Neem Research Newsletter

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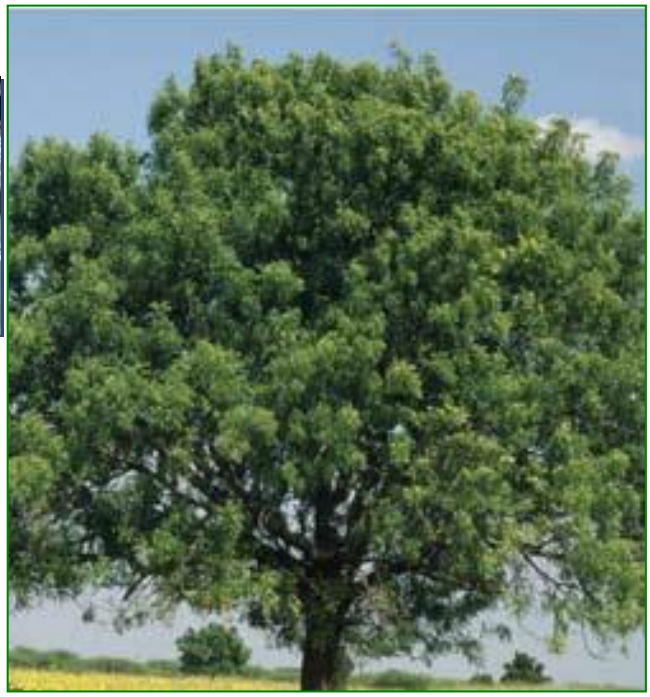

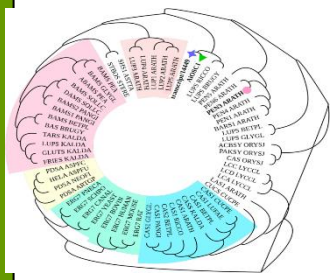

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WORLD NEEM ORGANISATION (WNO)

From The Editor's Desk.....

This is the first issue of WNO's Newsletter for 2023 showcasing developments in research on neem. Nanoformulations were found to improve the potential of neem oil as a fungicide agent. Silver nanoparticles phytofabricated through Azadirachta indica were demonstrated to display wound healing apoptotic and anticancer properties. Scientists report the discovery of 22 enzymes, including a pair of neofunctionalized sterol isomerases, that catalyze 12 distinct reactions in the total biosynthesis of kihadalactone A and azadirone, products that bear the signature limonoid furan. Computational evaluation revealed that bioactive compounds from neem are novel NLRP3 inhibitors useful for the treatment of Alzheimer's disease. The antimicrobial and antihyperlipidemic activities of neem have also been reported. Zinc oxide nanoparticles synthesized using neem leaf extract functioned as adsorbent for removing two widely used pharmaceutical compounds acetaminophen and sulfadiazine.

S. Nagini

Core Founding Member, WNO
Chief Scientific Coordinator &
Regional Director, South India

Neem in Agriculture

Tannins-lignin mixed nanoformulations for improving the potential of neem oil as fungicide agent.

Falsini S, Nieri T, Paolini A, Schiff S, Papini A, Mugnai L, Gonnelli C, Ristori S.
Environ Sci Pollut Res Int. 2023 Jan 3. doi: 10.1007/s11356-022-24991-6. PMID: 36595170

