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(RESEARCH ARTICLE)

Impacts of bio synthesized silver-nanoparticles ($AgNO_3$) and plant oils against *Trogoderma granarium*

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Abstract

Nano sciences or nanotechnology are the study of small things at nm scale, it is used across the all science fields, such as chemistry, Biology, physics, material sciences and engineering. Nano sciences is an emerging and vastly developed form that can encompasses the fundamental's elements which can understand and advanced arising form of exploitation of materials, which have one dimension. *Trogoderma Granarium* were collected from grain market, located in Faisalabad and population of insect was acclimatized to the laboratory. After extraction of plant materials (oils from *Datura stramonium* and *Syzygium aromaticum*) biosynthesis of nano-particles was done accordingly to standard procedure. Toxicity bioassays was done by three concentrations (5, 10 and 15 %) of the plant oils (for each of the simple plant oil) and 100, 200 and 300 ppm (for nano-particles) were used. Data regarding mortality was recorded after 24, 48, 72 and 96 hours of the treatment application. In case of plant oil, highest mortality (36.12%) was recorded by *Datura stramonium* at 15% and after exposure period of 96 (hr.) while *Datura stramonium* silver nanoparticle gave 41.40% at 300 ppm. Repellency bioassay was done by area preference method. Silver nanoparticles repellency highest range was 67.89% at 15% concentration of *Datura stramonium* and lowest was 28.31% at same concentration of the *Syzygium aromaticum oils*, used. Hence, plant based insecticides can be helpful for the management of stored commodities insect pests.

Keywords: Insects; Plant oils; Mortality; Repellency; Insecticides.

1. Introduction

Due to the rapid industrialization and urbanization, our environment is threatened by a large amount of vulnerable chemicals, gases released, and so there is a need to learn about the secrets present in the nature and its products that leads to the growth of scientific advancements in the synthesis of nanoparticles. Nanotechnology, a multidisciplinary scientific undertaking, involves the creation and utilization of materials, systems in the nanoscale. The field of nanotechnology is currently expected to create innovations and play a critical role in various fronts. In recent years, scientists in the field of nanotechnology found metal nanoparticles have extensive applications in diverse fields. The physical and chemical properties of metal nanoparticles are mainly determined by its size, shape, composition, crystallinity and structure [1,2].

Nanoparticles of noble metals like gold, silver and platinum are recognized to have significant applications in electronics, magnetic, optoelectronics and information storage. Among them silver nanoparticles being most exploited and has become the focus of much research interest due to their unexpected applications [3-6]. Silver nanoparticles has much significance in the field of nanotechnology because of their unique properties such as chemical stability,

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good conductivity, catalytic activity and most importantly antimicrobial activities which can be incorporated into superconducting materials, electronic components, cosmetic and food industries. It has been shown that silver nanoparticles have effective antimicrobial activity and have been applied to a wide range of health care products, such as burn dressings, medical devices and water purification systems [7,8]. A lot of literature has been reported to till date on biological syntheses of silver nanoparticles using microorganisms including bacteria, responsible for the reduction of metal compounds to their respective nanoparticles. The microbe mediated synthesis of silver nanoparticles is not of industrial feasibility due to the requirements of highly aseptic conditions and their maintenance. Therefore, the use of plant extracts for this purpose is potentially advantageous due to the ease of improvement, the less biohazard as well as providing natural capping agents for the stabilization of silver nanoparticles [9].

Storage of cereals is about to 9 % losses occurred in developed countries and 20% in more developing countries [10], it effects on the qualitative and quantitative loses of grains [11]. Postharvest loses range from 10 to 25% throughout the world due to infestation of insect pests and microbial deterioration [12]. Wheat is the staple food of Pakistan, also cultivated all over the world expect the Antarctica [13]. Globally, Pakistan is the 3rd largest food crop and eight in world-wide wheat producing country [14]. Green synthesis of silver nanoparticles is the subdivision of nanotechnology. Recently, biosynthetic strategies employing either biological microorganisms or fungus or vegetation extract have emerged as an easy and feasible opportunity to greater complex chemical synthetic techniques to attain nanomaterials [15]. Now a day's green synthesis of nanoparticles is one of the most interesting scientific areas of inquiry. The world health organization [16] has facilitated the use of bio pesticides which are less expensive, effective and environmental friendly [17]. The objective of the study is to compare the efficacy of plant oils and green synthesis silver nano particles.

