cutting. In spring condition (in a glass containing 10% bleach 90% warm water and clean seed coat are taken for 2-3 minutes; after wash seed and soak in warm water for 24 hours)[21,22,23,24].

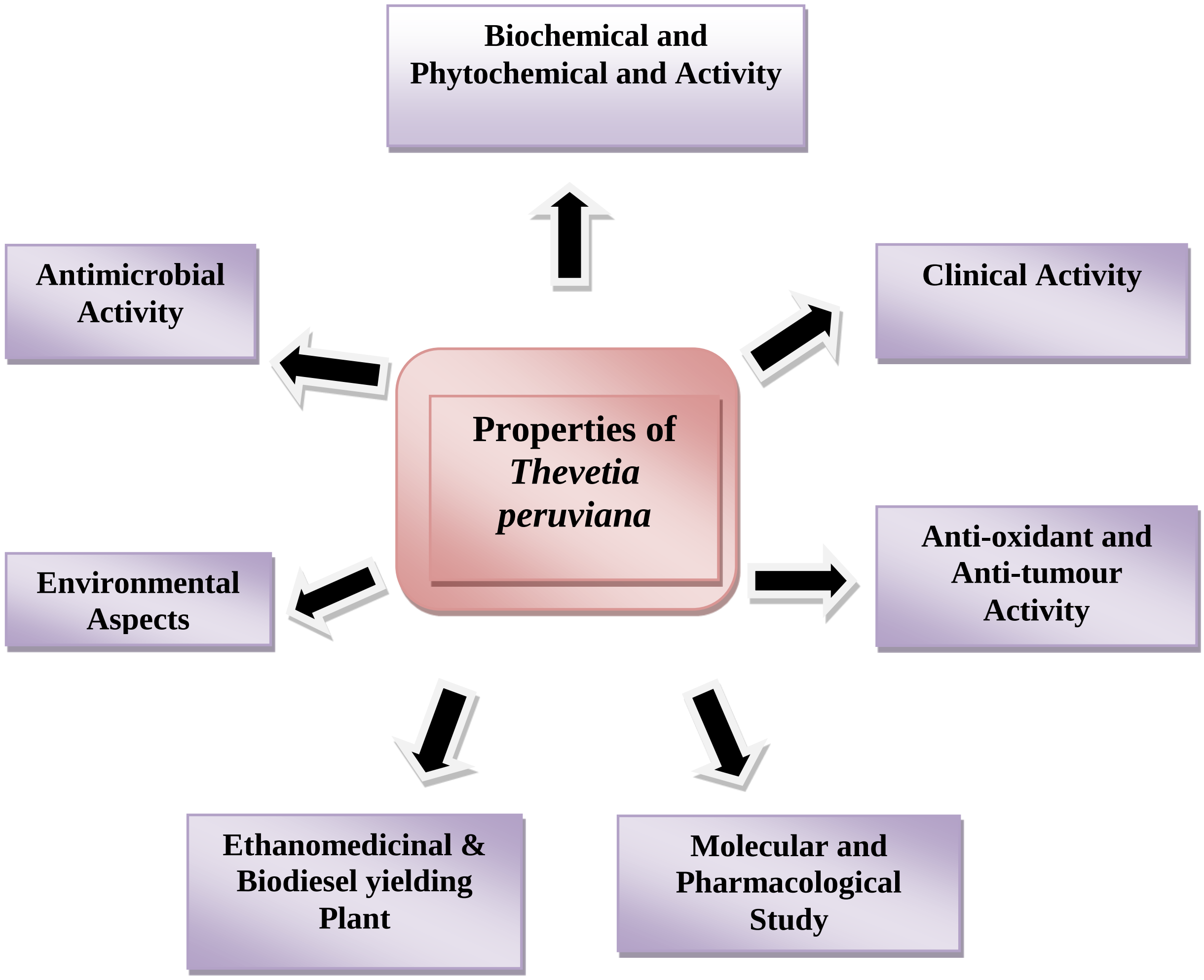

Fig. 4: Flow Chart for Antimicrobial, Antioxidant, Clinical, Phytochemical, and Pharmacological activity of *T. peruviana*

NUTRITIONAL, BIOCHEMICAL, PHYTOCHEMICAL AND PHARMACOLOGICAL ACTIVITY

Proximate analysis of twelve species of fruits commonly consumed by long-tailemacaques (Macaca fascicularis), i.e., *Arenga pinnata, Areca catechu, Terminalia catappa, Elaeis guineensis, Lagerstroemia tomentosa, Mangifera indica, Cascabela thevetia, Muntingia calabura, Musa sp., Artocarpus heterophyllus, Ficus tinctoria ssp. gibbosa* and *Ficus microcarpa*, was conducted with the specific objective to determine the nutritional composition of the foodstuffs of long-tailed macaques. The results showed the following order of nutrients: fibre, protein, fat and ash. Based on the results of the chemical analysis, the highest percentage of fibre content (52.7%), protein (9.9%), fat (77.2%) and ash (8.5%) were found in *A. catechu, T. catappa, E. guineensis and C. thevetia*, respectively. Here, *A. catechu* had the highest relative fibre content of all tested fruits, *E. guineensis* had the highest fat content, *T. catappa* had the highest protein content, and the total mineral content was highest in *C. thevetia*[25]. *Thevetia peruviana* (Pers.) K. Schum. (Apocynaceae) is known to possess cardioactive glycoside such as thevetin A, thevetin B,neriifolin, peruvoside, thevetoxin, and ruvoside. Traditionally, *Thevetia peruviana* leaves are used as abortifacient. The aim of the present study is to evaluate antifertility potential of *Thevetia peruviana* leaves[26]. Cardiac glycoside freed leaves of *Thevetia peruviana* were extracted with methanol using maceration method. The results demonstrated that phenolic content was maximally present in leaves of *Thevetia peruviana.* These results suggested that levels of total phenolics, flavonoids and their FRAP indices exhibited specificity to different plants and their parts[27]. Effect of medicinal and aromatic plants on rumen fermentation, protozoa population and methanogenesis in vitro. The potential of tannins from 21 medicinal and aromatic plant leaves as antimethanogenic additives in ruminant feeds was investigated. The fermentation pattern reflected increased total volatile fatty acid (TVFA) concentration from 0 to 28.3% with PEG addition among the leaves. Our results confirmed further observations that methanogenesis in vitro is not essentially related to density of protozoa population. Secondly, medicinal and aromatic plants such as *C. inerme, Gymnema sylvestre* and *Sapindus laurifolia* containing tannins appear to have a potential to suppress in vitro methanogenesis[28]. Cardiac glycosides from Yellow Oleander (*Thevetia peruviana*) seeds. *Thevetia* cardiac glycosides can lead to intoxication, thus they are important indicators for forensic and pharmacologic surveys. Six *thevetia* cardiac glycosides, including two with unknown structures, were isolated from the seeds of the Yellow Oleander (*Thevetia peruviana* (Pers.) K. Shum., Apocynaceae). LC-ESI$^+$-MS (/MS) analysis under high-resolution conditions used as a qualitative survey of the primary glycosides did not lead to fragmentation of the aglycones. Acid hydrolysis of the polar and non-volatile *thevetia* glycosides under severe conditions yielded the aglycones of the thevetia glycosides and made them amenable to GC-MS analysis. Comparison of mass spectral fragmentation patterns of the aglycones, as well as high-resolution mass spectrometric and NMR data of four of the primary thevetia glycosides including the two unknowns, revealed the structures of the complete set of six thevetia glycosides. The identified compounds are termed thevetin C and acetylthevetin C and differ by an 18, 20-oxido-20, 22-dihydro functionality from thevetin B and acetylthevetin B, respectively. The absence of an unsaturated lactone ring renders the glycosides cardio-inactive. The procedures developed in this study and the sets of analytical data obtained will be useful for screening and structure assessment of other, particularly polar, cardiac glycosides[29].