Sustainability and circular economy are increasingly pushing for the search of natural materials to foster antiparasitic treatments, especially in the case of economically relevant agricultural cultivations, such as grapevine. In this work, we propose to deliver neem oil, a natural biopesticide loaded into novel nanovectors (nanocapsules) which were fabricated using a scalable procedure starting from Kraft lignin and grapeseed tannins. The obtained formulations were characterized in terms of size and Zeta potential, showing that almost all the nanocapsules had size in the suitable range for delivery purposes (mean diameter 150-300 nm), with low polydispersity and sufficient stability to ensure long shelf life. The target microorganisms were three reference fungal pathogens of grapevine (Botrytis cinerea, Phaeoacremonium minimum, Phaeomoniella chlamydospora), responsible for recurrent diseases on this crop: grey mold or berry rot by B. cinerea and diseases of grapevine wood within the Esca complex of diseases. Results showed that grapeseed tannins did not promote inhibitory effects, either alone or in combination with Kraft lignin. On the contrary, the efficacy of neem oil against P. minimum was boosted by more than 1-2 orders of magnitude and the parasite growth inhibition was higher with respect to a widely used commercial pesticide, while no additional activity was detected against P. chlamydospora and B. cinerea.

Potential Alternatives to Spinosad as the Killing Agent Mixed With Two Attractant Products in Attract-and-Kill Formulations Used to Manage the Spotted-Wing Drosophila, Drosophila suzukii (Diptera: Drosophilidae).

Rhodes EM, Babu A, Sial AA, Liburd OE.
J Econ Entomol. 2023 Jan 7:toac204. doi: 10.1093/jee/toac204. PMID: 36617300

Spotted-wing drosophila, Drosophila suzukii (Matsumura) (Diptera: Drosophilidae), is a key pest of many berry and fruit crops worldwide. The primary method of controlling this pest is the application of insecticides. Attract-and-kill is a management tactic that may reduce the number of insecticide applications needed to manage D. suzukii. ACTTRA SWD OR1 and ACTTRA SWD TD, developed by ISCA Technologies Inc., combine D. suzukii attractants with a gel matrix. Growers add an insecticide as a killing agent. The only USDA National Organic Program approved organic insecticide that has been shown to be effective as a killing agent is spinosad. This study aimed to determine the efficacy of other USDA National Organic Program approved organic insecticides, including Grandevo 30 WDG (Chromobacterium subtsugae strain PRAA4-1 30%), MBI-203 SC2 (C. subtsugae strain PRAA4-1 98%), Venerate XC (Burkholderia spp. Strain A396 94.45%), MBI-306 SC1 (B. rinojensis Strain A396 94.45%), Azera (azadirachtin 1.2% + pyrethrins 1.4%), and PyGanic (pyrethrins 1.4%), when used as the killing agent with the two ACTTRA SWD products. Lab and cage bioassays were conducted. Entrust (spinosad 22.5%) and PyGanic were the only compounds that showed some efficacy when used with ACTTRA SWD OR1 and ACTTRA SWD TD.

Neem Limonoids Biosynthetic Route

Complex scaffold remodeling in plant triterpene biosynthesis.

De La Peña R, Hodgson H, Liu JC, Stephenson MJ, Martin AC, Owen C, Harkess A, Leebens-Mack J, Jimenez LE, Osbourn A, Sattely ES.Science. 2023 Jan 27;379(6630):361-368. doi: 10.1126/science.adf1017. Epub 2023 Jan 26.PMID: 36701471

Triterpenes with complex scaffold modifications are widespread in the plant kingdom. Limonoids are an exemplary family that are responsible for the bitter taste in citrus (e.g., limonin) and the active constituents of neem oil, a widely used bioinsecticide (e.g., azadirachtin). Despite the commercial value of limonoids, a complete biosynthetic route has not been described. We report the discovery of 22 enzymes, including a pair of neofunctionalized sterol isomerases, that catalyze 12 distinct reactions in the total biosynthesis of kihadalactone A and azadirone, products that bear the signature limonoid furan. These results enable access to valuable limonoids and provide a template for discovery and reconstitution of triterpene biosynthetic pathways in plants that require multiple skeletal rearrangements and oxidations.

Silver Nanoparticles Phytofabricated through *Azadirachta indica*: Anticancer, Apoptotic, and Wound-Healing Properties.

