Review Article

Modernized Review on Natural, Organic, Ayurvedic, and Homa Farming over Chemical Farming: Urgent Need of Sustainable Agricultural Practices

ABSTRACT

Agriculture lies at the heart of Indian civilization. The goal of sustainable agriculture is to integrate all factors into a production system that is appropriate for the environment, people, and local economic conditions. Another issue of great concern was the sustainability of soil productivity as land began to be intensively tilled to produce higher yields under multiple and intensive cropping systems. Waterlogging and secondary salinization have been the banes associated with excess and irrational irrigation. Groundwater table declined sharply as more and deeper bore wells were drilled. Recharging of groundwater has also been reduced due to severe deforestation. Indiscriminate use of chemical pesticides to control various insect pests and diseases over the years has destroyed many naturally occurring effective biological control agents. Sustainable organic farming practices needs proper eco-friendly pest and disease management practices in addition to balanced nutritional supplement to improve the quality and quantity of the agricultural outputs. Homemade bio-pesticides are prepared by household members using local resources without having any scientific study or research. Homemade bio-pesticides are always environment friendly, safe, low cost or free of cost locally available resources utilization system through engaging family labor. The common understanding on homemade bio-pesticides and organic pest management was very positive. Both preventive and control measures were taken by the farmers in the study area. Sustainable organic agriculture is not a prescribed set of specific practices; rather, it is an integrated system that considers a more complete account of both the costs and benefits of agriculture as it applies to environmental, social, and financial well-being of Indian farmers.

Key words: Natural Farming, Organic Agriculture practices, Ayurvedic Farming, Sustainable Agriculture, Vrakshaayurveda, Homa Farming.

1. INTRODUCTION:

Organic standards include a well-defined set of practices and a list of technical tools that are permitted by regulations (i.e., Reg n.889/08 in UE and the National Organic Program in U.S.). A diet based on organic products claims to provide health benefits due to the higher concentration of nutritional compounds compared to conventional ones, and the absence of pesticide residues [1]. The present challenge of feeding the world requires new strategies to not only food security which is surely based on food availability and access, but also on food safety and nutritional quality. Organic production systems may be a way to ensure the sustainability of production, allowing preservation of natural resources for present and future generations, while providing a high quality and long shelf life of the product [2]. Agriculture plays a vital role in a developing country like India. Apart from fulfilling the food requirement of the growing Indian population, it also plays a role in improving economy of the country. The Green Revolution (GR) technology adoption between 1960 to 2000 has increased wide varieties of agricultural crop yield per hectare which increased 12-13% food supply in developing countries. Southeast Asia and India were the first developing countries to show the impact of GR on varieties of rice yields [3]. Use of Biopesticides and Biofertilizers can play a major role in dealing with these challenges in a sustainable way [4]. The global population will grow to 10.12 billion by 2100 [5]. In order to fulfill the food demand of growing population; higher and advance productive agricultural materials are required [5]. In all successful biocontrol programs; most important parasitoids are Hymenoptera and predators (*Neuroptera, Hemiptera and Coleoptera)*. Globally more than 125 species of natural enemies are commercially available for biological control programs such as *Trichogramma spp*.; *Encarsia formosa Gahan*, and *Phytoseiulus persimilis Athias- Henriot* [6].

Table: 1 Some plant products used against target specific pests. [7]

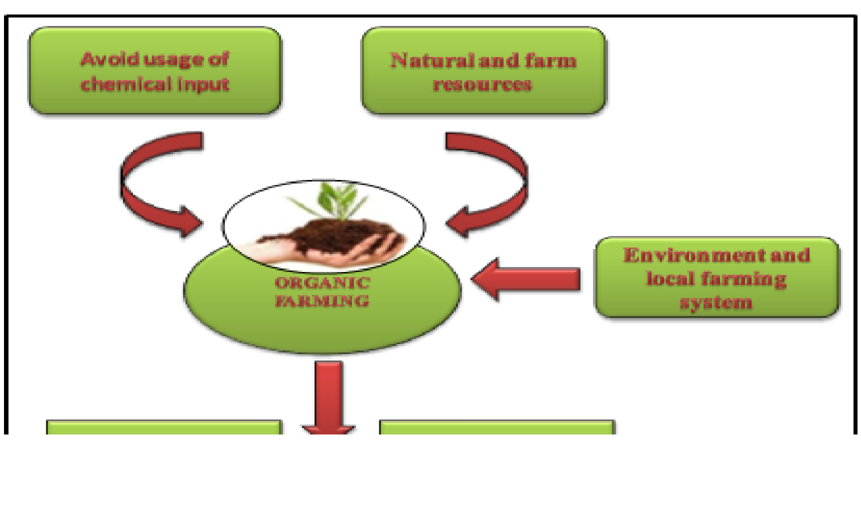
Plant product used as biopesticides	Target pest
Limonene and Linalool	Fleas, aphids and mites, also kill fire ants, several types of flies, paper waspsand house crickets.
Neem	A variety of sucking and chewing insect.
Pyrethrum/pyrethrins	Ants, aphids, roaches, fleas, flies, and ticks.
Rotenone	Leaf-feeding insects, such as aphids, certain beetles(asparagus beetle, bean leaf beetle, Colorado potato beetle, cucumber beetle, flea beetle, strawberry leaf beetle, and others) and Caterpillars, as well as fleas lice on animals.
Ryania	Caterpillars (European corn borer, corn earworm and others) and thrips
Sabadilla	Squash bugs, harlequin bugs, thrips, caterpillars, leaf hoppers, and stink bugs.

1.1 Homemade plant protection agents:

The use of homemade bio-pesticides in the farming practices is age old practice. It is very much friendly environment and can obtain from nature directly. It is an environment friendly, low cost technology without a negative effect on human health, plants and soils. Bio-pesticides are derived from natural materials such as animals, plants, bacteria, and minerals. Bio-pesticides tend to be less toxic, more quickly biodegradable, and more targeted to the specific pest [8].

1.2 Organic production system:

Organic standards include a well-defined set of practices and a list of technical tools that are permitted by regulations (i.e., Reg n.889/08 in UE and the National Organic Program in U.S.). A diet



based on organic products claims to provide health advantages due to the higher concentration of nutritional compounds compared to conventional ones, and the absence of pesticide residues [9]. The present challenge of feeding the world requires new strategies to ensure food security which is surely based on food availability and access, but also on food safety and nutritional quality. Organic production systems may be a way to ensure the sustainability of production, allowing preservation of natural resources for present and future generations, while providing a high quality and long shelf life of the product [10].

Fig1: Flow diagram on process and applications of Organic farming

Fig2: Different forms of Organic Farming introduced in agriculture system

1.3 MARKET TRENDS: Biopesticides are used globally for controlling insect pests and diseases. Bioinsecticides, biofungicides and bionematicides are rapidly growing market segments and are expected to boost the demand for biopesticides in future. Globally, there are 175 registered biopesticide active-ingredients and 700 products available in the market [11] Fig 3.The US biopesticides market is valued at around $205 million and expected to increase to approximately $300 million by 2020 [12].

A B

C **D**

Fig 3: Market value and future of organics A- Present and future of organic products, B- Global growth of organic farming, C- Main organic crops produced, D- Total area of organic production.

