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Repellency Action on Silverfish (*Lepisma Saccharina*) Of Some Essential Oils Like *Azardiracta Indica* And *Mentha*

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Abstract

The silverfish is a prime museum pest to over all museum specimens such as herbarium, animal specimen, book, bookbinding etc. Without effective intervention to counteract proliferation, specimen may be deteriorated, entire museum depleted and/or other specimen in close proximity affected. Essential oils are a promising means for control of silverfish population, which act as a fumigant and topical toxicity as well as antifeedant or repellent, and inhibit reproduction. Therefore, essential oils are designated as a reduced-risk pesticide under Health Indian Guidelines. This research tested the various concentrations (0.3, 0.6 and 0.9) at 1 and 2 hour effects of *M. piperita* and *A. indica* essential oil on the adult silverfish. The research shows that the repellency percentage significantly increased with increasing the oil concentration as well as treatment duration. The highest repellency was observed in higher concentration and treatment duration to both oils. *A. indica* was found more effective showing maximum repellency as compared to *M. piperita* for both treated and control area. On the basis of McDonald et al. (1970), they belong to the repulsive class I, I, II at 1-hours and I,III, IV at 2-hours in *A. indica* and 0, 0, I at 1-hours and I,I, III at 2-hours in *M. piperita* respectively. The repellency class increased with increasing the oil concentration and treatment duration, and highest repellency class IV and III was recorded 0.9ml oil concentration at 2-hours in *A. indica* and *M. piperita* respectively.

Keywords: Silverfish, Repellency, Repellency percentage, Repellency class, Essential oils

Introduction

India is a tropical country, here temperature, humidity, light, atmospheric pollution and biological agents plays a vital role in the destruction and deterioration of archival materials like herbarium, paper, cellulose, bookbinding etc. (Sabev *et al.*, 2006, Pangallo *et al.*, 2013). These

entire factors play a very important role in biodeterioration, in which insects are most common (Qin *et al*., 2010, Nasrin *et al.,* 2021). The commonly found insects pest in museum which causes deterioration to collections of herberium are Silverfish (*Lepisma saccharina*), German Cockroaches (*Blattela germanica),* Termites (*Reticulitermes flavipes)*, booklice (*Liposcelisbo strychophilus)*, Tobacco beetle (*Lasioderma serricorne)* and Carpet beetle (*Anthrenus verbasci)* (Pinniger,1994., Narsin, *et al.,* 2021a&b). Among them Silverfish is one of the most common insect pests responsible for the deterioration of Archival materials (Alam, 1989). They are small, wingless, nocturnal and about 13-25mm long insect. These are commonly found in India, Australia, Southern Africa, North America, Asia and Europe etc.

The herbarium specimens are a stock of safeguarded plant specimen affixed on paper which is useful for scientific and research studies (Thiers, 2016). These collections are the source of information about plants and their distribution and scientists are using to herbarium collection for many purposes like taxonomic and floristic (Greve *et al.,* 2016). Herbaria provide convenient sampling sweeps across geographically separated collection to identify species which may be useful as bioindicator (Brooks *et al*., 1977), historical records of species occurrence prior to habitat fragmentation (Suarez and Tsutsui, 2004). The herbarium is helpful in locating rare and possibly extinct species via recollecting areas listed on label data (Funk, 2004). These herbarium collections are organic in nature that's why the risk of biodeterioration in herbaria has been a great cause of concern all over the world.

The herbarium collections are rich source of natural heritage, preserved in Natural history museums and herbaria. The maintenance and protection of this herbarium have been practiced from a very long period of time. But after a long period of time the curators adopted chemical control method. These methods were not safe because of their toxicity and potential explosion of hazards to the curators as well as general public, that' why banned by the government. The scientist used to alternative resources such as herbal pesticides and natural products with biocidal activity for the control of biodeterioration. It is an innovative attempt for the control of biodeterioration and biodegradation and is ecofriendly.

In this paper the author used two essential oils Neem (*Azardiracta indica)* and pippermint (*Mentha piperita)* to determine the repellent activity against Silverfish (*Lepisma saccharina).* The repellent may be defined as an agent that drives away or irritation by insect pests.