Dutt Y, Pandey RP, Dutt M, Gupta A, Vibhuti A, Raj VS, Chang CM, Priyadarshini A.
Antibiotics (Basel). 2023 Jan 9;12(1):121. doi: 10.3390/antibiotics12010121. PMID: 36671322

Silver nanoparticles (AgNPs) have unlocked numerous novel disciplines in nanobiotechnological protocols due to their larger surface area-to-volume ratios, which are attributed to the marked reactivity of nanosilver, and due to their extremely small size, which enables AgNPs to enter cells, interact with organelles, and yield distinct biological effects. AgNPs are capable of bypassing immune cells, staying in the system for longer periods and with a higher distribution, reaching target tissues at higher concentrations, avoiding diffusion to adjacent tissues, releasing therapeutic agents or drugs for specific stimuli to achieve a longer duration at a specific rate, and yielding desired effects. The phytofabrication of AgNPs is a cost-effective, one-step, environmentally friendly, and easy method that harnesses sustainable resources and naturally available components of plant extracts (PEs). In addition, it processes various catalytic activities for the degradation of various organic pollutants. For the phytofabrication of AgNPs, plant products can be used in a multifunctional manner as a reducing agent, a stabilizing agent, and a functionalizing agent. In addition, they can be used to curtail the requirements for any additional stabilizing agents and to help the reaction stages subside. *Azadirachta indica*, a very common and prominent medicinal plant grown throughout the Indian subcontinent, possesses free radical scavenging and other pharmaceutical properties via the regulation of proinflammatory enzymes, such as COX and TOX. It also demonstrates anticancer activities through cell-signaling pathways, modulating tumor-suppressing genes such as p53 and pTEN, transcriptional factors, angiogenesis, and apoptosis via bcl2 and bax. In addition, it possesses antibacterial activities. Phytofabricated AgNPs have been applied in the areas of drug delivery, bioimaging, biosensing, cancer treatment, cosmetics, and cell biology. Such pharmaceutical and biological activities of phytofabricated AgNPs are attributed to more than 300 phytochemicals found in *Azadirachta indica*, and are especially abundant in flavonoids, polyphenols, diterpenoids, triterpenoids, limonoids, tannins, coumarin, nimbolide, azadirachtin, azadirone, azadiradione, and gedunin. Parts of *Azadirachta indica*, including the leaves in various forms, have been used for wound healing or as a repellent. This study was aimed at examining previously biosynthesized (from *Azadirachta indica*) AgNPs for anticancer, wound-healing, and antimicrobial actions (through MTT reduction assay, scratch assay, and microbroth dilution methods, respectively). Additionally, apoptosis in cancer cells and the antibiofilm capabilities of AgNPs were examined through caspase-3 expression, dentine block, and crystal violet methods. We found that biogenic silver nanoparticles are capable of inducing cytotoxicity in HCT-116 colon carcinoma cells (IC_{50} of 744.23 µg/mL, R^2: 0.94), but are ineffective against MCF-7 breast cancer cells (IC_{50} >> 1000 µg/mL, R^2: 0.86). AgNPs (IC_{50} value) induced a significant increase in caspase-3 expression (a 1.5-fold increase) in HCT-116, as compared with control cells. FITC-MFI was 1936 in HCT-116-

treated cells, as compared to being 4551 in cisplatin and 1297 in untreated cells. AgNPs (6.26 µg/mL and 62.5 µg/mL) induced the cellular migration (40.2% and 33.23%, respectively) of V79 Chinese hamster lung fibroblasts; however, the improvement in wound healing was not significant as it was for the controls. AgNPs (MIC of 10 µg/mL) were very effective against MDR *Enterococcus faecalis* in the planktonic mode as well as in the biofilm mode. AgNPs (10 µg/mL and 320 µg/mL) reduced the *E. faecalis* biofilm by >50% and >80%, respectively. Natural products, such as *Syzygium aromaticum* (clove) oil (MIC of 312.5 µg/mL) and eugenol (MIC of 625 µg/mL), showed significant antimicrobial effects against *A. indica*. Our findings indicate that *A. indica*-functionalized AgNPs are effective against cancer cells and can induce apoptosis in HCT-116 colon carcinoma cells; however, the anticancer properties of AgNPs can also be upgraded through active targeting (functionalized with enzymes, antibiotics, photosensitizers, or antibodies) in immunotherapy, photothermal therapy, and photodynamic therapy. Our findings also suggest that functionalized AgNPs could be pivotal in the development of a novel, non-cytotoxic, biocompatible therapeutic agent for infected chronic wounds, ulcers, and skin lesions involving MDR pathogens via their incorporation into scaffolds, composites, patches, microgels, or formulations for microneedles, dressings, bandages, gels, or other drug-delivery systems.