1.4 Vrikshayurveda: Vrikshayurveda literally means “The Science of Life of Plants”. There is a vast body of literature on Vrikshayurveda both in Sanskrit and our regional languages. Vrikshayurveda is traditional Indian knowledge of plants like sowing techniques, plant propagation techniques including pest and disease management/preventive and primitive care to build up disease resistance and to cultivate healthy plants. Based on these experiments, we have tested out practically the utility of a large number of plants and their extracts for different pests, crops and diseases. Some of the plants for which we have carried out such tests are neem, garlic, onion, Persian lilac, turmeric, ginger, tobacco, papaya, leucas, pongam, tulasi, aloe, custard apple, vitex, sweetflag, poison nut, calotropis etc [13]. Farmers are used to pesticides which are packaged and available from the shelf. The shelf life (i.e. the period for which they can be stored without loss of biological activity) of some ayurvedic preparations are as follows Swarasa or juice (3 – 4 hours), Kashayam or water extract (24 hours), the storage forms are - Churna or dry powder (6 – 12 months), Thailam or oil extract (1 – 3 years), Arkam or distillate (1 – 5 years), Asava / Arshta or fermented extracts (3 – 5 years) Fig. 4.

Fig 4: Vrikshayurveda is traditional Indian knowledge for plant protection

Table: 2 List of Specific plants formulation used in Vrikshayurveda for plant protection

Name of the Plant Formulation	**Crop tested**	**Effective Against**	**Shelf Life in Months (m)**
Adathoda kashayam *Pudhina kashayam*	Paddy Vegetables	Leaf folder, bacterial leaf blight, *Helminthosporium* leaf spot	3 m
Triphala kashayam	Paddy, ladies finger	Bacterial leaf blight, *Helminthosporium* leaf spot	3 m
Androgravis kashayam *Sida kashayam*	Vegetables	Aphids and borers in Brinjal, lady finger	3 m
Prosophis kashayam	Paddy	Bacterial leaf blight, *Helminthosporium* leaf spot, Blast	3 m
Barley sesamum Horsegram kashayam	Vegetables	Act as fruit yield enhancer	3 m
Cow’s urine arkam and Sweet flag arkam	Paddy, Ladies finger, Chilli	Bacterial leaf blight, *Helminthosporium* leaf spot, vein clearing disease, fusarium wilt	6 m
Garlic arkam	Paddy	Leaf folder, bacterial leaf blight, *Helminthosporium* leaf spot	6 m

Neem seed extract	All crops	Leaf folder, aphids, Jassids, fruit borer and stem borer	1 m

1.5 Homa Farming: Farmers have evolved various methods to use indigenous products and their own formulations to eliminate the menace created by chemical farming. The attempt to rejuvanate the soil by incorporating in to it farm yard manure (FYM) and making use of locally made bio-digesters like Panchgavya (Formulation from indigenous cow based products), Jeevamruta (Home made Formulation for microbial culture) and Beejamruta (Home made formulation for seed treatment) is a right step in that direction. However, farmers use both chemical farming and organic farming techniques in the same field and fail miserably since chemicals kill the useful micro flora in the soil thereby reducing the yields drastically. Total reliance on insecticides for insect pest control in most of the developing countries has resulted in certain ecological and economic imbalance with grave consequences to crop production, human health and environmental quality. It has become a common practice among the farmers to increase the application of insecticides, if the desired control of a target pest is not achieved. When the control becomes still inadequate, they switch over to another insecticide. This leads to resurgence of target pests. The widespread development of these manmade or entomologenic pest outbreaks is one of the most serious indictments of our present day pest control technology. As suggested by Paranjape (1989), one should note with concern that 'Homa therapy (Treatment of disorders through Yagna incorporated with fire and specific vaidic mantras)' is the only solution to fight 'Global Warming and Environmental Pollution'. Due to large costal lines, heavy population in certain areas and climatic changes through pollution, India is, in particular, a vulnerable area. On this earth everybody is inhaling polluted air and living a stressful life. Only by performing daily Agnihotra homa (Yagna incorporated with fire and specific vaidic mantras) and other homas, all the living beings on this earth can purify the air and enjoy a pollution-free life by consuming unpolluted air, food and water. Based on the findings of this investigation, it is suggested that farmers should follow Homa organic farming (HOF) practices along with other organic techniques in an integrated manner for better living and bright future [14].

2. APPROACHES FOR ORGANIC FARMING-

2.1 CURRENT STATE OF PESTICIDE USED

Melting glaciers release previously ice-entrapped chemicals to the surrounding environment. As glacier melting accelerates under future climate warming, chemical release may also increase. This is a review of studies conducted earlier on the state of pesticide and biopesticide usage. Pesticides were quantified in air, lake water, glacial meltwater, and streamwater in the catchment of Lake Brewster, an alpine glacier-fed lake located in the Southern Alps of New Zealand. Two historic-use pesticides (endosulfan I and hexachlorobenzene) and three current-use pesticides (dacthal, triallate, and chlorpyrifos) were frequently found in both air and water samples from the catchment. A multimedia environmental fate model was developed for these five chemicals in Brewster Lake. Modeling results indicated that seasonal lake ice cover melt, and varying contributions of input from glacial melt and streamwater, created pulses in pesticide concentrations in lake water. Under future climate scenarios, the concentration pulse was altered and glacial melt made a greater contribution (as mass flux) to pesticide input in the lake water [15]. Concrete samples from demolition waste of a former pesticide plant in Sweden were analysed for total contents and leachate concentrations of potentially hazardous inorganic substances, TOC, phenols, as well as for pesticide compounds such as phenoxy acids, chlorophenols and chlorocresols. Leachates were produced by means of modified standard column leaching tests and pH-stat batch tests. Due to elevated contents of chromium and lead, as well as due to high chloride concentrations in the first leachate from column tests at L/S 0.1, recycling of the concrete as a construction material in groundworks is likely to be restricted according to Swedish guidelines. The studied pesticide compounds appear to be relatively mobile at the materials own pH>12, 12, 9 and 7. Potential leaching of pesticide residues from recycled concrete to ground water and surface water might exceed water quality guidelines for the remediation site and the EU Water Framework Directive. Results of this study stress the necessity to systematically study the mechanism behind mobility of organic contaminants from alkaline construction and demolition wastes rather than rely on total content limit values [16]. Sorption is a key process in the distribution of substances between environmental compartments in marine ecosystems. Two persistent organic pesticides, also known as toxaphene congeners, namely B8-1413 (P26) and B9-1679 (P50), are of special interest because they are not detected in sediments while relatively concentrated in marine mammals. Sorption-desorption, entrapment and competition behaviors of these pesticides onto marine sediments were studied to explain their environmental distribution. However, the sorption-desorption investigations indicate that B8-1413/B9-1679 were on average 2.5 times less entrapped in sediments compared to B7-1450, a toxaphene congener known to accumulate predominantly in sediments. These results suggest that the low entrapment of B8-1413 and B9-1679 favor their availability and transfer to biological matrices [17].