Traditionally, clove oils are used in dental care, as an antiseptic and analgesic, and may be rubbed on the gums to treat toothache. Different studies found that clove oil is an anti bacterial (Friedman *et al.*, 2002) antifungal (Chami *et al.*, 2005), anticarcinogenic (Zhen *et al*., 1992) and antimutagenic activity (Miyazawa and Hisama, 2001). The primary component of clove oil is Euginol that shows antioxidant (Ogata *et al.*, 2000) and insecticidal (Park *et al.*, 2000) properties. The other essential oil is *A. indica* commonly known as Neem. Its oil is known a long time ago for insecticidal properties, oviposition deterrence, repellence, antifeedance and growth regulator activity (Schmutterer, 1990, 1995, Lale and Mustabha, 2000, Ahmad *et al.*, 2001, Isman, 2006). The most important bioactive compound in Neem against insect pests is Azadirachtin and has acquired the utmost attention few years back (Parakash and Srivastava, 2008).

Materials and Method

Stock culture

The insects were obtained from the storeroom and basement of Maulana Azad library, Aligarh Muslim University, Aligarh, U.P. India (27.88°N 78.08°E). The insects were reared in a plastic container and provide abundant amount of cellulose containing mixed food in a 1:1 ratio. In each container, only10 adult Silverfish was reared and food replenished daily. All above setup were placed at room temperature and 90% relative humidity in a dark place. Silverfish colony had been established at least 6 to 12 months before the study. All the experiments were carried out in the laboratory of Museology, department of Museology, AMU., Aligarh.

Experimental setup

Bioassay for repellency test

The repellent effect of the botanicals against the adult silverfish was evaluated using the method of the preferred area in the dry preservation insect box described by McDonald et al. in 1970. The three insect boxes (25.5cm×14.5cm×7.5cm) were used to detain insects during the experiment. The oils concentrations were prepared in distilled water as per required concentration of solution (v/v). The *M. piperita* and *A. indica* oils dosages of 0.3, 0.6, and 0.9 ml were taken, respectively and 25.5×14.5cm^2 blotting sheets were used for this experiment. The 0.3ml concentration of *M. piperita* solution were applied on the half area (called as treated area) of each blotting paper and half area remain as same (called as control area), then they are allowed to dry for 30 minutes in each cases of oils. After treated blotting papers were place in the

repellent boxes. The 10 adults of silverfish were released at the center of each blotting sheets in each boxes. These set up were placed in a laboratory room maintained at 25±2°C and 60 ± 5 % RH. The number of insect repellent, repellency percentage (RP%) and repellency classes (RC) was recorded after 1 and 2-hours respectively.

The following formula for the calculation of percentage repellency (PR) was used as described by Asawalam et al. (2006).

$$PR\% = \frac{(Nt - Nc)}{(Nc + Nt)} \times 100$$

Where Nc = Number of insects on the control (untreated) area and

Nt = Number of insects on the treated area.

The same experiment was repeated in 0.6ml and 0.9ml oils concentration of *M. piperita*. All the above sets up were also treated with *A. indica* oils at all oil concentration. The whole experiments were repeated up to 3 times.

Results

The result regarding repellency percentage of adult silverfish against *M. piperita* and *A. indica* revealed that the repellency percentage of adult silverfish was oil concentration and treatment duration dependent *i.e.*, increase in concentration and treatment duration resulted in significantly increased repellency percentage (Figure-1and Figure-2). *A. indica* was found more effective showing maximum repellency (83.3%) at 0.9ml (highest) concentration, while in case of *M. piperita* highest repellency observed was 66.7% at 0.9 ml concentration in treated area (Figure-1). Similarly in case of control area most effective essential oil was *A. indica* (Figure-2) showing highest repellency (73.3%) in 0.9 ml concentration at 2-hours, followed by *M. piperita* (66.7%). The repellency of adult silverfish was significantly influenced by *A. indica* oil concentration ($F=60.50$; $P<0.0001$; df=3,159) as well as treatment duration ($F=42.10$: $P<0.0001$: df=3,159) and interaction between two independent factors was also significant ($F=4.30$; $P<0.0001$; df=9,159). While in case of *M. piperita* oil, repellency of Adult Silverfish was significantly influenced by both oil concentration ($F=15.12$; $P<0.0001$; df=3,159) as well as duration of treatment ($F=8.22$; $P<0.000$; df=3,159). The overall interaction between the two independent factors were insignificant ($F=1.2$; $P=0.507$; df=9,159) (Table-1). On the basis of McDonald et al. (1970), they belong to the repulsive class V with an average of repellency 100%. Whereas in case of *A. indica* oil, the repellency classes (RC) were I, I and II at 1-hours

