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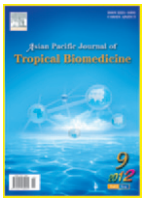

Document heading

Effect of germicidal UV-C light(254 nm) on eggs and adult of house dustmites, *Dermatophagoides pteronyssinus* and *Dermatophagoides* farinae (Astigmata: Pyroglyhidae)

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ABSTRACT

Objective: To examined the immediate and 24 hours post- irradiation germicidal effects of UV-C lamp on eggs and adults of house dust mites *Dermatophagoides pteronyssinus (D. pteronyssinus)* and *Dermatophagoides farinae (D. farinae)*. **Methods:** This study investigated the immediate and 24 hours post irradiation mortalities of adult mites exposed to UV-C at different exposure times (5 mins, 10 mins, 15 mins, 20 mins, 30 mins and 60 mins) and distances (10 cm, 25 cm, 35 cm, 45 cm and 55 cm). Fresh eggs of the 2 dust mites were also irradiated at 10, 35 and 55 cm for 0.5, 1, 2, 3, and 5 minutes, and observed daily post- irradiation for up to 7 days. **Results:** Highest immediate mortality of 100% occurred with direct irradiation at 10 cm distance from UV-C lamp and for 60 mins, for both species of mites. The post 24 hours mean mortality rates were (58.4±17.4)% for D. pteronyssinus and (27.7±9.7)% for *D. farinae* when irradiated for 1 hour at 55 cm distance under UV-C lamp. When mites were irradiated in the presence of culture media, the highest mortality rates were lower compared to the direct irradiation; at 10 cm distance and 60 mins exposure, the mean mortality was (74.0±6.8)% for *D. pteronyssinus* and (70.3±6.7)% for *D. farinae*. Egg hatchability for both species of mites was also notably reduced by greater than 50% following irradiation. **Conclusions:** Ultraviolet C irradiation is lethal to an array of organisms by damaging their nucleic acids (DNA and RNA). This study demonstrates the increasing mite mortalities with increasing exposure times and decreasing distances.

1. Introduction

House dust mites (HDM) are found in most homes. They are microscopic, eight-legged creatures closely associated with us, but they are not parasitic and do not bite. The concern about HDM is that some species produce allergens affecting humans. The HDM allergens cause allergic symptoms such as asthma and atopic dermatitis in atopic humans. A number of the allergen producing HDM belongs to the family Pyroglyphidae. Pyroglyphid mites usually account for >90% of the mite population in houses[1]. Dermatophagoides farinae and Dermatophagoides pteronyssinus are considered among the most important pyroglyphid mites because of their cosmopolitan occurrence and abundance in homes[2].

There are various approaches for the control of house dust mite and their allergen such as by reducing indoor relative humidity to below 50%, coupled with regular cleaning and use of encasement on mattress and pillows[3]. Several chemicals have been examined in laboratories but their effectiveness in the home is controversial or even if effective, they have not been commercialized for home use because have potential problems of toxicity to non targets such as humans and pets, produce unpleasant odor, damage household items, and unable to penetrate deeply into carpet and upholstery[4]. Physical strategies like irradiation has become an established technique for controlling aeroallergens because of residue free advantages over chemicals[5]. UV irradiation is widely used as a germicide and as an attractant for insects[6], in embryological physiological studies and for the surface disinfection of insect eggs[7]. Wharton[8] reported that UV irradiation (254 nm) killed nymphs of the American cockroach, Periplaneta americana. A number of other investigators also have considered the possibility of using UV rays to control, or at least to suppress development of various aeroallergens and insects[5,9]. Ultraviolet light is known to damage or kill living organisms because it will destroy the DNA by forming covalent

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bonds between certain adjacent bases in the DNA, thereby preventing further replication and growth.

Ultraviolet C (UV-C) is a short wavelength (100-280 nm) radiation and is primarily used for the disinfection of air, surfaces and liquids from microbial contaminants[10]. To date the UV-C is the wavelength in germicidal applications and is also recommended by the Centre for Disease Control and Prevention. Ultraviolet light air purification has been used for years by the medical field to sanitize rooms and equipment in order to prevent the spread of illness and disease. High intensity UV light modifies proteins as well, so it is possible that UV light might render an allergen non-allergenic. The efficacy of UV-C had been previously demonstrated against some stored product beetle and mite pests[11-14] with sensitivity varying with species and doses. It is, however, difficult to make direct comparisons between studies as the level of UV dose achieved is not always stated and UV intensities vary with light sources. Long lists of bacteria, viruses and moulds also are often quoted to assert the killing power of UV-C. The implication that goes with those long lists is often made that UV-C will be just as effective on HDM.