Phytochemical evaluation and antispermatogenic activity of *Thevetia peruviana* methanol extract in male albino rats. This study was conducted to evaluate the antifertility potential of *Thevetia peruviana* (Apocynaceae) in male albino rats with their phytochemical evaluations. Phytochemical examination showed that plant is rich in active constituents, i.e. α-amyrin acetate, lupeol acetate, α-amyrin, β-amyrin, lupeol and thevetigenin. In conclusion, *Thevetia peruviana* inhibited spermatogenesis in rats, indicating the possibility of developing a herbal male contraceptive[30]. Piscicidal activity of leaf and bark extract of *Thevetia peruviana* plant and their biochemical stress response on fish metabolism. The acetone leaf and bark extract of this plant was very effective in comparison to other solvent extract in both the conditions. So,the biochemical analysis is taken only acetone leaf and bark extract of *Thevetia peruviana* plant in laboratory condition.Exposure of sub-lethal doses (40% and 80% of LC,) of acetone leaf and bark extract of this plant over 24 h caused significant ($P < 0.05$) alterations in total protein, free amino acids, DNA & RNA, protease and acid and alkaline phosphatase activity in muscle, liver and gonadal tissues of fish Catla catla in laboratory condition.[31] Many aquatic snails act as intermediate hosts for the larvae of trematodes, *Fasciola hepatica* and *Fasciola gigantica*, which cause the diseases fascioliasis and schistosomiasis. The WHO has tested several thousands of synthetic compounds for the control of the snail host. Although effective, these molluscicides have so far not proved themselves to be entirely satisfactory. With a growing awareness of environmental pollution, efforts are being made to discover molluscicidal products of plant origin. Being products of biosynthesis, these are potentially biodegradable in nature. Several groups of compounds present in various plants have been found to be toxic to target organisms at acceptable doses ranging from <1 to 100 ppm. Common medicinal plants, i.e. *Thevetia peruviana*, *Alstonia scholaris* (Family; Apocynaceae), *Euphorbia pulcherima and Euphorbia hirta* (Family; Euphorbiaceae), have potent molluscicidal activity against freshwater snails. Although, at present very little literature is available on the control of vector snails through plant origin pesticides, an attempt has been made in this review to assemble all the known information on molluscicidal properties of common medicinal plants of eastern Uttar Pradesh, India, which might be useful for the control of harmful snails.[32] The potential larvicidal activity and insect growth regulator (IGR) properties of three selected indigenous medicinal Thai plants were tested against two species of mosquito with special reference to the late 3rd and early 4th instar larvae (L3 and L4, respectively). In addition, L3 was always more susceptible than L4 with both mosquito species.[33] Phytochemical studies on the stem bark of *Thevetia peruviana* resulted in the isolation of six new ursane-type triterpenes, named peruvianursenyl acetate A, peruvianursenyl acetate B, isolupenyl acetate, peruvianursenyl acetate C, lupedienyl acetate and peruvianursenyl glucoside along with two known triterpenoids, namely alpha-amyrin acetate and lupeol acetate. The structures of the new phytoconstituents have been established as 23--nor methyl urs-12-en-4 alpha-ethylenic-18 alpha-H-3 beta-yl acetate, urs-5.21-dien-18 alpha-H-3 beta-yl acetate, lup-20 (29)-en-3 alpha-yl acetate, urs-12 en-18 alpha-H-3 beta-yl acetate, lup-5,20 (29)-dien-3 beta-yl acetate, and urs-12-en-18 alpha-H-3-O-beta-D-glucopyranoside, respectively[34].

CLINICAL ACTIVITY

In this work, a mechanistic model for predicting the dynamic behavior of extracellular and intracellular nutrients, biomass production, and the main metabolites involved in the central carbon metabolism in plant cell cultures of *Thevetia peruviana* is presented.[35] Consequently, we herein aimed to cover all available data consisting of in vitro, in vivo, and human studies (if any) on cardiotonic effects of the aforementioned species through a wide literature search using Scopus, Web of Science as well as Pubmed[36]. Helicoverpa armigera Hübner is one of the most important agricultural crop pests in the world causing heavy crop yield losses. The continued and indiscriminate use of synthetic insecticides in agriculture for their control has received wide public apprehension because of multifarious problems, including insecticide resistance, resurgence of pest species, environmental pollution, and toxic hazards to humans and nontarget organisms. The midgut histological architecture of *H. armigera* larvae fed with 0.005%-0.05% extract-containing diet with negligible antifeedant potential showed significant damage,shrinkage, and distortion and vacuolization of gut tissues and peritrophic membrane, causing the disintegration of epithelial, goblet, and regenerative cells; the damage increased with the increase in concentration.These changes in the gut caused negative impact on the digestion and absorption of food and thus nutritional deficiency in the larvae, which could probably affect their growth and development. This study reveal the appreciable stomach poison potential of *T. neriifolia* stem methanol extract against *H. Armigera* larvae, which can be explored as an eco-friendly pest control strategy[37]. The fixed oil extracts from *Thevetia peruviana, Datura stramonium* and *Acacia sp.* were tested on Culex pipiens larvae. The estimated sublethal concentrations (LC50) were used in the present studies. The reproductive potential of females and the histochemistry of their ovaries were determined. The results indicated that oil treatments of larvae caused drastic changes in reproduction potential of female mosquitoes including the ovarian development in the first gonotrophic cycle, fecundity and fertility of treated females. 33% of the species were highly susceptible to the adverse effects of SPM, among which *Thevetia neriifolia, Saraca indica*, *Phyllanthus emblica* and *Cercocarpus ledifolius* showed low APTI values. 15% each of the species were at the intermediary and moderate tolerance levels.[38]