In silico docking studies of selected phytochemicals against papain like protease of SARS-CoV2.

Saranya P, Karunya R, Keerthi Varshini G, Kowsikan K, Prathiksha R.Vegetos. 2022 Dec 6:1-7. doi: 10.1007/s42535-022-00525-w. PMID: 36530568

The SARS-Cov-2 virus, which is evolving continuously and causing adverse effects throughout the world, needs an effective drug molecule for its treatment. There are several receptors of SARS Cov-2 which are targeted for its inhibition by many lead molecules both in-vitro and in-vivo. Papain like Protease (PLpro) is one of the two SARS-Cov-2 proteases that can be used as a drug target for SARS Cov-2. It is a coronavirus enzyme that plays a role in the cleavage and maturation of viral polyproteins, assembly of the replicase-transcriptase complex and disruption of host responses. PLpro has also been linked to the cleavage of proteinaceous post translational modifications on host proteins as a means of evading antiviral immune responses. Structure-based drug discovery can be one of the effective methods to screen for various molecules against the target receptors. In this study, PLpro of SARS CoV-2 was chosen as the target for docking. Forty phytochemicals from various plant sources and four synthetic drugs have been screened for their inhibitory potential against PLpro using *AutoDock Vina*. Phytochemicals such as Tinosponone, Rhoifolin, Rosmanol, Berberin, Nimbin and two other existing drugs Elbasvir and Declatasvir showed higher inhibitory potential in terms of higher binding affinities. ADME and toxicity analysis were also performed to predict the pharmacokinetics and drug likeliness properties. It was concluded from the study that Tinosponone possesss potential inhibitor property of papain-like proteases (PLpro) of SARS CoV-2. Tinosponone from the plant *Tinospora cordifolia* had a binding affinity of - 9.3 kcal/mol and obeyed the Lipinski rules, making it an effective lead molecule for treating SARS CoV-2. Molecular Dynamics simulation of Tinosponone with PLpro has proved the stability and validity of the binding with RMSD value

in range of 0.2 nm when it was run for 50 ns using GROMACS. Therefore, Tinosponone could be considered as a potential inhibitor of PLpro of SARS CoV-2.

Inhibition of SARS-CoV2 viral infection with natural antiviral plants constituents: an in-silico approach.

Das K, Das P, Almuqbil M, Mohammed Basheeruddin Asdaq S, K N, K P, Angelinkiruba A, Fawzan Alomar N, Al Harbi RM, Al Abdullah WA, Alshehri SM, Laghabi YA, Alsaegh AR, Mohzari Y, Alshehri S, Abdulaziz Mannasaheb B, Imam Rabbani S

.J King Saud Univ Sci. 2023 Jan 4:102534. doi: 10.1016/j.jksus.2022.102534. Online ahead of print.PMID: 36619666