The aim of this study is to investigate the mortalities induced by UV-C irradiation on eggs and adults of 2 species of HDM, *Dermatophagoides pteronyssinus* (*D. pteronyssinus*) and *Dermatophagoides farinae* (*D. farinae*).

2. Materials and methods

2.1. Sources of mites

Adult males and females *D. pteronyssinus* and *D. farinae*, and their eggs, were obtained from colonies established since 1960 in the Acarology Unit, Institute for Medical Research (IMR), Malaysia. The colonies are reared in small glass bottles and sterile ground rat chow mixed with fish flake is used as culture medium. All bottles are kept in desiccators at (75±3) % relative humidity (RH) and at an average room temperature of (25±2) ℃.

2.2. UV-C radiation source

The radiation source was a 30 watts UV germicidal lamp (G30T8, Sankyo Denki, Japan) measuring 88 cm x 2.5 cm, and emitting radiation at a wavelength of 254 nm. The lamp was fixed to the ceiling of a Laminar Flow cabinet (120 cm x 63 cm x 50 cm) that served as a test chamber; another similar cabinet without the lamp was used for controls. Bioassays were conducted at a room temperature of (25±2) ℃.

2.3. Bioassay with adult mites for direct exposure

Sets of 30, 15 - 25 days old adult mites of mixed male and female were placed in Petri dishes of 14 cm diameter and 1.5 cm high. The dishes and mites were next placed inside the UV-C chamber and irradiated for different times (5, 10, 15, 20, 30 and 60 mins) and at different distances (10, 25, 35, 45 and 55 cm) from the UV lamp. Controls were similarly treated in the control chamber. Three replicates were tested and the procedure was repeated 3 times for each irradiation time and distance. The exposed mites were examined immediately after irradiation under 400x magnifications and the number of dead mites was recorded. Mites that do not move when gently prodded were considered dead. Irradiation mites were maintained at (75 ± 3) % RH and (25 ± 2) ℃ and mortalities were determined again after 24 hours.

2.4. Bioassay with adult mites in presence of culture medium

Thirty 15 - 25 days old adult mites of mixed male and female were placed in clean glass Petri dishes, 14.0 cm diameter and 1.5 cm high along with 0.25 g of sterile culture medium. The Petri dishes were then placed inside the UV-C chamber and irradiated at different exposure times and distances as above for direct exposure. Controls were similarly prepared but placed in the control chamber. There were 3 replicates for each treatment and the test was repeated 3 times. The number of dead mites after irradiation was examined under 400x magnification and the immediately mortalities were recorded. Irradiated mites were maintained at (75±3)% RH and (25±2) ℃ and mortalities were determined again after 24 hours.

2.5. Bioassay with eggs

Ten freshly oviposited eggs were collected using fine applicator sticks and placed in glass Petri dishes, 9.0 cm diameter and 1.2 cm high. The Petri dishes with eggs were placed inside the test chamber and irradiated for 0.5, 1, 2, 3 and 5 mins at distances of 10, 35, and 55 cm, from the UV lamp. Control eggs were similarly irradiated in the control chamber. After treatment, eggs were placed individually in clear glass vials measuring 3.5 cm high and 2.0 cm diameter that were secured with snap caps. The eggs were maintained at (75±3)% RH and (25±2) ℃; hatchability was monitored daily for a week. All treatments were replicated 3 times, and the experiment repeated once.

2.6. Data and statistical analysis

Mean mortalities were compared and analyzed by independent sample *t*-test and one-way ANOVA at 95% confidence level using SPSS ver 11.0[15].

3. Results

3.1. Immediate mortalities of D. pteronyssinus and D. farinae for direct irradiation

Mortality rates for direct irradiation of *D. pteronyssinus* and *D. farinae* at difference exposure times and distances are shown in Table 1. No control mites died. Generally, mortality rates for both species, increased with increasing exposure times and decreasing distances. At 10 cm distance from lamp and 60 minutes exposure, 100% mortality resulted in both species of mites. For similar exposure times at 55 cm distance from lamp, there was significant difference among species ($P<0.05$); the mean mortality rates were (32.5±8.9)% for *D. pteronyssinus* and (11.0 ± 9.8)% for *D. farinae*. Increasing the exposure period at each distance significantly increased