2. Material and methods

2.1. Insects Rearing

Different and diverse age *Trogoderma Granarium* collected through grain market which is situated in Faisalabad. The population for all of the tow insect assimilate to the laboratory and 1.5 kg capacity having commodity in plastic jars (firstly decontaminate the store grain flour for *Trogoderma Granarium*, it can decontaminate for 30 minutes in 70 ℃ through the oven and it shielded through muslin cloths. Both insects' after three days from commodity adults will be sieved out. Target insects can have eggs which can be sieved commodities, will be placed in jars and it can place in an optimal condition (65±5 % R.H. and 30±2 ℃ and it can be homogeneous and also getting the F1 population.

2.2. Collection and preparation of plant oils

Firstly, we can collect the leaves of *Datura stramonium and Syzygium aromaticum* from different localities in Faisalabad, the sample leaves were thoroughly washed with tap water followed by distilled water to remove the impurities. The wet leaves were kept on shade for 25 days and put in air dry. Dried leaves will be converted into powder form through the electrical grinder and it will be sieved through a mesh (40mm) then we acquire a fine powder form. After, 50gm of plants leaves powder material extract were put in the Soxhlet apparatus by dipping or mixing 150ml of the acetone for 24 hours at 220 revolutions per minute.

2.3. Synthesis of nano particles

AgNO3 was get from market and is used as received without further purification. AgNO3 solution of 100ml having 3mM strength was prepared. To this solution, 20ml of oils was added and stirred continuously at ambient conditions. This resulted in color change of the mixture from faint yellow to dark brown solution within minutes which indicates the formation of AgNPs. The suspension of AgNPs is allowed to settle down and the excess liquid was decanted.

2.4. Efficacy of green synthesized silver nanoparticles against *Tribolium castaneum*

The experiment was conducted with 3 treatments and 5 replications for synthesized silver nanoparticles from *Datura stramonium* and *Syzygium aromaticum* to determine lethal concentration of green synthesized nanoparticles solution, serial dilution ranging from 100, 200 and 300 ppm were prepared. The required amount of adult was directly collected from field and put into the clean, air dried petri plates, Wheat grains were coated with different concentrations of silver nanoparticles solution and air dried. The control grains were treated with water alone. After every 24 hrs, 48 hrs, 72 hrs and 96 hrs data of mortality was recoded.

2.5. Repellency bioassays

Repellency bioassays of plant extracts against test insect (*Trogoderma Granarium*) was carried out by area preference method. Different concentrations of plant oils (ethanol acetone based) viz., 5%, 10% and 15% of were sprayed on one half of each filter paper. Whilst other half of each filter paper, were used as control unit (treated only with solvent alone (acetone)). Both the untreated and treated halves were stapled from center and were placed in Petri-dishes. 20 adult beetles were released at the joining point of both halves of each filter paper. Three replications of individually treatment and control unit were used and number of bio assayed on the both areas (two half paper disks) were counted after 12 and 24 hours of the post treatment.

2.6. Data analysis

The collected data were analyzed by using Statistica software 8.1. Treatments means were compared by using Tukey-HSD test at α = 5%.

3. Results

Table 1 Percent mortality (Mean) of *Trogoderma Granarium* adults treated with plant oils under store conditions

Treatments	Conc. (%)	No. of released larvae	Mean % mortality			
			24h	48h	72h	96h
Datura stramonium	control	20	0	2	2	4
	5	20	8.51	8.89	9.07	9.50
	10	20	8.72	8.99	9.38	14.54
	15	**20**	**22**	**25.62**	**34.05**	**36.12**
Syzygium aromaticum	control	20	2	4	4	6
	5	20	6.59	8.98	11.90	18.89
	10	20	16.27	18.99	21.80	22.20
	15	**20**	**19.09**	**20.56**	**25.87**	**29.50**

Table 1 Both the plant oils show great effect on mortality of red flour beetle (*Datura stramonium* and *Syzygium aromaticum)* but it is shown that highest mortality was recorded by *Datura stramonium* plant oil after 96 hrs. that is 36.12%.