ANTI-OXIDANT, ANTI-MICROBIAL, ANTI-TUMOUR, ANTI-FUNGAL AND ANTI- INFLAMMATORY ACTIVITY

An enhanced cardiac glycoside using polymeric micelles for enhanced therapeutic efficacy against lung cancer cells[39]. *Thevetia peruviana* has been considered as a potentially important plant for industrial and pharmacological application. All together, these results demonstrate the extraordinary effect of different lighting conditions on polyphenols production and antioxidant compounds by *Thevetia peruviana*[40]. The ecological context in which mosquitoes and malaria parasites interact has received little attention, compared to the genetic and molecular aspects of malaria transmission. These effects are likely the result of complex interactions between toxic secondary metabolites and the nutritional quality of the plant sugar source, as well as of host resource availability and parasite growth. Using an epidemiological model, we show that plant sugar source can be a significant driver of malaria transmission dynamics, with some plant species exhibiting either transmission-reducing or –enhancing activities.[41] Cardenolides, as a group of natural products that can bind to Na (+)/K (+)-ATPase with an inhibiting activity, are traditionally used to treat congestive heart failure. In this review, we compile the phytochemical characteristics and anticancer activity of the cardenolides from this family.[42] Phytochemical investigation of the seeds of *Thevetia peruviana* resulted in the isolation of seven cardiac glycosides (1-7), including two new compounds (1 and 2). Altogether, this study suggested that compound 1 may exhibit anticancer activity by its capability of induction of intrinsic apoptosis and cell cycle arrest at G2/M phase[43].

The aim of this study was analyze the effect of jasmonic acid (JA) and abscisic acid (ABA) as elicitors on fatty acids profile (FAP), phenolic compounds (PC) and antioxidant capacity (AC) in callus of Thevetia peruviana. In conclusion, JA may be used in *Thevetia peruviana* callus culture for obtain oil with different fatty acids profile.[44] Proteins that share similar primary sequences to the protein originally described in salt-stressed tobacco cells have been named osmotins. Osmotin-like proteins were not detected in the latex of *Thevetia peruviana, Himatanthus drasticus* and healthy *Carica papaya* fruits. Later, the two new osmotin-like proteins were purified through immunoaffinity chromatography with anti-CpOsm immobilized antibodies. Worth noting the chromatographic efficiency allowed for the purification of the osmotin-like protein belonging to *H. drasticus* latex, which was not detectable by immunoassays. The identification of the purified proteins was confirmed after MS/MS analyses of their tryptic digests. It is concluded that the constitutive osmotin-like proteins reported here share structural similarities to CpOsm. However, unlike CpOsm, they did not exhibit antifungal activity against *Fusarium solani* and *Colletotrichum gloeosporioides.* These results suggest that osmotins of different latex sources may be involved in distinct physiological or defensive events[45].

Plant latex: A promising antifungal agent for post harvest disease control.Bioactive compounds from plant latex is potential source of antifungic against post harvest pathogens. Latex from a total of seven plant species was investigated for its phytochemical and antifungal properties. Six fungi namely *Aspergillus fumigatus, A. niger, A. terreus, F. solani, P. digitatum* and *R.arrhizus* were isolated from infected fruits and vegetables and tested against various solvent extracts of latex. In conclusion, use of plant latex makes interest to control postharvest fungal diseases and is fitting well with the concept of safety for human health and environment[46]. Method validation of a survey of thevetia cardiac glycosides in serum samples.mA sensitive and specific liquid chromatography tandem mass spectrometry (HPLC-ESI (+) -MS/MS) procedure was developed and validated for the identification and quantification of thevetin B and further cardiac glycosides in human serum.The seeds of Yellow Oleander *(Thevetia peruviana)* contain cardiac glycosides that can cause serious intoxication. Finally, the method was applied to a case of thevetia seed ingestion[47].

Studies on the antidiarrhoeal, antimicrobial and cytotoxic activities of ethanol-extracted leaves of yellow oleander (*Thevetia peruviana*). This study screened the antidiarrhoeal, antimicrobial and cytotoxic effects of ethanol-extracted leaves of yellow oleander (*Thevetia peruviana*). The extract was tested against castor oil-induced diarrhoea in a model of albino rats and showed significant antidiarrhoeal activity ($P<0.01$). The wide range of LC50 value denotes the safety effect of the extract.[48] Antimicrobial activities of skincare preparations from plant extracts. In this study, *Tithonia diversifolia Helms.* (A Gray), *Aloe secundiflora* (Miller) and *Azadirachta indica* (A. Juss) plant extracts were used to make herbal soaps while *Thevetia peruviana* (Schum) seed oil was used to make a herbal lotion for skincare. The soaps were tested for the growth inhibition of Escherichia coli, and Candida albicans. Results from this study indicated that the 'Tithonia diversifolia' soap would have superior skin protection against the tested bacteria but would offer the least skin protection against *C. albicans*. The herbal lotion inhibited S.aureus and E. coli in a concentration dependent manner, however, the inhibitory effect was more pronounced on S. aureus.[49] The antimicrobial potential of seventy-seven extracts from twenty-four plants was screened against eight bacteria and four pathogenic fungi, using microbroth dilution assay. Lowest concentration of the extract, which inhibits any visual microbial growth after treatment with p-iodonitrotetrazolium violet, was considered to be minimum inhibitory concentration (MIC). Water extracts of Acacia nilotica, Justicia zelanica, Lantana camara and Saraca asoca exhibited good activity against all the bacteria tested and the MIC was recorded in range of 9.375-37.5 microg/ml and 75.0-300.0 microg/ml against the bacterial and fungal pathogens, respectively. The other extracts of *Phyllanthu urinaria, Thevetia nerifolia, Jatropha gossypifolia Saraca asoca, Tamarindus indica, Aegle marmelos, Acacia nilotica, Chlorophytum borivilianum, Mangifera indica, Woodfordia fruticosa* and *Phyllanthus emblica* showed antimicrobial activity in a range of 75-1200 microg/ml[50].