Though the use of pesticides has offered significant economic benefits by enhancing the production and yield of food and fibers and the prevention of vector-borne diseases, evidence suggests that their use has adversely affected the health of human populations and the environment. In order to highlight the global distribution of persistent organic pesticides and their impact on neighboring countries and regions, the role of persistent organic pesticides in Indian region is reviewed. Based on a review of research papers and modeling simulations, it can be concluded that India is one of the major contributors of global persistent organic pesticide distribution. This review also considers the health impacts of persistent organic pesticides, the regulatory measures for persistent organic pesticides, and the status of India's commitment towards the elimination of persistent organic pesticides [18]. Rainfall-triggered overflow is a major driver of pesticide input in streams. Only few studies have examined the suitability of passive sampling to quantify such episodic exposures. In this study, we used Empore™ styrene-divinylbenzene reverse phase sulfonated disks (SDB disks) and event-driven water samples (EDS) to assess exposure to 15 fungicides and 4 insecticides in 17 streams in a German vineyard area during 4 rainfall events. Sampling rates ranged from 0.26 to 0.77 L d(-1) and time-weighted average (TWA) concentrations from 0.05 to 2.11 µg/L. The 2 sampling systems were in good agreement and EDS exceeded TWA concentrations on average by a factor of 3. Our study demonstrates that passive sampling is suitable to quantify episodic exposures from polar organic pesticides [19]. Bioconcentration factors (BCFs) measured in the laboratory are important for characterizing the bioaccumulative properties of chemicals entering the environment, especially the potential persistent organic pollutants (POPs), which can pose serious adverse effects on ecosystem and human health. Traditional lethal analysis methods are time-consuming and sacrifice too many experimental animals. In the present study, in vivo solid-phase microextraction (SPME) was introduced to trace the uptake and elimination processes of pesticides in living fish. BCFs and elimination kinetic coefficients of the pesticides were also recorded. Moreover, the metabolism of fenthion was also traced with in vivo SPME. The method was time-efficient and laborsaving. Much fewer experimental animals were sacrificed during the tracing. In general, this study opened up an opportunity to measure BCFs cheaply in laboratories for the registering of emerging POPs and inspecting of suspected POPs, as well as demonstrated the potential application of in vivo SPME in the study of toxicokinetics of pollutants [20].

Selection of pesticides with small ecological footprints is a key factor in developing sustainable agricultural systems. Policy guiding the selection of pesticides often emphasizes natural products and organic-certified pesticides to increase sustainability, because of the prevailing public opinion that natural products are uniformly safer, and thus more environmentally friendly, than synthetic chemicals. We found that in addition to reduced efficacy against aphids compared to novel synthetic insecticides, organic approved insecticides had a similar or even greater negative impact on several natural enemy species in lab studies, were more detrimental to biological control organisms in field experiments, and had higher Environmental Impact Quotients at field use rates. All pesticides must be evaluated using an empirically-based risk assessment, because generalizations based on chemical origin do not hold true in all cases [21].The fluorescence characteristics of carbamate pesticide, namely carbaryl, was studied based on the basic theory that organic molecules can emit fluorescence as they are excited by rays. Consequently, a fluorescence spectrograph was applied to conduct fluorescence spectrum experiments with standard solution of carbaryl and the hydrolyzed carbaryl, the fluorescence spectra were obtained under the condition of different concentration, and the relation between their fluorescence intensity and concentration was also analyzed. The fluorescence spectra are located between 400 and 750 nm and they all have smooth spectrum forms and fine resolution, so the spectra are suitable for qualitative and quantitative analysis of carbaryl. As a result, it is feasible to carry out the detection and analysis of the concerned pesticides in soil directly or indirectly by fluorescence spectral analysis [22]. In the present study, Lu index and distance-based atom type topological index (DAI) previously developed in our team, were introduced and combined with molecular electronegativity chip to characterize quantitative structure-property relationship of GC relative retention time (RRT) for several types of structurally diverse organic pesticides on the four kinds of chromatographic columns. Using multiple linear regression technique, four several-variable models are obtained with the estimations correlation coefficient (R(2) being between 0.9655 and

0.9285, and the correlation coefficient (R(2)cv) in the leave-one-out cross-validation procedure are between 0.9560 and 0.9143, respectively. The results in this study indicate that the three topological indices Lu index, DAI, and molecular electronegativity chip can predict the gas chromatographic RRT of organic pesticides with diverse hetero-atoms [23].

In the present paper the basic theory that organic molecules can emit fluorescence as they are excited by ultraviolet rays is described, the molecular structures of a few common pesticides, such as carbamate, benzoylurea and fungicide, are analyzed, and the mechanism of fluorescence generation is also ascertained. Consequently, the theoretic basis for further detection of pesticides by means of fluorescence methods is provided. Moreover a steady-state fluorescence spectrograph was applied to conduct fluorescence spectrum experiments with standard solutions of these pesticides, the fluorescence spectra were obtained, and their fluorescence characteristics were also analyzed. The results indicate that carbamate, benzoylurea and fungicide pesticides may emit strong fluorescence when excited by UV rays under the condition of a certain solvent, their fluorescence spectra are distinct, and the resolution is fine. As a result, it is feasible to carry out qualitative and the quantitative analysis of the concerned pesticides by fluorescence spectral analysis [24].

This paper reports concentration levels of 22 chlorinated organic compounds (both primary compounds and metabolites) in food marketed in the city of Barcelona (Catalonia, Spain) in 2001-06. Samples included meat products, fish and seafood, eggs, milk and dairy, vegetal oils, cereal products and derivates, vegetables, fresh fruits, dry fruits, spices, formula and baby food, tea and wine. Levels of chlorinated organic compounds were determined by gas chromatography with selective detectors: electron capture (ECD), flame photometric (FPD) and confirmation with mass-spectrometry. Chlorinated organic pesticides were detected in 7 of the 1,484 samples analyzed in the 2001-06 period (0.5%): 1 dairy product, 1 fruit, 1 olive oil and 4 vegetables. Specific pesticides detected are lindane and endosulfan alpha, beta or sulphate. A decrease in both the proportion of samples with detectable residues and in the variety of chlorinated pesticides found is visible when comparing these results with those of the previous 1989-2000 period. These results suggest the gradual disappearance of regulated chlorinated organic pesticides as a consequence of the growing worldwide implementation of current regulatory agreements [25]. Polychlorinated biphenyls, DDT and its metabolites, polybrominated diphenyl ethers, and selected organochlorine pesticide concentrations were measured in blubber samples from 60 free-living harbor seals in 2003 from five sites around the United Kingdom coast. Increased serum TT3 levels were significantly related to higher blubber contaminant concentrations in the following order: sum of all contaminants > polybrominated diphenyl ethers > polychlorinated biphenyls > DDT. Serum TT3 levels in the harbor seals with the highest exposures might be indicative of a T3 thyrotoxicosis, but without information on free T3 and circulating thyroid-stimulating hormone levels, it is difficult to determine the importance of this observation for the health of the individuals or populations. However, the mixture of contaminants to which United Kingdom harbor seals are exposed has changed over the last few decades, and the toxicological and epidemiological importance of adding the brominated compounds to the classical organochlorine and heavy metal mixture is not known [26].