In 2019, a novel coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) was declared pandemic. Advancement in computational technology has provided rapid and cost-effective techniques to test the efficacy of newer therapeutic agents. This study evaluated some of the potent phytochemicals obtained from AYUSH (Ayurveda, Yoga, Naturopathy, Unani, Siddha, Sowa-Rigpa, and Homeopathy)-listed medicinal plants against SARS-CoV-2 proteins using computational techniques. **Materials and methods:** The potential SARS-CoV-2 protein targets were utilized to study the ligand-protein binding characteristics. The bioactive agents were obtained from ashwagandha, liquorice, amla, neem, tinospora, pepper, and stevia. Ivermectin was utilized as a reference agent to compare its efficacy with phytochemicals. **Results:** The computational analysis suggested that all the bioactive components from the selected plants possessed negative docking scores (ranging from -6.24 to -10.53). The phytoconstituents were well absorbed, distributed in the body except for the CNS, metabolized by liver enzymes, well cleared from the body, and well tolerated. The data suggest that AYUSH-recommended plants demonstrated therapeutic efficacy against SARS CoV-2 virus infection with significantly reduced toxicity. **Conclusion:** The phytoconstituents were found to hinder the early stages of infection, such as absorption and penetration, while ivermectin prevented the passage of genetic material from the cytoplasm to the nucleus. Additional research involving living tissues and clinical trials are suggested to corroborate the computational findings.

Computational Evaluation of Azadirachta indica-Derived Bioactive Compounds as Potential Inhibitors of NLRP3 in the Treatment of Alzheimer's Disease.

Ishabiyi FO, Ogidi J, Olukade BA, Amorha CC, El-Sharkawy LY, Okolo CC, Adeniyi TM, Atasie NH, Ibrahim A, Balogun TA.J Alzheimers Dis. 2023 Jan 18. doi: 10.3233/JAD-221020. PMID: 36683510

Background: The development of therapeutic agents against Alzheimer's disease (AD) has stalled recently. Drug candidates targeting amyloid-β (Aβ) deposition have often failed clinical trials at different stages, prompting the search for novel targets for AD therapy. The NLRP3 inflammasome is an integral part of innate immunity, contributing to neuroinflammation and AD pathophysiology. Thus, it has become a promising new target for AD therapy. **Objective:** The study sought to study the potential of bioactive compounds

derived from Azadirachta indica to inhibit the NLRP3 protein implicated in the pathophysiology of AD. **Methods:** Structural bioinformatics via molecular docking and density functional theory (DFT) analysis was utilized for the identification of novel NLRP3 inhibitors from A. indica bioactive compounds. The compounds were further subjected to pharmacokinetic and drug-likeness analysis. Results obtained from the compounds were compared against that of oridonin, a known NLRP3 inhibitor. **Results:** The studied compounds optimally saturated the binding site of the NLRP3 NACHT domain, forming principal interactions with the different amino acids at its binding site. The studied compounds also demonstrated better bioactivity and chemical reactivity as ascertained by DFT analysis and all the compounds except 7-desacetyl-7-benzoylazadiradione, which had two violations, conformed to Lipinski's rule of five. **Conclusion:** In silico studies show that A. indica derived compounds have better inhibitory potential against NLRP3 and better pharmacokinetic profiles when compared with the reference ligand (oridonin). These compounds are thus proposed as novel NLRP3 inhibitors for the treatment of AD. Further wetlab studies are needed to confirm the potency of the studied compounds.

Nimbin analogs N5 and N7 regulate the expression of lipid metabolic genes and inhibit lipid accumulation in high-fat diet-induced zebrafish larvae: An antihyperlipidemic study.

Sudhakaran G, Rajesh R, Guru A, Arasu MV, Gopinath P, Arockiaraj J.Tissue Cell. 2022 Dec 16;80:102000. doi: 10.1016/j.tice.2022.102000. PMID: 36542946