and I, III and IV on the basis of repellency rate (RP%), which was 6.6%, 13.4%, and 36.7% at 1-hours and 13.4%, 53.4% and 66.6% at 2-hours, respectively. While in case of *M. piperita*, the repellency classes 0, 0 and II at 1-hours and I,I and III at 2-hours on the basis of repellency rate was -6.6%, 0%, and 33.4% at 1 hours and 6.6%, 20.0% and 46.6% at 2-hours respectively (Table-2). The repellency class influenced the nature of oil, oil concentration as well as treatment duration, *i.e.*, repellency class increased with increasing the oil concentration and treatment duration. The highest repellency class (IV) was recorded in *A. indica* as compared to *M. piperita* oils.

Discussion

The result revealed that the repellency effectiveness of plant essential oils against museum insect pests. Data depicted considerable repellency activities of two indigenous essential oils against one of the most important economic loss causing museum insect pests to possess potential as well as alternative substitutes to currently use. The essential oils assessed in this study exhibited significant for treatment duration and concentration dependent repellency against adults silverfish, however *A. indica* was found more effective against higher concentration at 2-hours treatment duration. According to the results, it seems that Neem oil has the greatest repellent effect on adult silverfish and the repellency increases with increasing the oil concentration. My result was sported by Ogbuewu, et al. (2011), studied that the Azadirachtin derived from the neem tree, is one of the most potent natural repellents against many medical and agricultural pests. The repellency of neem oil has also been tested against various anopheline and culicine mosquito species, (Mishra, *et al.*, 1995, Ravindran, *et al.*, 2002, Ogbuewu, *et al.*, 2011, Maheswaran and Ignacimuthu, 2015). Although neem is a well-known botanical repellent against mosquitoes, sand flies, and biting midges (Kumar, et al., 2011). The *A. indica* used as a potential insecticide for the field evaluation and grain protectant (Rahim, 1998, Lale and Mustapha, 2000, Khan and Marwat, 2003). Similar trend was also observed by Manzoor et al. (2011) who studied the toxic effects of *Melia Azedarach, Mentha longifolia, Myrtus communis, Cymbopogon citratus* and *Datura stramonium* against insect pest.

The insecticidal activities of peppermint and neem oils are reported against Silverfish population (Nasrin, *et al.*, 2021) and the ethanol extracts from the leaves of *M. longifolia* have maximum 70% mortality after six days treated (Saljoqi, *et al.*, 2006). Few essential oil was also

highly potentially inhibitor for oviposition in stored grain insects (Tripathi, *et al.*, 2000, Jayasekhara, *et al.*, 2005) and show good insecticidal and repellent activity against crop field and house hold pest (Calmasur *et al.*, 2006, Jovanovic *et al.*, 2007, Upadhyay *et al.*, 2007, Magdy and Samir, 2008). The volatile oil of *Chenopodium ambrosoides* and *Thymus vulgaris* have shown the reducing the activity of larvae of ile *Lucilia sericala* (Morsy, *et al.*, 1998).

The peppermint essential oil is proved to be efficient larvicide and repellent against dengue vector and Human being were protected to the adult bites for at least 150 min (Kumar, *et al.*, 2011). The peppermint oil was found to be the most effective ovipositing deterring and suppressing egg hatch agents against female mosquitoes under laboratory conditions. No mosquito larvae hatched at concentrations of peppermint oil as low as 1% (Warikoo, *et al.*, 2011). The repellent action of peppermint oil was comparable to the commercially available repellent known as mylol oil, which is a mixture of dimethyl and dibutyl phthalates (Ansari, *et al.*, 2000).

Essential oils based insecticides are nontoxic and specific in there action so there is possibility of replacing synthetic pesticide with essential oil. In recent studies we found *M. piperita* and *A. indica* ether are strong repellent against museum and library insect pest silverfish. This study shows that both essential oil can play an important role as potential bio pesticide. Peppermint and neem can be used directly and effectively in pest management of library and museums without any adverse effect on human health. It is nontoxic, environment friendly and used from long time traditionally as medicine spices and coloring agent, originated from local natural resources economical and easily available target specific and biodegradable so the sustainable healthy environment can be kept.