Advances in research on pollution of organic pesticides (OPs) in surface water, pollution survey and risk assessments of organochlorine pesticides (OCPs) and organophosphorus pesticides (OPPs) of surface water in Hangzhou are conducted. Total concentrations of dichloro-diphenyl-trichloroethane (DDT) and hexachloride-benzene (HCH) in surface water were observed to be 0-0.270 microg/L and 0-0.00625 microg/L respectively. DDE, as a metabolite of DDT and many species of OPP(S) were determined in some samples of surface water. Parathion, the main pollutant among OPPs in surface water of Hangzhou, was observed to be 0-0.445 microg/L. Based on these experimental results, health risk assessments on the organic pollution are developed. It is observed that the total risk "R (T)" at present time of surface water in Hangzhou is mainly contributed by organophosphorus pesticides, especially Parathion; HCH and DDT are not the main contaminants; on the contrary, organophosphorous pesticides, especially Parathion, must be of concern at the present time [27]. A batch reactor was used to determine sorption kinetic parameters (k2, F, and K*) and the equilibrium sorption coefficient (K). The two-site nonequilibrium (TSNE) batch sorption kinetics model was used to calculate the kinetic parameters. Carbonatic soils contained more than 600 g kg(-1) CaCO3. Sorption is initially very fast up to 3h and then slowly reaches equilibrium. All soil-chemical combinations reached sorption equilibrium after about 24h and all sorption isotherms were linear. An inverse relationship between k3 and K was observed for atrazine and diuron separately in Chekika, Webster, and Lauderhill soils but not in Perrine and Krome soils. The sorption kinetic parameters were used to distinguish the sorption behavior between atrazine and diuron and to identify differences between soils. Using existing literature KOC values in solute transport models will most likely underestimate the mobility of atrazine, diuron, and other neutral organic chemicals in carbonatic soils [28].

We have tested whether some pesticides might cause inner membrane leakage in ML35 Escherichia coli cells, which express beta-galactosidase (lacZ; EC 3.2.1.23) constitutively but lack the permease (lacY) required for substrate entry. The activity of beta-galactosidase (indicative of substrate leakage through the inner membrane) was increased by various concentrations of pesticides, including the organometallic fungicides maneb and mancozeb, the insecticide Thiodan, and the herbicide Ally, as well as by antibiotics such as ampicillin, gramicidin D, and the calcium ionophore A23187. The enzyme activity was increased by up to approximately 30% when the E. coli ML35 strain was exposed to various concentrations (between 50 and 250 ppm) of both fungicides. In parallel with the increase in enzyme activity, both fungicides accumulated in the cells as a function of their concentration. This indicates a different uptake and/or metabolizing strategy by E. coli cells for the two fungicides [29]. The results and especially the high concentrations of DDTs reflect the influence of the industrial and urban wastes in the pollution for the Keratsini harbour environment [30].

A group contribution approach based on atom-type electrotopological state indices for predicting the soil sorption coefficient (log KOC) of a diverse set of 201 organic pesticides is presented. Using a training set of 143 compounds, for which the log KOC values were in the range from 0.42 to 5.31, multiple linear regressions (MLR) and artificial neural networks were used to build the models. The models were validated using two test sets of 20 and 38 chemicals not included in the training set. The statistics for a linear model with 12 structural parameters were, in test set 1, r2 = 0.79, s = 0.45 and, in test set 2, r2 = 0.74, s = 0.65. These results clearly show that soil sorption coefficients can be accurately and rapidly estimated from easily calculated structural parameters [31]. The aim of this study was to investigate the sorption behavior and mechanisms of the organic pesticides on soil. To establish the sorption isotherms of six commonly used pesticides (acetochlor, atrazine, diazinon, carbendazim, imidacloprid, and isoproturon), laboratory equilibrium studies were performed at extended concentration ranges on brown forest soil using the batch equilibrium technique. The adsorption processes could be described by a single-step (Langmuir) isotherm for acetochlor and carbendazim, by a two-step curve for diazinon, isoproturon, and atrazine, and by a three-step curve for imidacloprid. A nonlinear mathematical model-derived from the Langmuir equation-has been developed that represents well the detected single-step and multistep shaped adsorption isotherms. The parameters calculated from the equation provide an opportunity to estimate the extent of absorption constant, adsorption capacity, and concentration limit characteristic to the measured stepwise isotherms [32].

We evaluated the feasibility of extracting organic pesticides in soil using a hot-water percolation apparatus at 105 ^{0}C and 120 kPa pressure. Efficiency of the method was assessed by extracting six selected pesticides (acetochlor, atrazine, diazinon, carbendazim, imidacloprid, and isoproturon) from previously equilibrated soil at 13.6-65.8 mg/kg concentration range. Studies were performed on brown forest soil with clay alluviation (Luvisol). The method developed was compared to the traditional batch equilibrium method in terms of desorbed amount of pesticides from soil and extraction time. Desorbed quantities by hot-water percolation were 85% acetochlor, 62% atrazine, 65% carbendazim, 44% diazinon, 95% imidacloprid, and 84% isoproturon, whereas using batch equilibrium method 101, 66, 64, 37, 81, and 90% were desorbed, expressed as the percentage of the adsorbed amount of pesticide on soil following equilibration. The parameters calculated from the equation provide an opportunity to estimate the amount of compound available for desorption, the rate of desorption processes in the studied soil-pesticide-water system, and modeling the leaching process to obtain additional information on the environmental behavior of the examined pesticide [33]. Soil sorption coefficients (K (OC)) of 185 non-ionic organic heterogeneous pesticides have been studied searching for quantitative structure-property relationships (QSPRs). The chemical description of pesticide structure has been made in terms of some molecular descriptors: count descriptors, topological indices, information indices, fragment-based descriptors and weighted holistic invariant molecular (WHIM) descriptors; these last are statistical indices describing size, shape, symmetry and atom distribution of molecules in the three-dimensional space [34].

2.2 ULTIMATELY WE HAVE TO GO FOR NATURAL BIOPESTICIDES

An analytical procedure was developed for the determination of some natural pesticides (piperonyl butoxide, nicotine, rotenone, spinosad, and abamectin B1a) in fruit matrixes. The quick, easy, cheap, effective, rugged, and safe (QuEChERS) method was used for extraction. Analysis of the extract was performed by LC-electrospray ionization (ESI)-MS/MS. The ions prominent in the ESI spectra were $[M^+Na]^+$ for abamectin B1a, $[M^+ NH4]^+$ for piperonyl butoxide, and $[M^+H]^+$ for the rest of the compounds. A Zorbax SB-C18 column was used with a programmed gradient mobile phase consisting of (A) water containing 0.1% formic acid and 5 mM ammonium formate, and (B) acetonitrile containing 2 mM sodium acetate. The method was linear within the investigated concentration range, displaying a calibration curve correlation factor of 0.99. The CVs obtained were below 20%, and recoveries were in the 70-110% range [35]. This paper describes a method for the sensitive and selective determination of two macrocyclic lactones (abamectin and spinosad) and azadirachtin in apple purée, concentrated lemon juice, tomato purée and canned peas. The general sample extraction-partitioning method for our gas chromatography and liquid chromatography multiresidue methods has been used. The analytical procedure involves an extraction with acetone and liquid-liquid partitioning with ethyl acetate/cyclohexane combined in one step. Studies at fortification levels of 2.5-10 microg/kg and 25-100 microg/kg gave mean recoveries ranging from 70-100% for all compounds with satisfactory precision (relative standard deviation (RSD) from 3-20%). The excellent selectivity and sensitivity allows quantification and identification of low levels of pesticides in canned peas, tomato and apple purées (limits of quantitation (LOQs) 1-5 microg/kg) and in concentrated lemon juice (LOQs 2-10 microg/kg). The quantification of analytes was carried out using the most sensitive transition for every compound and by 'matrix-matched' standards calibration [36].

