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Potential Use of Medicinal Plants as Biological Crop Protection Agents

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ABSTRACT

Nowadays, limitations in chemical crop protection products, high costs in their development and toxic residues of pesticides in raw material, poses serious concerns of risk in the environment and human health. Therefore, the last few decades the need to discover alternative methods for controlling plant pests and diseases is in great importance. Compounds derived from medicinal plant parts are generally used in traditional medicine to cure human diseases. Their potential action against plant pests and diseases is recently under researcher's scientific study.

Keywords: Crop Protection; Biological Control; Antimicrobial Activity; Antioxidants; Medicinal Plants

Introduction

Rapid expansion of human population improving quality of life as a result of economic development and per capita demand are responsible for the intensification of food needs [1,2]. For this reason, control and elimination of factors, such as pests and diseases that affects yield production in many economically important crops by causing serious losses, have become challenges of amount importance [3]. Over the last few decades, crop protection technologies for effective, low cost and elimination of harmful pests and numerous of plant diseases, are mainly based on application of chemical and biotechnological products [4-8]. Limited application of chemical crop protection products and impact of climate change is believed that it could cause decrease of world's food production and thus, rise of food prices [9]. However, their extensive use along with other toxical residues such as heave metals has been linked to environmental pollution and undesirable immediate and non-immediate health risk effects in human health affecting also the food chain [10-18]. Thus, the last decades, has been an increased interest in alternative, eco-friendly treatments to control plant pests and diseases [19-23].

Biological control of plant pathogens can be accomplished by using one living organism to control another [24]. Although, biological control of soil-borne pathogens has been studied for several years [25-33]. biological products, with a very few exceptions, are not yet commercially feasible for large scale application.

Regarding, biological control methods, use of botanical extracts of plant tissues and wastes of agri-food processing are under research since they contain a wide range of secondary metabolites such as polyphenols with potential antimicrobial, antioxidant, anti-inflammatory and cytotoxic properties that can benefit food-producers, consumers and environment [34-48] enhancing soil physicochemical properties and microbial community [49-53]. Thus, efforts by using appropriate methods of decontamination and extraction techniques [54-66]. Have been completed, regarding their use in pharmaceutical, cosmetic and food industry as natural bioactive materials as well as to control plant and food pathogens. The objective of this special issue is a compilation of the most recent,

state-of-the-art studies pertaining to the potential use of medicinal plants as biological crop protection agents. Khan et al. [67] explore the various plant parts such as bark, stem, leaf, fruit and seed against Gram negative and Gram-positive bacteria, using different solvents such as methanol, ethyl acetate, chloroform, acetone, n. hexane, butanol, petroleum ether and benzene for extraction. Results provided by their review suggested that medicinal plants appear a potential antiviral, bactericidal and fungicidal activity including honey bee protection by pathogens such as fungi *(Ascosphaera apis)*, mites (*Varroa* spp. and *Tropilaelaps* sp.), bacteria *(Melissococcus plutonius, Paenibacillus larvae)*, and microsporidia *(Nosema apis and N. ceranae)*.

Van Wyk and Prinsloo [68] focus their research on South African traditional medicinal plant material as a potential cultivation in order to increase farmers income. Furthermore, according to Gahukar [69] only in India, over 6000 species of medicinal plants containing phenolic acids, flavonoids and aromatic compounds such as terpenoids, steroids, alkaloids and organic cyanides have been identified. Among plants, shrubs and trees, the neem tree *(Azadirachta indica A. Juss.)* has been used to control cancer cells, pests, fungi, bacteria and nematodes [70-79]. Recently, in a study completed by de Freitas Silva et al. [80] more than 30 medicinal plant's volatiles such as *Cymbopogon nardus* and *Dysphania ambrosioides* applied against the root-knot nematode.

Zhang et al. [81] examined the root-associated microbiomes of *P. cuspidatum* and the potential correlation between the bioactive compounds and microbiomes. The relationships among root-associated bacteria, soil properties, and four major bioactive compounds (polydatin, resveratrol, emodin, and physcion) were explored by a multivariate correlation study. Among root endosphere microbes, Stenotrophomonas was specifically enriched from rhizosphere increased about 15 times of relative abundance. This study provides insights into the interaction networks among *P. cuspidatum* root-associated bacteria, cultivation years, soil properties, and bioactive compounds, providing a new opportunity to manipulate the production of bioactive compounds, and thus improve the industrial and medicinal value of *P. cuspidatum* in future.

El-Din Hassan, [82] delivers an investigation on bacterial and fungal endophytes isolated from medicinal plant of *Teucrium polium*, as plant growth-promoting agents. The results of this study indicated that microbial endophytes isolated from medicinal plants possessing a vital role to improve plant growth and could be used as inoculants to establish a sustainable crop production system. Furthermore, Xiang et al. [83] examined 208 endophytic fungal isolates collected from stems, leaves and flowers of 26 medicinal plant species for their antimicrobial activities. Pospelov et al. [84] investigated the potential use of extracts from *Hypericum perforatum*, *Helichrysum arenarium, Calendula officinalis, Achillea millefolium* and seeds of *Hippophae rhamnoides*. The biological activity of native extracts, as well as fractions without lectins and lectins isolated from extracts was studied. It was proved that the activity can be the result of the action of both native extracts and individual components, especially lectins that it could inhibit the germination of teliospores of *Ustilago nuda*.

Vanichpakorn et al. [85] screened twenty-five extracts of five Chinese medicinal plant species against *Plutella xylostella* L., larvae by a leaf dipping bioassay method. Results from this study showed that extracts of *Veratrum nigrum* L. root and rhizome, *Phytolacca americana* L. root, and *Pseudolarix kaempferi* Gord. root bark were effective against *P. xylostella*. Among them, the ethyl acetate extract of *V. nigrum* showed the strongest insecticidal activity against the second and third instar larvae of P. xylostella supporting that this extract could be used as a promising naturally occurring agent for *P. xylostella* larval control. Beside potential use of compounds derived by medicinal plants as biological control agents against plant pests and diseases, these compounds can be also used for weed control. Exploitation and discovery of novel natural herbicides is crucial to address increased weed resistance and environmental issues. Thus, Feng et al. [86] studied the herbicidal activity of ethanol extracts of leaves and stems of *Piper sarmentosum* against *Echinochloa crusgalli* and *Amaranthus retroflexus*. Thei phytotoxic analyses revealed that sarmentosine and sarmentine were more phytotoxic against *E. crusgalli* and A. retroflexus. The weed-controlling spectrum test indicated that sarmentosine could effectively control *E. crusgalli*, *Chloris virgata*, *Pharbitis nil*, *A. retroflexus* and *Abutilon theophrasti*.

In summary, compounds derived from medicinal plants has demonstrated excellent control of pests and diseases resulting in higher quality crops and increased potential in crop yields. The use of these substances promises to offer farmers around the world a valuable new tool for crop protection and pest and diseases management.

Conflicts of Interest

The authors declare no conflict of interest.

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