There is a severe shortage of affordable antivenoms and antitoxins in the developing world. An anti-digoxin antitoxin for oleander poisoning was introduced in Sri Lanka in July, 2001, but because of its cost, stocks ran out in July, 2002. Treatments for poisoning and envenoming should be included in the present campaign to increase availability of affordable treatments in the developing world[51]. Seeds of *Thevetia peruviana* were screened for their antifungal photoactivity. Extracts obtained either with n-hexane or dichloromethane were fractionated by column chromatography and further analysed by thin-layer chromatography. All seed extracts and fractions were tested for inhibition of the fungus *Cladosporium cucumerinum* for the evaluation of photoactive inhibitory effects. Two major groups of compounds were identified, terpenes and fatty acids and derivatives. Pulegone, linoleic acid and palmitic acid were the major compounds. Terpenes seem to be the major substances with antifungal photoactivity[52]. Two new flavanone glucosides, (2R)- and (2S)-5-O-beta-D-glucopyranosyl-7,4'-dihydroxy-3',5'-dimethoxyflavanone[pervianosi de I (3), peruvianoside II(4)] and a new flavonol glycoside, quercetin 3-O-[beta-D-glucopyranosyl-(1-->2)-[alpha-L-rhamnopyranosyl-(1-->6)]-beta-D-galactopyranoside] (peruvianoside III, 13) were isolated from the leaves of Thevetia peruviana Schum., together with nine known flavonol glycosides and two known iridoid glucosides. Their inhibitory effects against HIV-1 reverse transcriptase and HIV-1 integrase were also investigated[53].

MOLECULAR STUDY

The latex from *Thevetia peruviana* is rich in plant defense proteins, including a 120 kDa cysteine peptidase with structural characteristics similar to germin-like proteins. Peruvianin-I exhibited no oxalate oxidase and superoxide dismutase activity or antifungal effects. Peruvianin-I represents the first germin-like protein (GLP) with cysteine peptidase activity, an activity unknown in the GLP family so far.[54] Pathogenesis-related protein expression in the apoplast of wheat leaves protected against leaf rust following application of plant extracts. Leaf rust (Puccinia triticina) is a major disease of wheat. We tested aqueous leaf extracts of *Jacaranda mimosifolia* (Bignoniaceae), *Thevetia peruviana* (Apocynaceae), and *Calotropis procera* (Apocynaceae) for their ability to protect wheat from leaf rust. Extracts from all three species inhibited *P*. We conclude that pretreatment of wheat leaves with spray formulations containing previously untested plant leaf extracts enhances protection against leaf rust provided by fungicide sprays, offering an alternative disease management strategy[55]. Euglossine bees interact with more than 60 plant families of the Neotropical region. The richness and abundance of these bees have been intensively studied in different ecosystems using the methodology of capturing males with chemical baits. Females are poorly known for most of the species and morphological characters for their taxonomic classification have not yet been described. The purpose of this study was to use allozymes and restriction patterns of the mitochondrial regions 16S and Cyt b to identify species of Euglossa Latreille. Bees were collected while visiting *Thevetia peruviana* (Apocynaceae) flowers in five cities of the state of São Paulo, Brazil. Three Euglossa species were identified among the 305 individuals collected. *Euglossa cordata (*L.*)* was the only species found in all cities. Our results describe potentially useful genetic markers for the identification of Euglossa spp. at the species and group level[56]. *Thevetia peruviana* seed carboxyl esterase was employed as a biosensor for the detection of selenium compounds by an enzyme inhibition technique on paper chromatograms. The selenium compounds (sodium selenite and selenium dioxide) appeared as white spots on a magenta background due to the inhibition of *Thevetia peruviana* seed carboxyl esterase (substrate 1-naphthyl acetate, coupling reagent fast blue B salt). The minimum detectable amounts were about 5 microg of sodium selenite and 5 microg of selenium dioxide. Many other animal and plant carboxyl esterases gave no inhibition spot under the same conditions. Soil and water samples were fortified with sodium selenite and selenium dioxide. A procedure for preparing test solutions and conditions for paper chromatography was established[57].

ETHANOMEDICINE, NANOTECHNOLOGY AND BIODIESEL YIELDING ACTIVITY

Silver nanoparticles (AgNPs) were biosynthesized via a green route using ten different plants extracts (GNP1- *Caryota urens*, GNP2-Pongamia glabra, GNP3-Hamelia patens, GNP4-Thevetia peruviana, GNP5-*Calendula officinalis*, GNP6-*Tectona grandis*, GNP7-*Ficus petiolaris*, GNP8- *Ficus busking*, GNP9- *Juniper communis*, GNP10-*Bauhinia purpurea).* AgNPs were tested against drug resistant microbes and their biofilms. This study suggests that the action of AgNPs on microbial cells resulted into cell lysis and DNA damage. Excellent microbial biofilm inhibition was also seen by these green AgNPs. AgNPs have proved their candidature as a potential antibacterial and antibiofilm agent against MDR microbes.[58] Lipid-rich biomass, generally opted for biodiesel production, produces a substantial amount of by-product (de-oiled cake and seed cover) during the process. Complete utilization of *Cascabela thevetia* seeds for biofuel production through both chemical and thermochemical conversion route is investigated in the present study. The present investigation depicts a new approach towards complete utilization of lipid-rich bio-resources to different types of biofuels and biochar.[59] Ethnobotanical survey of biopesticides and other medicinal plants traditionally used in Meru central district of Kenya. The purpose of this study was to carry out a survey and document plants used in Meru-central district by traditional healers with emphasis on those used as biopesticides. The study was carried out at Igane and Gatuune sub-locations, Abothuguchi East division of Meru-Central district, Kenya. The data collection involving 23 traditional healers was done using semi-structured questionnaire, focused group discussion and transect walks. Plants samples were collected and botanically identified at the herbarium of the Department of Land Resource Management and Agriculture Technology in the University of Nairobi.The results of the ethnobotanical survey revealed that herbalists belonged to both gender with the majority being male (82.6%) and female (17.4%). Meru central district is rich in biodiversity of biopesticides and other medicinal plants and there is need for further pharmacological studies to validate their use as potential drugs for pests and disease control[60].

ENVIROMENTAL ASPECTS

Being the second largest manufacturing industry in India, cement industry is one of the major contributors of suspended particulate matter (SPM). Since plants are sensitive to air pollution, introducing suitable plant species as part of the greenbelt around cement industry was the objective of the present study. Analyses of individual parameters showed variation in the different zones.[61] Auto-pollution is the by-product of our mechanized mobility, which adversely affects both plant and human life. Foliar surface configuration and biochemical changes in two selected plant species, namely *Ficus religiosa L.* and *Thevetia nerifolia L.,* growing at IT crossing (highly polluted sites), Picup bhawan crossing (moderately polluted site) and Kukrail Forest Picnic Spot (Low polluted site) were investigated. The changes in the foliar configuration reveal that these plants can be used as biomarkers of auto-pollution.[62] Mortality caused by the aqueous extract of latex of *Thevetia peruviana, Alstonia scholaris* and *Euphorbia pulcherrima* against two harmful freshwater snails,Lymnaea cuminate and Indoplanorbis exustus, is reported. Therefore, these plant extracts may eventually be of great value for the control of harmful aquatic snails and other molluscan pests[63].