The cyanobacterium Nostoc strain ATCC 53789, a known cryptophycin producer, was tested for its potential as a source of natural pesticides. The antibacterial, antifungal, insecticidal, nematocidal, and cytotoxic activities of methanolic extracts of the cyanobacterium were evaluated. Among the target organisms, nine fungi (Armillaria sp., Fusarium oxysporum f. sp. melonis, Penicillium expansum, Phytophthora cambivora, P. cinnamomi, Rhizoctonia solani, Rosellinia, sp., Sclerotinia sclerotiorum, and Verticillium albo-atrum) were growth inhibited and one insect (Helicoverpa armigera) was killed by the extract, as well as the two model organisms for nematocidal (Caenorhabditis elegans) and cytotoxic (Artemia salina) activity. To fully exploit the potential of this cyanobacterium in agriculture as a source of pesticides, suitable application methods to overcome its toxicity toward plants and nontarget organisms must be developed [37]. Six compounds, representing the mono-tetrahydrofuran (THF) (gigantetrocin A, annomontacin), adjacent bis-THF (asimicin, parviflorin), and nonadjacent bis-THF (sylvaticin, bullatalicin) classes of annonaceous acetogenins, were compared with technical grades of synthetic amidinohydrazone (hydramethylnon), carbamate (propoxur, bendiocarb), organophosphate (chlorpyrifos), and pyrethroid (cypermethrin) insecticides to determine their dietary toxicities to insecticide-resistant and insecticide-susceptible strains of the German cockroach, Blattella germanica (L.). The acetogenins caused high percentages of mortality and delays in development of the 5th instars of both strains. Low resistance ratios values for 2nd instars ranged from 0.9 to 2.2 with the natural acetogenins and from 1.0 to 3.8 with the synthetic compounds; the 5th instars ranged from 0.2 to 3.9 with the natural acetogenins and from 0.6 to 8.0 with the synthetic compounds. Insecticidal properties and characteristics of acetogenins and the possible use of acetogenins in baits for cockroach control are discussed [38].

Five commercial preparations of natural pesticides were tested for in vitro compatibility with muscardine fungi, Beauveria brongniartii and Metarhizium anisopliae. Neemark (azadirachtin) was found compatible with both the fungi. Phytoallexin, the natural fungicide, significantly inhibited the growth of both the fungi, while other natural pesticides showed moderate to severe inhibition [39]. Based upon the US National Toxicology Program (NTP) rodent carcinogenicity data base, CASE, an artificial intelligence structure-activity evaluation method, predicts that a large proportion of natural pesticides present in edible plants are rodent carcinogens [40]. In this review, some common food plants and their toxic or otherwise bioactive components and mycotoxin contaminants have been considered. Crucifers contain naturally occurring components that are goitrogenic, resulting from the combined action of allyl isothiocyanate, goitrin, and thiocyanate. Celery field workers and handlers continually have photosensitization problems as a result of these indigenous celery furanocoumarins. Since there is no regulatory agency or body designated to oversee potential toxicological issues associated with naturally occurring toxicants, photodermatitis continues to occur from celery exposure. Sweet potatoes contain phytoalexins that can cause lung edema and are hepatotoxic to mice. At least one of these, 4-ipomeanol, can cause extensive lung clara cell necrosis and can increase the severity of pneumonia in mice. Some phytoalexins in sweet potatoes are hepatotoxic and nephrotoxic to mice. The common mushroom Agaricus bisporus contains benzyl alcohol as its most abundant volatile, and *A. bisporus* and *Gyromitra esculenta* both contain hydrazine analogues. Mycotoxins are found in corn, cottonseed, fruits, grains, grain sorghums, and nuts (especially peanuts); therefore, they also occur in apple juice, bread, peanut butter, and other products made from contaminated starting materials [41].

2.3 WONDER-NEEM BASED (*Azadiracta indica*) BIOPESTICIDES

Among the plant derived product, azadirachtin, a neem-based insecticide, is exceptional in having a broad range of bioactivity including toxicity, growth, development and reproduction effects, repellency and antifeedancy. In addition, all tested flies revealed a clear preference for solvent odour rather than azadirachtin odour. Moreover, azadirachtin treatment decreased significantly the amount of food intake in the adults. Finally, azadirachtin was found to affect digestive enzyme activities in the midgut of flies. Indeed, an inhibition of α-amylase, chitinase, and protease activities and an increase of lipasic activity were noted. These results may reflect interference of azadirachtin with regulation of feeding and metabolism, and provide some evidence of a long term antifeedancy and delayed effects through developmental stage which may reinforce the insecticidal activity of this bioinsecticide [42]. The chewing lice (Mallophaga) are common parasites of different animals. Most of them infest terrestrial and marine birds, including pigeons, doves, swans, cormorants and penguins. However, the entomopathogenic fungus *Metarhizium anisopliae* has been reported as effective in vitro and in vivo experiments against *Damalinia bovis* infestation on cattle. Furthermore, different *Bacillus thuringiensis* preparations have been tested against Mallophaga, the most effective were *B. thuringiensis* var. kurstaki, kenyae and morrisoni. Lastly, plant-borne insecticides have been evaluated against Mallophaga. Tested products mainly contained bioactive principles from two Meliaceae, *Azadirachta indica*, and *Carapa guianensis*. Behavior-based control of Mallophaga, using pheromone-based lures or even the Sterile Insect Technique (SIT) may also represent a potential route for their control, but our limited knowledge on their behavioral ecology and chemical communication strongly limit any possible approach [43].

Over the years, extensive use of commercially available synthetic pesticides against phytophagous insects has led to their bioaccumulation in the environment causing increased resistance and reduction in soil biodiversity. Further, 90% of the applied pesticides enter the various environmental resources as a result of run-off, exposing the farmers as well as consumers of the agricultural produce to severe health issues. Therefore, growing attention has been given toward the development of alternate environmentally friendly pesticides/insecticides that would aid an efficient pest management system and also prevent chronic exposures leading to diseases. One such strategy is, the use of neem plant's (Binomial name: *Azadirachta indica*) active ingredients which exhibit agro-medicinal properties conferring insecticidal as well as immunomodulatory and anti-cancer properties. The most prominent constituent of neem is azadirachtin, which has been established as a pivotal insecticidal ingredient. This review discusses, key neem pesticidal components, their active functional ingredients along with recent strategies on employing nanocarriers, to provide controlled release of the active ingredients and to improve their stability and sustainability [44].