Background: Excess accumulation of lipids leads to obesity. Triterpenoids are a group of plant compounds which poses various biological activities. The biological activities of Nimbin analogs N5 and N7 were addressed in this study on inhibiting lipid aggregation and underlying the derivatives molecular mechanisms for a therapeutical approach. **Aim:** This study aims to evaluate the anti-adipogenic activity of semi-natural Nimbin analogs, N5 and N7, on zebrafish larvae induced with oxidative stress due to a high-fat diet (HFD) and adipogenesis using specific fluorescent stains. **Materials and methods:** Zebrafish at 4 days post fertilized (dpf) larvae were divided into groups for the HFD diet along with exposure to various concentrations of N5 and N7. HFD induced accumulation of neutral lipids and triglycerides (Oil Red O and Nile red staining, respectively) with weight gain, which generated intracellular ROS (DCFH-DA staining) and superoxide anion production (DHE staining) with depleted glutathione levels (NDA staining) were assayed. HFD exposure promoted the accumulation of inflammatory macrophages (Neutral red staining) and impaired glucose metabolism (2NBDG staining). The ability of N5 and N7 to reduce total regulating lipogenic specific genes C/EBP-α, SREBP-1 and FAS were evaluated using relative gene expression. **Key findings:** The Nimbin analogues N5 and N7 suppressed adipogenesis, forming intracellular ROS and superoxide anion while simultaneously restoring glutathione levels. The analogues significantly lowered total TC and TG levels, prevented inflammatory macrophage build-up and boosted glucose absorption. Also, N5 and N7 down-regulate the lipogenic-specific genes. **Significance:** Nimbin analogs N5 and N7 enhance lipolysis and inhibit adipogenesis in in-vivo zebrafish larvae model.

Larvicidal effects of some essential oils against *Aedes aegypti* (L.), the vector of dengue fever in Saudi Arabia.

Aljameeli M.

Saudi J Biol Sci. 2023 Feb;30(2):103552. doi: 10.1016/j.sjbs.2022.103552. Epub 2022 Dec 26.PMID: 36624737

Essential oils are very popular among organic growers because they are ecologically safe, do not have mammalian toxicity, and cannot be resistant to a variety of contaminants. Four essential oils, Lemon, Lavender, Peppermint, and Neem, were tested for larvicide efficacy against the dengue fever vector *Aedes aegypti* larvae under laboratory conditions using dipping bioassay techniques. Among the essential oils tested, lemon, peppermint, and lavender oils showed high larvicidal activity against larvae of *Ae. aegypti*. Lemon oil showed the highest effects (LC_{50} 10.676 ppm), while Peppermint, Lavender and Neem oil showed the lowest effects (LC_{50} 21.380, 29.818 and 38.058 ppm, respectively). As a result, the mixture of lemon oil (LC_{50}) with Peppermint oil (LC_{25}) showed the highest co-toxicity factor, whereas the mixture of Lemon oil (LC_{50}) with Diesel oil (LC_{25}) showed the lowest co-toxicity factor. Based on the results of this study, it appears that essential oils may be useful as larvicides against *Ae. aegypti* larvae. In search of new natural larvicides, these compounds may provide an alternative to Synthetic insecticides as these are environmentally safe insecticides.

Antimicrobial and Antibiotic-Resistance Reversal Activity of Some Medicinal Plants from Cameroon against Selected Resistant and Non-Resistant Uropathogenic Bacteria.

Arsene MMJ, Viktorovna PI, Davares AKL, Parfait K, Andreevna SL, Mouafo HT, Rehailia M, Vyacheslavovna YN, Pavlovna SI, Manga IAM, Sergueïevna DM.

Front Biosci (Elite Ed). 2022 Sep 22;14(4):25. doi: 10.31083/j.fbe1404025.PMID: 36575849