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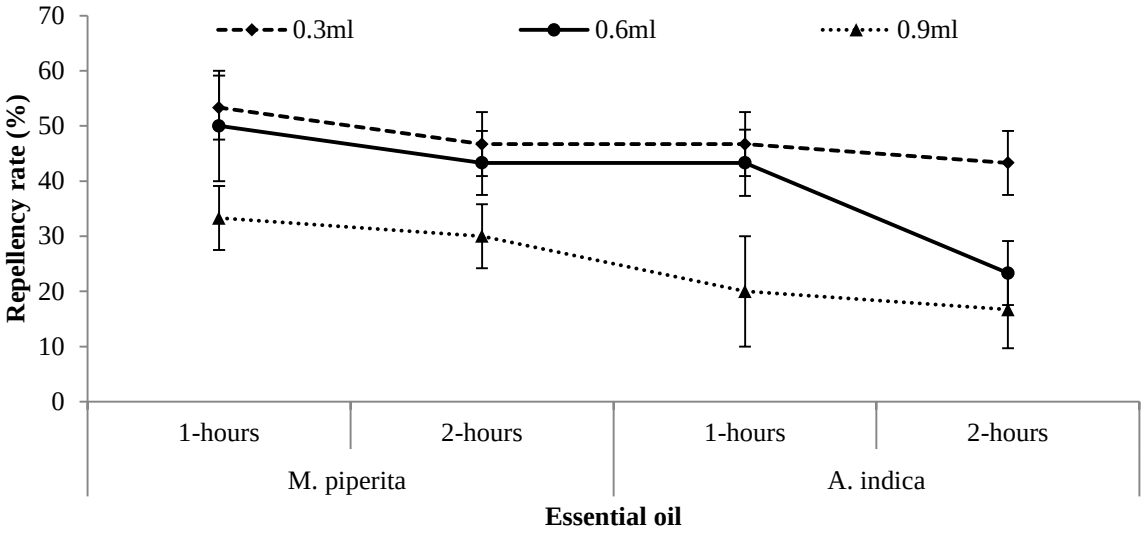

Figure-1: Effect of various concentrations (0.3, 0.6 and 0.9ml/cm^3) of *Mentha piperita* and *Azadirachta indica* oil at 1 and 2-hours treatment duration in control area on repellency rate of adult silverfish.

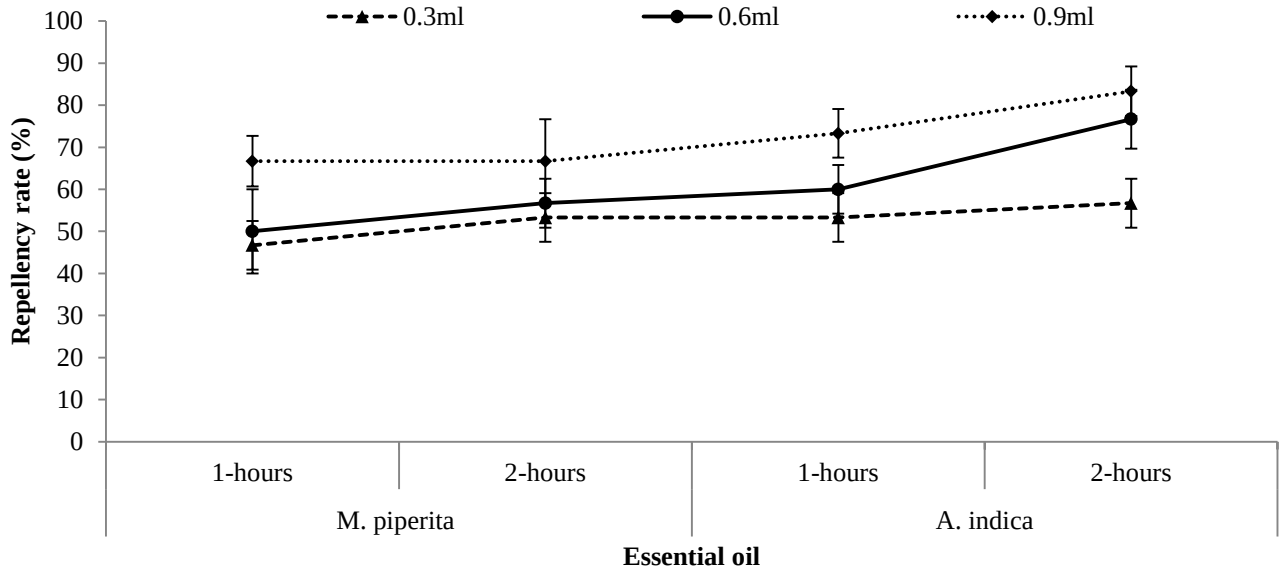

Figure-1: Figure-1: Effect of various concentrations (0.3, 0.6 and 0.9ml/cm^3) of *Mentha piperita* and *Azadirachta indica* oil at 1 and 2-hours treatment duration in treated area on repellency rate of adult silverfish.