The utility of neem based green silver nanoparticles (AgNPs) in veterinary medicine is steadily increasing as they have many therapeutic applications against pathogens and arthropods of livestock. In this study, green AgNPs using neem (N-AgNPs), 2,3-dehydrosalanol (2,3-DHS-AgNPs) and quercetin dihydrate (QDH-AgNPs) were synthesised and characterised. In DLS analysis, the hydrodynamic diameter of neem leaf extract was found to be 259.8 nm, followed by 5.3, 6.7 and 261.8 nm for 2,3-DHS-AgNPs, N-AgNPs and QDH-AgNPs, respectively. Based on the transmission electron microscopy and scanning electron microscopy image analyses, confirmed the formation of N-AgNPs, 2,3-DHS-AgNPs and QDH-AgNPs. These eco-friendly phyto-AgNPs may be of use as an effective alternative to chemical control methods against the arthropods of livestock [45].The present clinical trial was conducted to obtain additional data for the safety and efficacy of a head lice shampoo that is free of silicone compared with an anti-head lice product containing dimethicone. Both products act by a physical mode of action. Children older than 2 years with an active head lice infestation were treated with either a shampoo-based head lice treatment containing neem extract (Licener®) or dimethicone (Jacutin® Pedicul Fluid) on day 1 and additionally on day 9. Sixty-one children in the test-group (Licener®) and 58 children in the reference group (Jacutin® Pedicul Fluid) were included in this study. The test product and the reference product were very well tolerated. Both products exceeded the objective of cure rates of over 85% after single treatment (test group 60/60 = 100%; 95% CI = 94.04-100.00%; reference group 54/57 = 94.74%; 95% CI = 85.38-98.90%; p = 0.112; CI by Clopper-Pearson) and after two treatments (test group 58/58 = 100%; 95% CI = 93.84-100.00%; reference group 52/54 = 96.30%; 95% CI = 87.25-99.55%; p = 0.230) with higher cure rates and non-inferiority for the test product. The combined success rate shows significant superiority of the test product against the reference product (test group 58/58 = 100%; 95% CI = 93.84-100.00%; reference group 49/54 = 90.7%; 95% CI = 79.70-96.92%; p = 0.024). The test product showed higher ovicidal efficacy than the reference product. Thus, the present study demonstrates that a single treatment with a head lice product like Licener® can be sufficient to eliminate a head lice infestation [46].

Acute skin toxicity is a frequent finding during combined radiotherapy and chemotherapy in head and neck cancer patients. Its timely and appropriate management is crucial for both oncological results and patient's global quality of life. We herein report clinical data on the use of Hypericum perforatum and neem oil in the treatment of acute skin toxicity during concurrent chemo-radiation for head and neck cancer. Median times spent with G2 or G3 toxicity were 23.5 and 14 days. Patients with G3 toxicity were reconverted to a G2 profile in 80% of cases, while those with a G2 score had a decrease to G1 in 58% of cases. Time between maximum acute skin toxicity and complete skin recovery was 30 days. Mean worst pain score evaluated with the Numerical Rating Scale-11 was 6.9 during treatment and 4.5 at the end of chemo-radiotherapy. Hypericum perforatum and neem oil proved to be a safe and effective option in the management of acute skin toxicity in head and neck cancer patients submitted to chemo-radiation with weekly cisplatin. Further studies with a control group and patient-reported outcomes are needed to confirm this hypothesis [47]. Azadirachtin (Aza) is a promisor biopesticide used in organic production and aquaculture. In our study, LC_{50} was estimated at 80 µL/L. We exposed carp to Aza at 20, 40, and 60 µL/L, values based on 25, 50, and 75% of LC_{50} , respectively. At 60 µL/L, Aza promoted significant changes in several parameters, increasing the distance traveled and absolute turn angle. In addition, the same concentration decreased the time spent immobile and the number of immobile episodes. Hematological parameters, such as hematocrit, hemoglobin, hematimetrics index, and red cell distribution, were decreased at 60 µL/L Aza exposure. In conclusion, our study demonstrates that 60 µL/L Aza altered locomotor activity, motor pattern, and hematological parameters, suggesting potential toxicity to carp after acute exposure. In addition, this is the first report that evaluates the actions of a chemical contaminant using automated behavioral tracking of carp, which may be a useful tool for assessing the potential toxicity of biopesticides in conjunction with hematological tests [48].

Pesticide resistance is going to change rapidly our antibiotics and insecticides arsenal. In this scenario, plant-derived natural products are considered valuable candidates to reverse this negative trend. In this review, we summarised the knowledge on neem oil and neem cake by-products in arthropod pest control, with special reference to mosquito vectors of public health importance. In particular, the potentiality of neem cake as ideal and affordable source of mosquitocidal compounds in anopheline and aedine control programmes is outlined. Overall, we propose the employ of neem-based products as an advantageous alternative to build newer and safer arthropod control tools [49]. The pine sawyer beetle Monochamus alternatus Hope, a major forest insect pest, is the primary vector of the destructive forest pest pine wood nematode, Bursaphelenchus xylophilus. Azadirachtin, an active compound of neem, is biologically interesting because it represents a group of important, successful botanical pesticides. We provide insight into the molecular effects of azadirachtin on M. alternatus at the transcriptional level to provide clues about possible molecular-level targets and to establish a link between azadirachtin and insect global responses. The Encyclopedia of Genes and Genomes pathway enrichment analysis indicated that the DEGs were enriched in 50 pathways. Detailed gene profile knowledge of the interaction of azadirachtin with M. alternatus should facilitate the development of more effective azadirachtin-based products against M. alternatus and other target Coleoptera. These results further enhance the value of azadirachtin as a potential insecticide of biological origin, as well as for other biological applications [50].

These infections are associated with a significantly reduced quality of life and frequent medical consultations. The approved drugs for the treatment of infections have some disadvantages in the treatment despite their good efficacy and an alternative to classical products [51]. India is the second largest producer of black tea in the world. The biggest challenge for tea growers of India nowadays is to combat pests and diseases. Tea crop in India is infested by not less than 720 insect and mite species. The application of plant extracts with insecticidal properties provides an alternative to the synthetic pesticides. Botanical products, especially neem-based products, have made a relatively moderate impact in tea pest control. Research has also demonstrated the potential of 67 plant species as botanical insecticides against tea pests. The majority of plant products used in pest management of tea in India are in the form of crude extracts prepared locally in tea garden itself, and commercial standardized formulations are not available for most of the plants due to lack of scientific research in the area. Apart from systematic research in this area, to facilitate the simplified and trade friendly registration procedures with quality assurance of the products, there is an increasing need of regulatory authority and national norms in India [52]. The aim of this systematic review was to evaluate the effectiveness of *Azadirachta indica* (neem)-based herbal mouthrinse in improving plaque control and gingival health. Literature search was accomplished using electronic databases and manual searching, up to February 2015, for randomized controlled trials (RCTs) presenting clinical data for efficacy of neem mouthrinses when used alone or as an adjunct to mechanical oral hygiene as compared to chlorhexidine mouthrinses for controlling plaque and gingival inflammation in patients with gingivitis. The total 206 articles searched, three randomized controlled trials evaluating neem-based herbal mouthrinses were included. Despite the promising results shown in existing randomized controlled trials, the evidence concerning the clinical use of neem mouthrinses is lacking and needs further reinforcement with high-quality randomized controlled trials based on the reporting guidelines of herbal CONSORT statement [53].