Table 2 Percent mortality (Mean) of Trogoderma Granarium adults treated with green synthesized silver nanoparticles under store conditions

Treatments	Conc. (ppm)	No. of released Larvae	Mean % mortality			
			24h	48h	72h	96h
Datura stramonium AgNPs	Control	20	**0**	2	0	2
	100	20	18.87	19.0	22.12	25.76
	200	20	27.8	28.7	31.77	32.45
	300	**20**	**32.12**	**33.9**	**36.61**	**41.40**
Syzygium aromaticum AgNPs	Control	20	0	0	2	2
	100	20	18.11	20.2	22.43	23.04
	200	20	29.92	31.98	32.06	32.98
	300	**20**	**26.12**	**28.3**	**34.76**	**38.81**

Table 2 Both the green synthesized silver nanoparticles shows effect on mortality of red flour beetle (*Datura stramonium* AgNPs and *Syzygium aromaticum* AgNPs*)* but it is shown that highest mortality was recorded by *Datura stramonium* AgNPs after 96 hrs. that is 41.40%.

3.1. Data for repellency

Table 3 Comparison of the mean percentage repellency of Trogoderma Granarium after exposure to various concentration of plant oil Datura stramonium after 24 hrs.

Concentration (%)	% Repellency ± SE
5%	41.60 ± 2.98 c
10%	51.21 ± 2.49 b
15%	54.36 ± 2.33a

The outcome of the repellency bioassays in table 3 revealed that repellency was found increased with increase in concentration for all extract of plants. Maximum repellency 54.36% was recorded at 15% concentration while minimum 41.60% was recorded at 5% concentration.

Table 4 Comparison of the mean percentage repellency of *Trogoderma Granarium* after exposure to various concentration of plant oil *Syzygium aromaticum* after 24 hrs.

Concentration (%)	% Repellency ± SE
5%	28.60 ± 2.98 c
10%	32.21 ± 2.49 b
15%	36.36 ± 2.33a

The outcome of the repellency bioassays in table 4 revealed that repellency was found increased with increase in concentration for all extract of plants. Maximum repellency 36.36% was recorded at 15% concentration while minimum 28.60% was recorded at 5% concentration.

Table 5 Comparison of the mean percentage repellency of *Trogoderma Granarium after exposure to various concentration of Datura stramonium AgNPs after 24 hrs.*

Concentration (ppm)	% Repellency ± SE
100	49.60 ± 2.98 c
200	56.21 ± 2.49 b
300	67.89 ± 2.33a

The outcome of the repellency bioassays in table 5 revealed that repellency was found increased with increase in concentration for all extract of plants. Maximum repellency 67.89ppm was recorded at 300ppm concentration while minimum 49.60% was recorded at 5ppm concentration.

Table 6 Comparison of the mean percentage repellency of *Trogoderma Granarium* after exposure to various concentration of *Syzygium aromaticum* AgNPs after 24 hrs.

Concentration (ppm)	% Repellency ± SE
100	36.60 ± 2.98 c
200	42.21 ± 2 .49 b
300	48.31 ± 2.33a

4. Conclusion

We used two plant oils *(Datura stramonium* and *Syzygium aromaticum*) against stored grain insect pest red flour beetle and also use green synthesized nanoparticles from these plants. All the treatments show good results but the effect of *Datura stramonium* AgNPs was more than the *Syzygium aromaticum* AgNPs and also as compared to plant oils of these two plants. Hence the green synthesized nanoparticles of *Datura stramonium* AgNPs is more reliable to control the *Trogoderma Granarium* then the *Syzygium aromaticum* AgNPs. Repellency bioassay was done by area preference method. Silver nanoparticles repellency highest range was 67.89% at 300ppm concentration of *Datura stramonium* and lowest was 48.31% at same concentration of the *Syzygium aromaticum oils*, used. Hence, plant based insecticides can be helpful for the management of stored commodities insect pests.

Compliance with ethical standards

Disclosure of conflict of interest

No observed conflict of interest among the authors.

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