Background and aim: Antibiotics' resistance is the leading cause of complications in the treatment of urinary tract infections. This study aimed to screen the antimicrobial potential of 8 plants from Cameroon against multi-resistant uropathogenic (MRU) bacteria and to investigate their antibioresistance reversal properties. **Method:** Bioactive compounds were extracted from leaves of *Leucanthemum vulgare*, *Cymbopogon citratus*, *Moringa oleifera* and *Vernonia amygdalina*; barks of *Cinchona officinalis* and *Enantia chlorantha* barks and seeds of *Garcinia lucida* and leaves and seeds of *Azadirachta indica* using water and ethanol as solvents. The extracts were tested against *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 6538 and *Candida albicans* 10231 using the well diffusion and the broth microdilution methods. The antibiotic-resistance reversal activity was assessed against selected MRU bacteria. The phytochemical composition and the elemental composition of the most active extracts were assessed respectively using HPLC-MS/MS and X-ray fluorescence (XRF) spectrometry. **Results:** Among the most active plants, in decreasing order of antimicrobial activity we found ethanolic (EE) and aqueous extracts (AE) of *E. chloranta* bark (ECB), EE of *L. vulgare* leaves and *G. lucida* seeds. The best synergies between common antibiotics and extracts were found with EE-ECB which well-modulated kanamycin nitrofurantoin and ampicillin. All the compounds identified in EE-ECB were alkaloids and the major constituents were palmatine (51.63%),

columbamine+7,8-dihydro-8-hydroxypalmatine (19.21%), jatrorrhizine (11.02%) and pseudocolumbamine (6.33%). Among the minerals found in EE-ECB (S, Si, Cl, K, Ca, Mn, Fe, Zn and Br), Br, Fe and Cl were the most abundant with mean fluorescence intensities of 4.6529, 3.4854 and 2.5942 cps/uA respectively. **Conclusions:** The ethanol extract of the bark of *E. chlorantha* has remarkable, broad-spectrum antimicrobial and contains several palmatine derivatives.

Antioxidative hypoglycemic herbal medicines with in vivo and in vitro activity against C-reactive protein; a systematic review.

Mirahmad M, Mohseni S, Tabatabaei-Malazy O, Esmaeili F, Alatab S, Bahramsoltani R, Ejtahed HS, Qulami H, Bitarafan Z, Arjmand B, Nazeri E.
Phytomedicine. 2023 Jan;109:154615. doi: 10.1016/j.phymed.2022.154615. Epub 2022 Dec 18. PMID: 36610136

Background: Inflammation is a double-edged sword in the pathophysiology of chronic diseases, such as type 2 diabetes mellitus (T2DM). The global rise in the prevalence of T2DM in one hand, and poor disease control with currently-available treatments on the other hand, along with an increased tendency towards the use of natural products make scientists seek herbal medicines for the management of diabetes and its complications by reducing C-reactive protein (CRP) as an inflammatory marker. **Purpose:** To systematically review the literature to identify the efficacy of various medicinal plants with antioxidative and anti-inflammatory properties considering their effect on CRP in animal models of T2DM. **Study design:** systematic review. **Methods:** Electronic databases including PubMed, Scopus, Web of Science and Cochran Library were searched using the search terms "herbal medicine", "diabetes", "c-reactive protein", "antioxidants" till August 2021. The quality of evidence was assessed using the Systematic Review Centre for Laboratory animal Experimentation (SYRCLE's) tool. The study protocol was registered in PROSPERO with an ID number CRD42020207190. A manual search to detect any articles not found in the databases was also made. The identified studies were then critically reviewed and relevant data were extracted and summarized. **Results:** Among total of 9904 primarily-retrieved articles, twenty-three experimental studies were finally included. Our data indicated that numerous herbal medicines, compared to placebo or hypoglycemic medications, are effective in treatment of diabetes and its complications through decreasing CRP concentrations and oxidative stresses levels. Medicinal plants including Psidium guajava L., Punica granatum L., Ginkgo biloba L., Punica granatum L., Dianthus superbusn L.. Moreover, Eichhornia crassipes (Mart.) Solms, Curcuma longa L., Azadirachta indica A. Juss., Morus alba L., and Ficus racemosa L. demonstrated potential neuroprotective effects in animal models of diabetes. **Conclusion:** Hypoglycemic medicinal plants discussed in this review seem to be promising regulators of CRP, and oxidative stress. Thus, these plants are suitable candidates for management of diabetes' complications. Nevertheless, further high-quality in vivo studies and clinical trials are required to confirm these effects.