Neem products have been used frequently as an alternative to synthetic pesticides, because of their insecticidal, insect antifeedant, and growth-regulating effects. Moreover, new formulations are continually being developed and therefore, they have to be evaluated for their efficacy and persistence. The efficacy, persistence, and dose response of the two soil-applied NeemAzal (a neem based formulation) in substrates with different amount of organic matter. Persistence of the NeemAzal formulations was not influenced by the substrate type but rather by time span between treatment application and infestation, with significant decrease in efficacy when whiteflies were exposed 10 days after treatments [54]. Herbal remedies are widely used in many malaria endemic countries to treat patients, in particular in the absence of anti-malarial drugs and in some settings to prevent the disease. Furthermore, neem secondary metabolites have been shown to interfere with various physiological processes in insect vectors. Stephensi mosquitoes were offered 5 consecutive blood meals on female BALB/c mice treated with NeemAzal at an azadirachtin A concentration of 60, 105 or 150 mg/kg. The blood feeding capacity was estimated by measuring the haematin content of the rectal fluid excreted by the mosquitoes during feeding. Similarly, after the fifth treated blood meal exposure, hatchability was found to be reduced by 62% and 70% in the 105 and 150 mg/kg group respectively. The findings of this study, taken together with the accumulated knowledge on neem open the challenging prospects of designing neem-based formulations as multi-target phytomedicines exhibiting preventive, parasite transmission-blocking as well as anti-vectorial properties [55]. Comparative evaluation and antibacterial activity of six Indian plant extracts and 0.2% chlorhexidine against clinical strains of Streptococcus mutans was performed, which were isolated from the plaque samples of 45 pediatric patients. Six plant extracts were prepared in three different forms, namely aqueous extracts, organic solvent-based extracts and crude (raw) extracts. This study suggests that plant extracts like garlic in crude form, amla as aqueous infusion and ginger as alcoholic tincture have potential for the control of S. mutans. These extracts can be used as an alternative remedy for dental caries prevention or in the form of mouthwash, which is safe and economical [56].

Mosquitoes (Diptera: Culicidae) represent an important threat to millions of people worldwide, since they act as vectors for important pathogens, such as malaria, yellow fever, dengue and West Nile. In this review, we examined (i) the latest achievements about neem cake metabolomics with special reference to nor-terpenoid and related content; (ii) the neem cake ovicidal, larvicidal and pupicidal toxicity against Aedes, Anopheles and Culex mosquito vectors; (iii) its non-target effects against vertebrates; and (iv) its oviposition deterrence effects on mosquito females. Overall, neem cake can be proposed as an eco-friendly and low-cost source of chemicals to build newer and safer control tools against mosquito vectors.[57] The peculicidal activity of eight plant essential oils in 75% isopropyl alcohol was in vitro investigated. Of them, the substances that were most active against lice were tea tree (Melaleuca), eucalyptus, neem, citronella (*Cymbopogon nardus*), and clove (*Syzygium aromaticum*) oils; KT50 was not more than 3 minutes on average; KT95 was 4 minutes. After evaporating the solvent, only five (tea tree, cassia, clove, anise (Anisum vulgare), and Japanese star anise (Illicium anisatum) oils) of the eight test botanical substances were active against lice. At the same time, KT50 and KT95 showed 1.5-5-fold increases. Citronella and anise oils had incomplete ovicidal activity. Since the lice were permethrin-resistant, the efficacy of preparations based on essential oils was much higher than permethrin [58]. C-seco triterpenoids are widely bioactive class of natural products with high structural complexity and diversity. The preparative isolation of these molecules with high purity is greatly desirable, although restricted due to the complexity of natural extracts. In this article we have demonstrated a Medium Pressure Liquid Chromatography (MPLC) based protocol for the isolation of eight major C-seco triterpenoids of salannin skeleton from Neem(Azadirachta indica) oil. The structure-fragment relationships were established on the basis of plausible mechanistic pathway for the generation of daughter ions. The MS/MS spectral information of the triterpenoids was further utilized for the identification of studied molecules in the complex extract of stem and bark tissues from Neem [59]. The study was undertaken to investigate the relative repellency of *Pongamia pinnata* and *Azadirachta indica* seed oils on vector mosquito, *Aedes aegypti u*nder laboratory conditions. Different formulations of each oil were tested at the concentrations of 1% and 5% on human baits. Efficiency was assessed, based on the total protection time; biting rate and percent protection provided by each formulation. Results showed that 5% formulation of the *Pongamia pinnata* and *Azadirachta indica* seed oils mixed in 1:1 ratio exhibited highest percentage repellency of 85%, protection time of 300 min and bite rate of 6%. 5% concentration of A. indica and P. pinnata seed oil in mustard oil base offered 86.36% and 85% protection respectively with total protection time of 230 and 240 min respectively. These formulations are very promising for topical use (> 5 hrs complete protection) and are comparable to the protection provided by advanced Odomos mosquito repellent cream available commercially and thus are recommended for field trial [60].

An experiment was conducted in Field Laboratory, Department of Entomology at Bangladesh Agricultural University, Mymensingh, during 2013 to manage the mango hopper, Idioscopus clypealis L, using three chemical insecticides, Imidacloprid (0.3%), Endosulfan (0.5%), and Cypermethrin (0.4%), and natural Neem oil (3%) with three replications of each. All the treatments were significantly effective in managing mango hopper in comparison to the control. In case of biopesticide, azadirachtin based Neem oil was found effective against mango hopper as 48.35, 60.15, and 56.54% reduction after 24, 72, and 168 hours of spraying, respectively, which was comparable with Cypermethrin as there was no statistically significant difference after 168 hours of spray. Natural enemies were also higher after 1st and 2nd spray in case of Neem oil [61].

Octadecanoic acid-3,4-tetrahydrofuran diester, isolated from neem (*Azadirachta indica*) oil, exhibited potent acaricidal activity against Sarcoptes scabiei var. cuniculi. In this paper, the acaricidal mechanism of octadecanoic acid-3,4-tetrahydrofuran diester against *Sarcoptes scabiei* var. cuniculi was evaluated based on pathologic histology and enzyme activities. The activities of super oxide dismutase (SOD), per oxide dismutase (POD), and Ca (2+)-ATPase were significantly suppressed, whereas that of GSTs was activated. These results indicated that the mechanism of the acaricidal activity of octadecanoic acid-3,4-tetrahydrofuran diester was mainly achieved through interference with the energy metabolism of mites, thus resulting in insect death [62]. The aim of this study was to investigate the hepatoprotective role of azadirachtin-A in carbon tetrachloride (CCl4) induced hepatotoxicity in rats. On the 9th day, blood was obtained for measuring the biochemical parameters, and liver tissue was obtained for pathological examination. The results from this study indicate that pretreatment with azadirachtin-A at the higher dose levels, moderately restores the rat liver to normal. This study confirms that azadirachtin-A possesses greater hepatoprotective action; however, the effective concentration needs to be determined [63]. Presence of several biochemical constituents in neem makes it an efficient antimicrobial agent for pathogenic diseases. The current investigation was aimed to assess the therapeutic potential of neem nanoemulsion as a control measure for Pseudomonas aeruginosa infection in freshwater fish *Labeo rohita*. The results were corroborative with histopathology and ultrastructural analysis. The bacterial infection of *P. aeruginosa* treated using neemnanoemulsion was more effective in both in vitro and in vivo methods. Present findings suggest that neem-based nanoemulsion has negligible toxicity to Rohu fishes. This makes neem-based nanoemulsion as an efficient therapeutic agent against *P. aeruginosa* infection, leading to its possible usage in the aquaculture industry [64]. The use of synthetic pesticides and repellents to target pests of veterinary and medical significance is becoming increasingly problematic. One alternative approach employs the bioactive attributes of plant-derived products (PDPs). These are particularly attractive on the grounds of low mammalian toxicity, short environmental persistence and complex chemistries that should limit development of pest resistance against them.Several pesticides and repellents based on PDPs are already available, and in some cases widely utilised, in modern pest management. A limited residual activity, often due to photosensitivity or high volatility, is a further drawback in some cases (though potentially advantageous in others). Four main types of PDP are considered (pyrethrum, neem, essential oils and plant extracts) for their pesticidal, growth regulating and repellent or deterrent properties [65]. In the present investigation, neem and mahua methyl ester were prepared by transesterification using potassium hydroxide as a catalyst and tested in 4-stroke single cylinder water cooled diesel engine. Tests were carried out at constant speed of 1500 rev/min at different brake mean effective pressures. The specific fuel consumption (SFC) was more for almost all blends at all loads, compared to diesel. At part load, the EGT of MME and its blends were showing similar trend to diesel fuel and at full load, the exhaust gas temperature of MME and blends were higher than diesel. Based on this study, NME could be a substitute for diesel fuel in diesel engine [66].