Table-1: Repellent effect of *Mentha piperita* and *Azadirachta indica* essential oil against adult silverfish at 1 and 2 hours of treatment duration.

Treatment duration (Hours)	Oil Concentration (ml)	Repellency of *Mentha piperita*		Repellency of *Azadirachta indica*	
		Adults on control area (Nc)	Adults on treated area (Nt)	Adults on control area (Nc)	Adults on treated area (Nt)
1	0.3	5.33±0.58	4.67±0.58	4.67±0.58	5.33±0.58
	0.6	5.00±1.00	5.00±1.00	4.00±1.00	6.00±1.00
	0.9	3.33±0.58	6.67±0.58	2.67±0.58	7.33±0.58
2	0.3	4.67±1.15	5.33±1.15	4.33±0.58	5.67±0.58
	0.6	4.33±5.67	5.67±0.58	2.33±0.58	7.67±0.58
	0.9	3.00±1.00	6.67±1.00	1.67±0.58	8.33±0.58

Values are Mean± S.E.

Table-2: Repellency rate (RP%) and Repellency class (RC) of *Mentha piperita* and *Azadirachta indica* essential oils against adult silverfish after 1 and 2-hours treatment duration.

Essential oils	Concentration (ml/cm3)	Repellency rate (RP) % RP (%)= (Nt - Nc ÷Nc + Nt)×100		Repellency Class (RC)	
		1-hours	2-hours	1-hours	2-hours
M. piperita	0.3	-6.6	6.6	0	I
	0.6	0.00	20.0	0	I
	0.9	33.4	46.6	II	III
A. indica	0.3	6.6	13.4	I	I
	0.6	13.4	53.4	I	III
	0.9	36.7	66.6	II	IV

References

Ahmed, K.S., Yasui, Y. and Ichikawa, T. 2001. Effect of neem oil on mating and oviposition behavior of azuki bean weevil, *Callosobruchus chinensis* L. (Coleoptera: Bruchidae). *Pak. J. Biol. Sci.* 4(11):1371-1373.

Alam, I. 1989. Bionomics and control of *Lepisma saccharina* (Thysanura). *Nat. Resea. Labor. Conser. Cult. Property (NRLC) Pub., Lucknow*.

Ansari, M.A., Vasudevan, P., Tandon, M. and Razdan, R.K. 2000. Larvicidal andmosquito repellent action of peppermint (*Mentha piperita*) oil. *Bioresour. Technol.* 71: 267-271.

Brook, R.R., Lee, J., Reeves, R.D. and Jaffre, T. 1977. Detection of nickeliferous rocks by analysis of herbarium specimens of indicator plants. *J. Geoch. Explor.* 7: 49-57.

Calmasur, O., Kordali, S., Kaya, O. and Aslan, I. 2006. Toxicity of essential oil vapours obtained from Achillea spp. to *Sitophilus granarius* (L.) and *Tribolium confusum*. *J. Plan Disea. Prote.* 113(1): 37-41.

Chami, F., Chami, N., Bennis, S., Bouchikhi, T. and Remmal, A. 2005. Oregano and clove essential oils induce surface alteration of *Saccharomyces cerevisiae*. *Phytother. Res*. 19: 405-408

Friedman, M., Henika, P.R. and Mandrell, R.E. 2002. Bactericidal activities of plant essential oils and some of their isolated constituents against *Campylobacter jejuni*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella enterica*. *J. Food. Prot.* 65: 1545-1560

Funk, V.A. 2004. 100 uses for a herbarium (well at least 72). *Ameri. Soci. Plant Taxon.* 17: 17-19.