MISCELLANEOUS

Investigation of the seeds of *Thevetia peruviana* resulted in the isolation of 15 new (2-16) and 18 known (1 and 17-33) cardiac glycosides. In addition, cardiac glycosides 1, 22, 26, and 28 were evaluated for their apoptosis-inducing activities in MGC-803 cells, showing IC50 values in the range 0.02-0.53 μM[64]. *Thevetia peruviana*[65]. Methanol extracts of *Thevetia peruviana* (METP) (Apocynaceae) fruit showed antitumor activity against Ehrlich's ascites carcinoma (EAC) cell line in Swiss albino mice. In summary, METP exhibited remarkable antitumor activity in Swiss albino mice, which is plausibly attributable to its augmentation of endogenous antioxidant mechanisms[66].

The authors describe three cases of severe accidental poisoning by plants used as part of a traditional treatment in Mayotte. The established, or suspected, toxicity of *Thevetia peruviana* (Yellow oleander), *Cinchona pubescens* (Red quinine-tree), *Melia azaderach* (Persian lilac, also called china berry) and *Azadirachta indica* (Neem), is discussed. The need for cooperation with local botanists, familiar with traditional medicine, is also underlined[67]. The real mechanism for *Thevetia peruviana* poisoning remains unclear. Cholinergic activity is important for cardiac function regulation, however, the effect of T. peruviana on cholinergic activity is not well-known. he increased levels of AChE and the hearth tissue infiltrative lesions induced by the aqueous seed kernel extract of *Thevetia peruviana* explain in part the poisoning caused by this plant, which can be related to an inflammatory process[68]. A 25-year-old woman was evaluated and treated for ingestion of *Thevetia peruviana* seeds and flower petals-a natural digoxin cross reacting cardinolide-with intent to cause self-harm. The following case report provides the clinical presentation, treatment and management of acute yellow oleander poisoning[69]. Yellow oleander poisoning in eastern province: an analysis of admission and outcome. Cardiac toxicity after self-poisoning from ingestion of yellow oleander seeds is common in Eastern Sri Lanka. Multiple activated charcoals alone were safe and adequate in most cases even late presentation[70].

The absorption, distribution, metabolism and elimination of medicines are partly controlled by transporters and enzymes with diurnal variation in expression. Dose timing may be important for maximizing therapeutic and minimizing adverse effects. We found strong evidence that the outcome of oleander poisoning was associated with time of ingestion ($P < 0.001$). There was weaker evidence for OP insecticides ($P = 0.041$) and no evidence of diurnal variation in the outcome for carbamate, glyphosate and paraquat pesticides. Compared with ingestion in the late morning, and with confounding by age, sex, time of and delay to hospital presentation and year of admission controlled, case fatality of oleander poisoning was over 50% lower following evening ingestion (risk ratio = 0.40, 95% confidence interval 0.26-0.62). Variation in dose across the day was not responsible. We have shown for the first time that timing of poison ingestion affects survival in humans. This evidence for chronotoxicity suggests chronotherapeutics should be given greater attention in drug development and clinical practice.[71] Patterns of sugar feeding and host plant preferences in adult males of An. gambiae (Diptera: Culicidae). Sugar feeding by male mosquitoes is critical for their success in mating competition. However, the facets of sugar source finding under natural conditions remain unknown. The number of sugar-positive males was variable in a no-choice cage assay, consistent with the olfactory response patterns towards corresponding odor stimuli. These experiments provide the first evidence both in field and laboratory conditions for previously unstudied interactions between males of An. gambiae and natural sugar sources[72]. Fatal flower[73]. Cardenolide glycosides of *Thevetia peruviana* and triterpenoid saponins of Sapindus emarginatus as TRAIL resistance-overcoming compounds. A screening study for TRAIL resistance-overcoming activity was carried out, and activity-guided fractionations of Thevetia peruviana and Sapindus emarginatus led to the isolation of four cardenolide glycosides (1-4) and four triterpenoid saponins (5-8), respectively. In particular, cardenolide glycosides (1 and 2) from *T. peruviana* were shown to have a significant reversal effect on TRAIL resistance in human gastric adenocarcinoma cells, and real-time PCR showed that thevefolin (2) enhanced mRNA expression of death receptor 4 (DR4) and DR5. In addition, 1H and 13C NMR characterizations are shown for thevefolin (2) for the first time[74].

Cardiac conduction disorders following oral ingestion of Oleander plant materials were documented earlier. Transcutaneous absorption of yellow oleander (*Thevetia peruviana*) leaf extract applied over non intact skin (raw wound) resulting in reversible cardiac conduction disorder observed in four healthy males who were free from any other systemic or electrolyte or metabolic disorders or exposure to pesticide or toxins is reported for the first time. Hence, it is suggested that physicians and practitioners have to elicit history and route of administration of unconventional therapy, whenever they are confronted with clinical challenges and during medical emergencies before embarking final decision.[75] Is this the epitaph for multiple-dose activated charcoal?[76] Mortality caused by the aqueous extracts of leaf and stem bark of four plant belonging to family Euphorbiaceae and Apocynaceae against freshwater fish Channa punctatus has been reported. It was found that dilute aqueous solutions of leaf and stem bark were active in killing the fishes. The toxic effect of stem bark of all the plants were time as well as dose dependent. There was significant negative correlation between LC50 and exposure periods. It has been suggested that these plant products cannot be used directly in freshwater bodies, without their detailed studies on long-term effects on non-target organism as well their structure activity relationship[77].

CONCLUSION

Thevetia peruviana plant shows a diverse array of properties ranging from being a toxin to a cardiotonic[78]. Kernels of the plant exhibit toxicity mainly coming from cardiac glycosides present in the plant, which are mostly triosides or monosides of digitoxigenin. Thevetin found in seeds is a mixture of 2 triosides Thevetin A and Thevetin B in the 2:1 ratio. Monosides isolated from the seeds are neriifolin, cerberin, peruvoside, thevenerin, and perubosidic acid showed positive inotropic effect. Peruvoside has been a thriving oral drug in the market for its digitalization activity. Thevetin mixture-A and B, cardiac glycosides, has been helpful a decompensation cardiotonic[78]. Flavonoids, steroids and terpenoids, found in *Thevetia peruviana* are the prominent secondary metabolites that have resulted into antiinflammatory, anti-bacterial and anti-fungal activity. Secondary metabolites like Quercetin, Kaempferol found in the flowers. Oleanic acid, Ursolic acid, and β-sitosterol isolated from fresh crushed leaves have shown the presence for these activities. Flavonoids and tannins in *Thevetia peruviana* are possessing antimicrobial activity. The antimicrobial activity in a flavonoid is primarily due to its ability to complex with extracellular and soluble proteins that leads to binding with a bacteria cell wall, while that of tannins is related to their ability to inactivate microbial hold enzymes and cell surround proteins. *Thevetia peruviana* is a plant which contains so many phytochemical properties, medicinal uses for various therapeutic purposes. Looking upon large diagnosis and possible of Peruvian for a various purposes. The plant or its individual parts can be used for the management of various disorders in human being such as diabetes, liver toxicity fungal infection, microbial infection, inflammation, and pyrexia and relive pain. Still, so much work is required with the *Thevetia peruviana* to study the mechanism of action with other beneficial activities. The plant starts flowering after one and a half year and gives fruits throughout the year providing a steady deliver of seeds.