2.4. BOTANICAL BIOPESTICIDES-A GREENER WAY OF PLANT PROTECTION

Carvacrol and linalool are natural compounds extracted from plants and are known for their insecticidal and repellent activities, respectively. Inclusion complexes between beta-cyclodextrin (β-CD) and carvacrol (CVC) or linalool (LNL) were investigated. Inclusion complexes were prepared by the kneading method. Both complexes presented 1:1 host: guest stoichiometry and the highest affinity constants were observed at 20 °C for both molecules. Biological assays with mites (*Tetranychus urticae)* showed that the nanoparticles possessed repellency, acaricidal, and oviposition activities against this organism. The nanoformulations prepared in this study are good candidates for the sustainable and effective use of botanical compounds in agriculture, contributing to the reduction of environmental contamination, as well as promoting the effective control of pests in agriculture [67]. The issues including excessive pesticide residues and heavy metal contamination have become the bottle-neck in the development of Chinese herbal medicines. Compared with traditional chemical pesticides, biological pesticides, especially botanical pesticides, are more safe and environment-friendly, which were beneficial to the quality improvement Chinese medicinal materials. This paper reviews the current situation of botanical pesticides, and gives some pertinence suggestions according to the existing problems and challenges. Research on botanical pesticides will become the key point to solve the problem of excessive pesticides residues and heavy metal contamination, and promote the healthy development of Chinese materia medica [68].

Combinations of celangulin mixed with matrine or toosendanin at 1:9 exhibited synergism, which is attributed to the interference of matrine or toosendanin with the detoxification enzymes of celangulin. Both the synergistic combinations were inappropriate for rotifer extermination in Isochrysis sp. cultivation owing to the high phytotoxicity resulting from the absence of cell walls. However, the celangulin/toosendanin (1:9) mixture decreased rotifer reproduction without damaging cells of Chlorella and Nannochloropsis sp. Application of frequent, low doses of celangulin/toosendanin (1:9) mixture also reduced the dosage of biocides, thereby reducing the cost of exterminating rotifers, and indicating a considerable practical application in microalgal cultivation [69]. This study presents a consumer and farmer safety evaluation on the use of four botanical pesticides in pepper berry crop protection. The pesticides evaluated include preparations from clove, tuba root, sweet flag and pyrethrum. For the other three botanical pesticides the margin of safety (MOS) between established acute reference doses and/or acceptable daily intake values and intake estimates for the consumer, resulting from their use as a botanical pesticide are not of safety concern, with the exception for levels of rotenone upon use of tuba root extracts on stored berries. Used levels of clove and pyrethrum as botanical pesticides in pepper berry crop production is not of safety concern for consumers or farmers, whereas for use of tuba root and sweet flag some risk factors were defined requiring further evaluation and/or risk management. It seems prudent to look for alternatives for use of sweet flag extracts containing β-asarone [70]. The effects of synthetic pesticides on the soil microbial community have been thoroughly investigated in the past mostly by culture-dependent methods and only few recent studies have used culture-independent approaches for this purpose. This response was attributed to the release of copious amounts of organic carbon and nutrients in the soil by the PMF. On the other hand, MS inhibited fungi and gram-negative bacteria, while fosthiazate and the botanical pesticides quillaja and azadirachtin did not impose significant changes in the soil microbial community. Similar results were obtained by the field study where application of the fumigants MS and SoTe significantly altered the structure of the soil microbial community with the former having a more prominent effect. Fosthiazate imposed mild significant effect. Overall, botanical pesticides, at their recommended dose, did not alter the structure of the soil microbial community compared to synthetic nonfumigant and fumigant pesticides which induced significant changes [71]. Herbivorous and carnivorous arthropods use chemical information from plants during foraging. Aqueous leaf extracts from the syringa tree Melia azedarach and commercial formulations from the neem tree *Azadirachta indica*, Neemix 4.5, were investigated for their impact on the flight response of two parasitoids, Cotesia plutellae and Diadromus collaris. Among these are alcohols, aldehydes, ketones, esters, terpenoids, sulfides, and an isothiocyanate. Cabbage plants that had been treated with the syringa extract emitted larger quantities of volatiles, and these increased quantities were not derived from the syringa extract. Therefore, the syringa extract seemed to induce the emission of cabbage volatiles. To our knowledge, this is the first example of a plant extract inducing the emission of plant volatiles in another plant. This interesting phenomenon likely explains the preference of *C. plutellae* parasitoids for cabbage plants that have been treated with syringa extracts [72].

3. CONCLUSION

The interest in organic agriculture in developing countries is growing because it requires less financial inputs and places more reliance on natural and human resource available. Organic farming on small land holdings, especially under rain fed zones, tribal areas and North West to North East Himalayas still will go to long way in promoting organic farming in India. In order to address the aforesaid challenges in a better way, integration of these systems and develop package of Jaivik Krishi (organic farming), which can be promoted in different parts of the country by the common Indian farmers. It is interesting to record that in all four systems "COW" particularly those with hump (indigenous breed) is one of the key components, hence provision of at least one cow per hectare need to be promoted for Jaivik Krishi activities in organic farming. Suggestive evidence indicates that organic food consumption may reduce the risk of allergic disease and of overweight and obesity, but residual confounding is likely, as consumers of organic food tend to have healthier lifestyles overall. Organic agriculture has been neglected in the agricultural policy in past years, and therefore there was less government assistance for the promotion of organic agriculture, as it exists for the conventional agriculture in the form of subsidies, agricultural extension services and official research. But the present Government is giving proper encouragement for organic farming; thus it will progress tremendously in India, especially in the dry land regions of the country, taking advantage of the diverse soil and climatic conditions for the sustainable agricultural practices

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