Greve, M., Lykke, A.M., Fagg, C.W., Gereau, R.E., Lewis, G.P., Marchant, R., Marshall, A.R. Ndayishimiye, J., Bogaert, J. and Svenning, J.C. 2016. Realising the potential of herbarium records for conservation biology. *South Afri. J.Bot*. 105: 317-323.

Hueck Van Der Plas, H.E. 1968. The microbiological deterioration of porous building materials. *Internat. Biodeterio. Bullet*. 4 (1): 11-28.

Hueck, H.J. 1965. The biodeterioration of materials as a part of hylobiology. *Material Organismen*. 1: 5-34.

Isman, M.B. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Ann. Rev. Entomol*. 51: 45-66.

Jovanovic, Z., Kosti, M. and Popovic, Z. 2007. Grain-protective properties of herbal extract against the bean weevil *Acanthoscelides obtectus* Say. *Indust. Crops. Produc*. 26: 100-104.

Khan, S.M. and Marwat, A.A. 2003. Deterrent/Repellent effect of different plant parts of Neem and Kanair against Lesser Grain Borer "*Rhyzopertha dominica* F". *J. Pak. Entomol*. 25 (2): 131-136.

Kingsolver, R. 1981. Illustrated guide to common pests of museums. In Pest Control in Museums: A Status Report. *University of Kansas Pub*. Pp. 1-20.

Kumar, A.N., Murugan, K., Madhiyazhagan, P. and Prabhu, K. 2011. Spinosad and neem seed kernel extract as bio-controlling agents for malaria vector, *Anopheles stephensi* and non-biting midge, *Chironomus circumdatus*. *Asian Pac. J. Trop. Med.* 4(8): 614-618.

Lale, N.E.S. and Mustapha, A. 2000.Potential of combining neem (*Azadirachta indica* A. Juss) seed oil with varietal resistance for the management of the cowpea bruchid, *Callosobruchus maculatus* (f.). *J. Stor. Prod. Resea*. 36(3): 215-222.

Magdy, I.E.M. and Samir, A.M.A. 2008. Chemical composition and insecticidal potential of essential oils from Egyptian plants against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) and *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *Appl. Entomol. Zool*. 43(4): 599-607.

Maheswaran, R. and Ignacimuthu, S. 2015. A novel biopesticide PONNEEM to control human vector mosquitoes *Anopheles stephensi* L. and *Culex quinquefasciatus* Say. *Environ. Sci. Pollut. Es. Int.* 22(17): 13153-13166.

Manzoor, F., Nasim, G., Saif, S. and Malik, S.A. 2011. Effect of ethanolic plant extracts on three storage grain pests of economic importance. *Pak. J. Bot.* 43(6): 2941-2946.

McDonald, L.L., Guy, R.H. and Speirs, R.D. 1970. Preliminary evaluation of new candidate materials as toxicants, repellents, and attractants against stored product insects: *US Agricultural Research Service*

Mishra, A.K., Singh, N. and Sharma, V.P. 1995. Use of neem oil as a mosquito repellent in tribal villages of Mandla District, Madhya Pradesh. *Indian J. Malariol.* 32: 99-103.

Miyazawa, M and Hisama, M. 2001. Suppression of chemical mutagen-induced SOS response by alkylphenols from clove (*Syzygium aromaticum*) in the *Salmonella typhimurium* TA1535/pSK1002 umu test. J. Agric. Food. Chem. 49:4019-4025.

Morsy, T.A., Shoukry, A., Mazyad, S.A. and Makled, K.M. 1998.The effect of volatile oils of Chenopodium ambrosioides and Thymus vulgaris against the larvae of *Lucilia sericata* (Meigen).*J. Egypt. Parasitol.* 28(2): 503-510.

Nasrin, S., Shahid, M. and Abduraheem, K. 2021a. Insecticidal activity of peppermint and Nutmeg essential oil against museum pest Silverfish. *J. Emer. Techno. Innov. Resear.* 8(8): 605-616.

Nasrin, S., Shahid, M. and Abduraheem, K. 2021b. Insecticidal activities of some essential oils against American cockroach *Periplaneta americana* (L.). *Intern. J.Advan. Resear. Biolog. Sci.* 8(7): 164-170.

Ogata, M., Hoshi, M., Urano, S. and Endo, T. 2000. Antioxidant activity of eugenol and related monomeric and dimeric compounds. *Chem. Pharmac. Bulletin*. 48: 1467-1469.