Acknowledgement

We take this opportunity to acknowledge sincere thanks to our respected chairman, Dr S.C. Kulshreshtha, Hounrable Executive Director Dr B.K Tyagi, Director Dr. N.P Singh, Shri Ram Group of Colleges Muzaffarnagar, U.P. India for providing necessary facility and tools to carry out the research dissertation work for post graduate students of MSc Biotechnology.

REFERENCES

1. Kokate, C.K., Purohit, A.P, and Gokhle, S.B., Pharmacognosy, Nirali Prakashan, Thirty Second Edition, 201-202, (2005).
2. Barua, P., Dutta, K., Basumatary, S., Deka, D.C., and Deka, D.C., Seed oils from non-conventional sources in north-east India: potential feedstock for production of biodiesel. *Natural Product Research*, **28(8):** 577–580 (2014).
3. Basumatary, S., Non-Conventional Seed Oils as Potential Feedstocks for Future Biodiesel Industries. A Brief Review, Res. J. Chem. Sci, **3(5):** 99–103 (2013).
4. Takase, M., Feng, W., Wang, W., Gu, X., Zhu, Y., Li, T., Yang, L., and Wu, X., *Silybum marianum* oil as a new potential non-edible feedstock for biodiesel: A comparison of its production using conventional and ultrasonic assisted method, *Fuel Process. Technol.*, **123:** 19–26, (2014).
5. Basumatary, S., *Pithecellobium monadelphum* Kosterm: A non-edible feedstock for biodiesel production, Der Chemica Sinica, **4(3):** 150–155 (2013).
6. Ma, F., and Hanna, M.A., Biodiesel production: a review, *Bioresour. Technol,* **70:** 1–15 (1999).
7. Conceicuao, M.M., Candeia, R.A., Dantas, H.J., Soledade, L.E.B., Fernandes, V.J., and Souza, A.G., Rheological Behavior of Castor Oil Biodiesel, *Energy Fuels,* **19(5):** 2185–2188 (2005).
8. Nesy, E.A., and Mathew, L., Studies on Antimicrobial and Antioxidant Efficacy of

Thevetia neriifolia, Juss Leaf Extracts against Human Skin Pathogens (2014).
9. Misra, M.K., Sarwat, M., Bhakuni, P., Tuteja, R., and Tuteja, N., Oxidative stress and ischemic myocardial syndromes. *Med Sci Monit*, **15:** 209-219 (2009).
10. Kokate, C.K., Purohit, A.P., and Gokhle, S.B., Pharmacognosy; Nirali Prakashan; Thirty Second Edition; 201-202 (2005).
11. Sastri, B.N., Wealth of India *Thevetia peruviana*; New Delhi National Institute of Science Communication CSIR; **1:** 1218.
12. Singh K, Agrawal, K.K., Mishra V, Uddin, S.M., and Shukla A; A review on: *Thevetia peruviana*; *International Research Journal of Pharmacy;* **3(4):** 74-77 (2012).
13. Eddleston, M.S., Rajakanthan S, Jayalath L, and Santharaj W; Anti-digoxin Fan fragments in cardio toxicity induced by ingestion of yellow oleander: a randomized controlled trial; *The Lancet;* **355:** 967-972 (2000).
14. Kokate, C.K., Purohit, A.P., and Gokhle, S.B; Pharmacognosy; Nirali Prakashan; Thirty Second Edition; 201-202 (2005).
15. Singh K, Agrawal, K.K., Mishra V, Uddin, S.M., and Shukla A; A review on: *Thevetia peruviana*; *International Research Journal of Pharmacy*; **3(4):** 74-77 (2012).
16. Eddleston, M.S., Rajakanthan S, Jayalath L, and Santharaj W; Anti-digoxin Fan fragments in cardio toxicity induced by ingestion of yellow oleander: a randomized controlled trial; *The Lancet*; **355:** 967-972 (2000).
17. Kokate, C.K., Purohit, A.P, and Gokhle, S.B; Pharmacognosy; Nirali Prakashan; Thirty Second Edition; 201-202 (2005).
18. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=a551; Access online from (2016).
19. Singh K, Agrawal, K.K., Mishra V, Uddin, S.M., and Shukla A; A review on: *Thevetia peruviana*; *International Research Journal of Pharmacy*; **3(4):** 74-77 (2012).
20. Eddleston, M.S., Rajakanthan S, Jayalath L, and Santharaj W; Anti-digoxin Fan fragments in cardio toxicity induced by ingestion of yellow oleander: a randomized controlled trial; *The Lancet*; **355:** 967-972 (2000).
21. Kokate, C.K., Purohit, A.P., and Gokhle, S.B; Pharmacognosy; Nirali Prakashan; Thirty Second Edition; 201-202 (2005).
22. http://age.Arizona.edu/gardening/aridplants/Thevetia_peruviana.htm1; Access online from (2001).
23. Singh K, Agrawal, K.K., Mishra V, Uddin, S.M., and Shukla A; A review on: *Thevetia peruviana*; *International Research Journal of Pharmacy;* **3(4):** 74-77 (2012).
24. Eddleston, M.S., Rajakanthan S, Jayalath L, and Santharaj W; Anti-digoxin Fan fragments in cardio toxicity induced by ingestion of yellow oleander: a randomized controlled trial; *The Lancet;* **355:** 967-972 (2000).
25. Kassim N, Hambali K, and Amir A. Nutritional Composition of Fruits Selected by Long-Tailed Macaques (Macaca fascicularis) in Kuala Selangor, Malaysia. *Trop Life Sci Res* **28(1):** 91-101 (2017).
26. Samanta J, Bhattacharya S, and Rana, A.C., Antifertility activity of Thevetia peruviana (Pers.) K. Schum leaf in female Sprague-Dawley rat *Indian J Pharmacol*. **48(6):** 669-674 (2016).
27. Srivastava N, Chauhan, A.S., and Sharma B. Isolation and characterization of some phytochemicals from Indian traditional plants. *Biotechnol Res Int.* **2012:**549850 (2012).
28. Bhatta R, Baruah L, Saravanan M, Suresh, K.P., and Sampath, K.T., Effect of medicinal and aromatic plants on rumen fermentation, protozoa population and methanogenesis in vitro. *J Anim Physiol Anim Nutr (Berl).* **97(3):** 446-56 (2013).
29. Kohls S, Scholz-Böttcher, B.M., Teske J, Zark P, and Rullkötter J. Cardiac glycosides from Yellow Oleander (Thevetia peruviana) *seeds. Phytochemistry* **75:** 114-27 (2012).