Neem for Sustainable Environment

Adsorptive removal of pharmaceutically active compounds from multicomponent system using Azadirachta indica induced zinc oxide nanoparticles: analysis of competitive and cooperative adsorption.

Sanjeev NO, Vallabha MS, Valsan AE.

Water Sci Technol. 2023 Jan;87(1):284-303. doi: 10.2166/wst.2022.428.PMID: 36640038

In this research, zinc oxide (ZnO) nanoparticles synthesized using neem leaf (Azadirachta indica) extract were used as an adsorbent for removing two widely used pharmaceutical compounds acetaminophen (AMP) and sulfadiazine (SDZ). The synthesized ZnO nanoparticles were characterized using SEM-EDS, FTIR, TEM, BET, and XRD analysis. The synthesized ZnO nanoparticles were found to be in the size range of 10 nm with a surface area of 48.551 m^2/g. The adsorptive performance of ZnO nanoparticles in both mono-component (MoS) and multi-component system (MuS) was investigated under various operational parameters viz. contact time, temperature, pH, concentration of pharmaceutical compound and ZnO nanoparticles dose. It was observed that the maximum adsorption capacity of ZnO nanoparticles was 7.87 mg/g and 7.77 mg/g for AMP and SDZ, respectively, under the optimum conditions of 7 pH and 2 g/L adsorbent dosage. The experimental data best-fitted with the pseudo-second-order model and Langmuir model, indicating monolayer chemisorption. Further investigation on removal of AMP and SDZ from multicomponent system was modelled using a Langmuir competitive model. The desorption study has shown 25.28% and 22.4% removal of AMP and SDZ from the surface of ZnO nanoparticles. In general, green synthesized ZnO nanoparticles can be utilized effectively as adsorbent for removal of pharmaceutically active compounds from wastewater.

Response of tropical trees to elevated Ozone: a Free Air Ozone Enrichment study.

Jamal R, Narayan S, Dubey R, Kannaujia R, Rai R, Behera SK, Behera SK, Shirke PA, Pandey V, Barik SK.

Environ Monit Assess. 2022 Dec 27;195(1):238. doi: 10.1007/s10661-022-10713-5.PMID: 36574061

Tropospheric ozone (O_3) has become one of the main urban air pollutants. In the present study, we assessed impact of ambient and future ground-level O_3 on nine commonly growing urban tree species under Free Air Ozone Enrichment (FAOE) condition. During the study period, mean ambient and elevated ozone (EO_3) concentrations were 48.59 and 69.62 ppb, respectively. Under EO_3 treatment, stomatal density (SD) significantly decreased and guard cell length (GCL) increased in Azadirachta indica, Bougainvillea spectabilis, Plumeria rubra, Saraca asoca and Tabernaemontana divaricata, while SD increased and GCL decreased in Ficus benghalensis and Terminalia arjuna. Proline levels increased in all the nine plant species under EO_3 condition. EO_3 significantly reduced photosynthetic rate, stomatal conductance (gs), and transpiration rates (E). Only A. indica and N. indicum showed higher gs and E under EO_3 treatment. Water use efficiency (WUE) significantly increased in F. benghalensis and decreased in A. indica and T. divaricata. Air Pollution

Tolerance Index (APTI) significantly increased in Ficus religiosa and S. asoca whereas it decreased in B. spectabilis and A. indica. Of all the plant species B. spectabilis and A. indica were the most sensitive to EO_3 (high g_s and less ascorbic acid content) while S. asoca and F. religiosa were the most tolerant (lowg_s and more ascorbic acid content). The sensitivity of urban tree species to EO_3 is a cause of concern and should be considered for future urban forestry programmes. Our study should guide more such studies to identify tolerant trees for urban air pollution abatement.