Ogbuewu, I.P., Odoemenam, V.U., Obikaonu, H.O., Opara, M.N., Emenalom, O.O., Uchegbu, M.C., Uchegbu, I.C., OKoli, B.O., Esonu. And Iloeje, M.U. 2011. The growing importance of neem (*Azadirachta indica* A. Juss) in agriculture, industry, medicine and environment: a review. *Res. J. Med. Plant.* 5: 230-45.

Pangallo, D., Krakova, L., Chovanova, K., Buckova, M., Puskarova, A. and Simonovicova, A. 2013. Disclosing a crypt: microbial diversity and degradation activity of the microflora isolated from funeral clothes of Cardinal Peter Pazmany. *Mirobiol. Res.* 168: 289-299.

Parakash, G. and Srivastava, A.K. 2008. Statistical elicitor optimization studies for the enhancement Azadirachtin production in bioreactor *Azadirachta indica* cell cultivation. *Biche. Engine. J.* 40(2): 218-226.

Park, I.K., Lee, H.S., Lee, S.G., Park, J.D. and Ahn, Y.J. 2000. Insecticidal and fumigant activities of Cinnamomum cassia bark-derived materials against *Mechoris ursulus* (Coleoptera: Attelabidae). *J. Agri. Food chem.* 48: 2528-2531.

Pinniger, D. 1994. Insect Pests in Museums, Archetype, London.

Qin, W., Huang, S., Li, C., Chen, S. and Peng, Z. 2010. Biological activity of the essential oil from the leaves of *Piper sarmentosum* Roxb. (Piperaceae) and its chemical constituents on *Brontispa longissima* (Gestro)(Coleoptera: Hispidae). *Pestic. Biochem. aPhysio.* 96(3):132-9.

Rahim, M., 1998. Biological activity of some plant derivatives that protect grain against the pulse beetle, *Callosobruchus maculatus*. *J. Insect Sci.* 6(3):1-10.

Ravindran, J., Eapen, A. and Kar, I. 2002. Evaluation of repellent action of neem oil against the filarial vector, *Culex quinquefasciatus* (Diptera: Culicidae). *Indian J. Malariol.* 39: 13-7.

Sabev, H., Barratt, S.R., Handley, P.S., Greenhalgh, M. and Robson, G. 2006. Biodegradation and biodeterioration of manmade polymeric materials. In: Gadd GM (ed) Fungi in biogeochemical cycles. *Cambridge University Press, Cambridge.*

SaIjoqi, A.U.R., Afridi, M.K., Khan, S.A. and Rehman, S. 2006. Effects of six plant extracts on rice weevil *Sitophilus oryzae* L. in the stored wheat grains. *J. Agri. Biolog. Sci*. 1(4):1-5.

Schmutterer, H. 1990. Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. *Ann. Rev. Entomol.*

Schmutterer, H., 1995. The neem Tree, Source of Unique Natural Products for Integrated Pest Management, Medicine, Industry and Other Purposes. *VCH Publishers Inc. New York*.

Suarez, A.V. andTsutsui, N.D. 2004. The value of museum collections for research and society. *Bio. Sci.* 54: 66-74.

Thiers, B. 2016. Index Herbariorum: A global directory of public herbaria and associated staff, New York Botanical Garden's Virtual Herbarium, http://sweetgum.nybg.org/science/ih/ (Accessioned on Accessioned on 24th July, 2016).

Tripathi, AK., Prajapati, V., Aggrawal, K.K., Khanuja, S.P.S. and Kumar, S. 2000. Repellency and toxicity of oil from *Artemisia annua* to certain stored product beetles. *J. Econ. Ent.* 93: 43-47.

Upadhyay, R.K., Jaiswal, G. and Yadav, N. 2007. Toxicity, repellency and oviposition inhibitory activity of some essential oils against *Callosobruchus chinensis*. *J. Appl. Biosci.* 33: 21-26.

Warikoo., Radhika., Wahab, N. and Kumar, S. 2011. "Oviposition-Altering and Ovicidal Potentials of Five Essential Oils against Female Adults of the Dengue Vector, *Aedes aegypti* L." *Parasit. Resea.* 109 (4): 1125-1131.

Zheng, G.Q., Kenney, P.M. and Lam, L.K. 1992. Sesquiterpenes from clove (Eugenia caryophyllata) as potential anticarcinogenic agents. *J. natural prod.* 55(7): 999-1003.