30. Gupta R, Kachhawa, J.B., Gupta, R.S., Sharma, A.K., Sharma, M.C., Dobhal, M.P., Phytochemical evaluation and antispermatogenic activity of Thevetia peruviana methanol extract in male albino rats. *Hum Fertil (Camb).* **14(1):** 53-9 (2011).
31. Singh, S.K., Yadav, R.P., and Singh A. Piscicidal activity of leaf and bark extract of Thevetia peruviana plant and their biochemical stress response on fish metabolism. *Eur Rev Med Pharmacol Sci.* **14(11):** 915-23 (2010).
32. Singh, S.K., Yadav, R.P., and Singh A. Molluscicides from some common medicinal plants of eastern Uttar Pradesh, *India. J Appl Toxicol.* **30(1):** 1-7 (2010).
33. Lapcharoen P, Apiwathnasorn C, Komalamisra N, Dekumyoy P, Palakul K, and Rongsriyam Y.Three indigenous Thai medicinal plants for control of Aedes aegypti and Culex quinquefasciatus. *Southeast Asian J Trop Med Public Health.36* Suppl **4:** 167-75 (2005).
34. Ali M, Ravinder E, and Ramachandram R. New ursane-type triterpenic esters from the stem bark of Thevetia peruviana. Pharmazi. **55(5):** 385-9 (2000).
35. Villegas A, Arias, J.P., Aragón D, Ochoa S, and Arias M. Structured model and parameter estimation in plant cell cultures of Thevetia peruviana. *Bioprocess Biosyst Eng.* (2016).
36. Orhan, I.E., Gokbulut A, and Senol, F.S., Adonis sp., Convallaria sp., Strophanthus sp., Thevetia sp., and Leonurus sp. - Cardiotonic plants with known traditional use and a few preclinical and clinical studies. *Curr Pharm Des.* (2016).
37. Mishra M, Gupta, K.K., and Kumar S. Impact of the Stem Extract of Thevetia neriifolia on the Feeding Potential and Histological Architecture of the Midgut Epithelial Tissue of Early Fourth Instars of Helicoverpa armigera Hübner. *Int J Insect Sci.* **7:** 53-60 (2015).
38. Hussein, K.T., Pathological alterations in the ovaries of Culex pipiens induced by fixed oil extracts from Thevetia peruvine, Datura stramonium and Acacia sp. J Egypt Soc Parasitol. **29(3):** 997-1005 (1999).
39. Zhu, J., Zhang, X.X., Miao, Y.Q., He, S.F., Tian, D.M., Yao, X.S., Tang, J.S., and Gan Y. Delivery of acetylthevetin B, an antitumor cardiac glycoside, using polymeric micelles for enhanced therapeutic efficacy against lung cancer cells. *Acta Pharmacol Sin* **38(2):** 290-300 (2017).
40. Arias, J.P., Zapata K, Rojano B, and Arias M. Effect of light wavelength on cell growth, content of phenolic compounds and antioxidant activity in cell suspension cultures of Thevetia peruviana. *J Photochem Photobiol* B. **163:** 87-91 (2016).
41. Hien, D.F., Dabiré, K.R., Roche B, Diabaté A, Yerbanga, R.S., Cohuet A . Yameogo, B.K., Gouagna, L.C., Hopkins, R.J, Ouedraogo, G.A., Simard F, Ouedraogo, J.B., and Ignell R, Lefevre T. Plant-Mediated Effects on Mosquito Capacity to Transmit Human Malaria. *PLoS Pathog.* **12(8):** e1005773 (2016).
42. Wen S, Chen Y, Lu Y, Wang Y, Ding L, and Jiang M. Cardenolides from the Apocynaceae family and their anticancer activity. Fitoterapia. **112:** 74-84 (2016).
43. Cheng, H.Y., Tian, D.M., Tang, J.S., Shen, W.Z., and Yao, X.S., Cardiac glycosides from the seeds of Thevetia peruviana and their pro-apoptotic activity toward cancer cells. *J Asian Nat Prod Res.* **18(9):** 837-47 (2016).
44. Rincón-Pérez J, Rodríguez-Hernández L, Ruíz-Valdiviezo, V.M., Abud-Archila M, Luján-Hidalgo, M.C., Ruiz-Lau N, González-Mendoza D, and Gutiérrez-Miceli, F.A., Fatty Acids Profile, Phenolic Compounds and Antioxidant Capacity in Elicited Callus of Thevetia peruviana (Pers.) K. *Schum. J Oleo Sci.* **65(4):**311-8 (2016).
45. Freitas, C,D., Silva, M.Z., Bruno-Moreno F, Monteiro-Moreira A.C., Moreira, R.A., and Ramos, M.V., New constitutive latex osmotin-like proteins lacking antifungal activity. Plant Physiol Biochem. **96:** 45-52 (2015).

