Proposal title:

Synthesizing novel pesticides formulations from different substances

Target level: MSc students

Student name: Ajeen M Pirbal

Prepared by supervisors: Dr. Qasim A Marzani and Sahand K Khidr

Introduction

Pesticides include herbicides, insecticides, fungicides, nematicides, bactericides, and rodenticides that are used to target weeds, pests, plant pathogens, nematodes, microbes, and rodents. Although, the use of chemical pesticides is not favourable due to environment and human health concerns but the increasing world population is dictating more agricultural production and this is impossible to achieve without the use of pesticides, at least for now. However, the excessive and unmanaged use of pesticides left various problems due to contamination of our ecological systems including soil, sediments, and waterways (that adversely impact the wildlife) and through transfer of residues across the food chain. The global pesticide market was accounted $56 billion in 2012. This market was projected to reach $70.57 billion by 2021 at a compound annual growth rate (CAGR) of 5.15% between 2016 and 2021.

Globally, research efforts have been focusing on the reduction of pesticide use (e.g., 42% reduction) without any adverse effects on productivity and profitability in most arable farms. However, under diverse production situations, the controlled use of pesticides and fertilizers through an environment-friendly approach is recommended to increase the efficacy while reducing the amount of active ingredients (AIs) and also ensuring their targeted delivery to specific sites. Consequently, the ultimate solution can be sought from using advanced tools such as nanotechnology that deals with materials at the nano-scale to achieve a multitude of unique physicochemical properties. Nanotechnology is the most promising field of interdisciplinary research that deals with materials at the nanometer scale. Nanomaterials have novel physical, chemical, and mechanical properties (through conversion from their bulk forms), and they can overcome a number of limitations inherent in existing products (e.g., in terms of cost, fabrication strategies, functionality, and overall performance). As such, this emerging technology opened up a wide array of opportunities in diverse fields including medicine, food processing, agriculture, pharmaceuticals, materials science, electronics, and energy technologies. Thus, development of nano-based active ingredients (AI) s of pesticides is to achieve higher efficacy with reduced pesticide volumes and economic production with increasing yields.

Nanoformulations of pesticides or nanopesticides must offer a wide variety of benefits (including increased effectiveness and durability, good dispersion and wettability, ability to biodegrade in the soil and environment, lack of toxicity, photogenerative nature) and have a reduced amount of AIs with convenient pesticide properties so that they can be employed to effectively protect crops against insect pests and diseases. The rapid research developments in nanopesticides have motivated researchers to develop nanopesticides that are less harmful to the environment as well as target-specific without sacrificing their efficacy. Target-specific nanopesticides should thus help in reducing the damage to non-target plants and decrease the amount released into the surrounding environment.

Aims

- Synthesizing new formulations
- Characterization of new formulations
- Evaluation the efficiency of new formulations in vitro and in vivo

Materials and methods

Materials - chemicals

Main ingredient (Active ingredients):

Pure analytical standards, Crude plant extract, Acids, essential oils

Surfactants and dispersals:

Pesticides need carriers or inert materials to support and deliver the active ingredients to the target. Several surfactants have been used, we will test some of them. For example:

Anionic surfactants (Polysorbate 80 (Tween 80), Polysorbate 20)

Nonionic and anionic (Palm oil-based. anionic: methyl ester sulfonate (MES)/Nonionic: polyethylene glycol dioleate (PDO)/and polyethylene glycol monooleate (PMO))

Organic phase and solvents

Some common oils used as the organic phase in the pesticide formulations and showed antimicrobial activity are: Neem oil, Thyme essential oil, Castor oil, Linseed oil, ..)

A variety of solvents are used in formulating nanoemulsion systems. The use of solvents can improve the properties of aqueous phase (viscosity, density, interfacial tension). Solvents include conventional organic solvents and green solvents or biosolvent (for example: Bougainvillea plant flowers extract, and N,N-methyl oleate) which are safe for agrochemical industry which leading to low risk for farmer or customers.

Materials - apparatus

Size detector

HPLC or/and GC-MS

Spectrophotometer

High-speed centrifuge

Tensiometer

Methods

Synthesis of formulations

The synthesis will follow the procedures for each specific formulation whether it is Standard formulation or Nano-formulations (Nano-emulsion, microencapsulation).

Characterization

This include a series of standard test needed for evaluating and new pesticide formulation which include the following:

Test of stability

This evaluates the stability of synthesized pesticide during distribution and storage, assistant to handling and application of the product, protection against adverse environmental factors.

Surface tension

Surface tension is a decisive parameter for the quality of a pesticide product. New pesticide need to know how it sink due to their higher density to swim or that achieve good wetting on some and collect into drops on other surfaces. This can be done by using tensiometers.

Size measurement

Spectrometers are used to calculate the particle size.

Thermostability test

It is a standard evaluation for agrochemical products to show stability in different climates. The selected formulations will be stored at different temperatures (room temperature, other higher temperatures)

Shelf life

Shelf life is a period of time during which the product remains suitable for use. Shelf life measurement is conducted to know the storage to ensure that products are fit for the intended purpose. There are International Standards of quality for pesticides. In the test the degradation of pesticides is measured in different tome laps.

Evaluation

In vitro

Antimicrobial and insecticidal activities of formulated pesticides in vitro. In other words, they evaluated on synthetic cultures, normally on agar media.

In vivo

Antimicrobial and insecticidal activities of formulated pesticides in vivo. This to confirm the activity of formulated pesticide on a living pest as a pest on plants.

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