46. Sibi G, Wadhavan R, Singh S, Shukla A, Dhananjaya K, Ravikumar, K.R., and Mallesha H. Plant latex: a promising antifungal agent for post harvest disease control. Pak J Biol Sci. **16(23):** 1737-43 (2013).
47. Kohls S, Scholz-Böttcher B, Rullkötter J, and Teske J. Method validation of a survey of thevetia cardiac glycosides in serum samples. Forensic Sci Int. **215(1-3):**146-51 (2012).
48. Hassan, M.M., Saha, A.K., Khan, S.A., Islam A, Mahabub-Uz-Zaman M, and Ahmed, S.S., Studies on the antidiarrhoeal, antimicrobial and cytotoxic activities of ethanol-extracted leaves of yellow oleander (Thevetia peruviana). Open Vet J. **1(1):** 28-31 (2011).
49. Kareru, P.G., Keriko, J.M., Kenji, G.M., Thiong'o, G.T., Gachanja, A.N., and Mukiira, H.N., Antimicrobial activities of skincare preparations from plant extracts. Afr J Tradit Complement Altern Med. **7(3):** 214-8 (2010).
50. Dabur R, Gupta A, Mandal, T.K., Singh, D.D., Bajpai V, Gurav, A.M., and Lavekar, G.S., Antimicrobial activity of some Indian medicinal plants. Afr J Tradit Complement Altern Med. **4(3):** 313-8 (2007).
51. Eddleston M, Senarathna L, Mohamed F, Buckley N, Juszczak E, Sheriff, M.H., Ariaratnam A, Rajapakse S, Warrell D, and Rajakanthan K. Deaths due to absence of an affordable antitoxin for plant poisoning. *Lancet.* **362(9389):** 1041-4 (2003).
52. Gata-Gonçalves L, Nogueira, J.M., Matos O, and Bruno de Sousa R. Photoactive extracts from Thevetia peruviana with antifungal properties against Cladosporium cucumerinum. *J Photochem Photobiol* B. **70(1):** 51-4 (2003).
53. Tewtrakul S, Nakamura N, Hattori M, Fujiwara T, and Supavita T. Flavanone and flavonol glycosides from the leaves of Thevetia peruviana and their HIV-1 reverse transcriptase and HIV-1 integrase inhibitory activities. *Chem Pharm Bull* (Tokyo). **50(5):** 630-5 (2002).
54. De Freitas, C.D., Da Cruz, W.T., Silva, M.Z., Vasconcelos, I.M., Moreno, F.B., Moreira, R.A., Monteiro-Moreira, A.C., Alencar, L.M., Sousa, J.S., Rocha, B.A., and Ramos, M.V., Proteomic analysis and purification of an unusual germin-like protein with proteolytic activity in the latex of Thevetia peruviana. Planta. **243(5):** 1115-28 (2016).
55. Naz R, Bano A, Wilson, N.L., Guest D, and Roberts, T.H., Pathogenesis-related protein expression in the apoplast of wheat leaves protected against leaf rust following application of plant extracts. Phytopathology.X **104(9):** 933-44 (2016).
56. López-Uribe, M.M., and Del Lama, M.A., Molecular identification of species of the genus Euglossa Latreille (Hymenoptera: Apidae, Euglossini). Neotrop Entomol. **36(5):** 712-20 (2007).
57. Saritha K, and Nanda Kumar, N.V., Qualitative detection of selenium in fortified soil and water samples by a paper chromatographic-carboxyl esterase enzyme inhibition technique.*J Chromatogr A.* **919(1):** 223-8 (2001).
58. Qayyum S, and Khan, A.U., Biofabrication of broad range antibacterial and antibiofilm silver nanoparticles. IET Nanobiotechnol. **10(5):** 349-357 (2016).
59. Sut D, Chutia, R.S., Bordoloi N, Narzari R, and Kataki R. Complete utilization of non-edible oil seeds of Cascabela thevetia through a cascade of approaches for biofuel and by-products. *Bioresour Technol.* **213:** 111-20 (2016).
60. Gakuya, D.W., Itonga, S.M., Mbaria, J.M., Muthee, J.K. and, Musau, J.K., Ethnobotanical survey of biopesticides and other medicinal plants traditionally used in Meru central district of Kenya. *J Ethnopharmacol.* **145(2):** 547-53 (2013).
61. Radhapriya P, Navaneetha Gopalakrishnan A, Malini P, and Ramachandran A. Assessment of air pollution tolerance levels of selected plants around cement industry, Coimbatore, *India. J Environ Biol.* **33(3):** 635-41 (2012).
62. Verma A, and Singh, S.N., Biochemical and ultrastructural changes in plant foliage

exposed to auto-pollution. Environ Monit Assess. **120(1-3):** 585-602 (2006).

63. Singh A, and Singh, S.K., Molluscicidal evaluation of three common plants from India. *Fitoterapia.* **76(7-8):** 747-51 (2005).
64. Tian, D.M., Cheng, H.Y., Jiang, M.M., Shen, W.Z., Tang, J.S., and Yao, X.S., Cardiac Glycosides from the Seeds of Thevetia peruviana. *J Nat Prod.* **79(1):** 38-50 (2016).
65. Kumar, G.N., Atreya A, and Kanchan T. Thevetia peruviana. Wilderness Environ Med. **26(4):** 590-1 (2015).
66. Haldar S, Karmakar I, Chakraborty M, Ahmad D, and Haldar, P.K., Antitumor Potential of Thevetia peruviana on Ehrlich's Ascites Carcinoma-Bearing Mice. J Environ Pathol Toxicol Oncol. **34(2):** 105-13 (2015).
67. Durasnel P, Vanhuffel L, Blondé R, Lion F, Galas T, Mousset-Hovaere M, Balaÿ I, Viscardi G, and Valyi L. [Severe poisoning by plants used for traditional medicine in Mayotte]. *Bull Soc Pathol Exot.* **107(5):** 306-11 (2014).
68. Marroquín-Segura R, Calvillo-Esparza R, Mora-Guevara, J.L., Tovalín-Ahumada, J.H., Aguilar-Contreras A, and Hernández-Abad, V.J., Increased acetylcholine esterase activity produced by the administration of an aqueous extract of the seed kernel of Thevetia peruviana and its role on acute and subchronic intoxication in mice. *Pharmacogn Mag.* **10(Suppl 1):** S171-5 (2014).
69. Fentanes E. Eating seeds from the 'be still' tree, yet having lucky nut poisoning: a case of acute yellow oleander poisoning. BMJ Case Rep. pii: bcr 2013200392 (2014).
70. Pirasath S, and Arulnithy K. Yellow oleander poisoning in eastern province: an analysis of admission and outcome. *Indian J Med Sci.* **67(7-8):** 178-83 (2013).
71. Carroll R, Metcalfe C, Gunnell D, Mohamed F, and Eddleston M. Diurnal variation in probability of death following self-poisoning in Sri Lanka--evidence for chronotoxicity in humans. *Int J Epidemiol*. **41(6):** 1821-8 (2012).
72. Gouagna, L.C., Poueme, R.S., Dabiré, K.R., Ouédraogo, J.B., Fontenille D, and Simard F. Patterns of sugar feeding and host plant preferences in adult males of An. gambiae (Diptera: Culicidae). *J Vector Ecol.* **35(2):** 267-76 (2010).
73. Shriyan A, More V, Purandare S, and Sude A. Fatal flower. *Indian J Pediatr.* **78(3):** 364-5 (2011).
74. Miyagawa T, Ohtsuki T, Koyano T, Kowithayakorn T, and Ishibashi M. Cardenolide glycosides of Thevetia peruviana and triterpenoid saponins of Sapindus emarginatus as TRAIL resistance-overcoming compounds. *J Nat Prod.* **72(8):** 1507-11 (2009).
75. Senthilkumaran S, Saravanakumar S, and Thirumalaikolundusubramanian P. Cutaneous absorption of Oleander: Fact or fiction.J Emerg Trauma Shock. **2(1):** 43-5 (2009).
76. Eyer, P., and Eyer, F., Is this the epitaph for multiple-dose activated charcoal? Lancet. **371(9612):** 538-9 (2008).
77. Singh, D., and Singh, A., Piscicidal effect of some common plants of India commonly used in freshwater bodies against target animals. *Chemosphere* **49(1):** 45-9 (2002).
78. Nesy, E.A., and Lizzy Mathew, Detection and Quantification of Cardiotonic Drug Peruvoside Using HPTLC from *Thevetia neriifolia*, Juss Seed Extracts. *International Journal of Pharmaceutical Science Invention*, **3 (4):** 11-16 (2014).