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Evaluation of using essential oil constituents isolated from aromatic plants against insect pests attacking historical textiles in Egyptian Museums

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Abstract

Historical textiles in museums or historic houses are exposed to insect attacks, resulting in loss of parts and chemical change of these textiles. There are many ways of resisting insects in museums and historic houses. Many of these methods are very harmful to the health of the conservators and harmful to historical textiles. This research presents the use of a new method and safe materials such as clove oil and camphor oil in the control of insects that affect historical textiles. Therefore, the new silk textiles were dyed with natural dyes such as madder dye and turmeric dye mordent with alum, cupper, and iron. The dyed silk fabrics are processing in a way similar to the historical textiles. The clove oil and camphor oil have been applied and studied for their efficiency in the control of insects. The effect of using cloves oil and eucalyptus oil on the mechanical, optical and chemical properties of silk fabrics studied by using SEM, FTIR, CIE Lab, digital microscope image, and UV image. Very interesting results were obtained and this method and these materials were suitable for historical textiles conservation.

Keywords: *Historical, Textiles, Insect, Essential oils, Museums, Clove oil, Eucalyptus oil; .*

1. Introduction

Collections of textiles are a vital portion of our social legacy. They are esteemed for their notable stylish request and social in intrigued. Since of their wide offer, textiles- especially notable ensemble are frequently on the lasting show in exhibition halls. They make striking shows and are exceptionally reminiscent of a time gone. But our incredible intrigued in them can be their most prominent foe [1-3].

Historic edge craftsmanship exhibition halls too endure from creepy crawly harm, but here it depends exceptionally much on the materials. The historic textiles frequently have a few harms by moths or creepy crawlies. As shown in Fig.1, one can see the effect of insects on historical textiles at the museum of faculty of Archeology. Be that as it may, in the event that craftsmanship collections are well looked after, they can remain without bugs for long periods of time [4-8].

Fifty a long time of maintained battle against destructive creepy crawlies utilizing engineered and oil-derivative particles has created unreasonable auxiliary impacts (mammalian harmfulness, creepy crawly resistance, and environmental dangers).

It is prescribed that objects with a tall degree of insect's defilement are sanitized some time recently being joined to a collection. Nowadays, due to the advance in inquire about on the impacts of sanitization on authentic fabric, dangers to wellbeing and the environment, unused strategies of cleansing are still being created.

The broadening of the approaches inalienable in IPM is vital for way better natural assurance. Among the elective procedures, the utilize of plants, insecticidal chemicals shows up to be promising. Fragrant plants, and their basic oils, are among the foremost productive botanicals [9-15].

The aim of this research is to use environmentally friendly materials that are not harmful to human health or historical textiles in resisting the effects of insects. Then, study the efficiency of the use of these materials in resisting the impact of insects on historical textiles. In addition, study the effect of using this material on the mechanical, optical and chemical properties of historical textiles.

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2. Materials and Methods

2.1. Materials

1. Greek silk fabrics were supplied by TSIAKIRIS Co., Soufli—Greece. www.tsiakiris.gr.

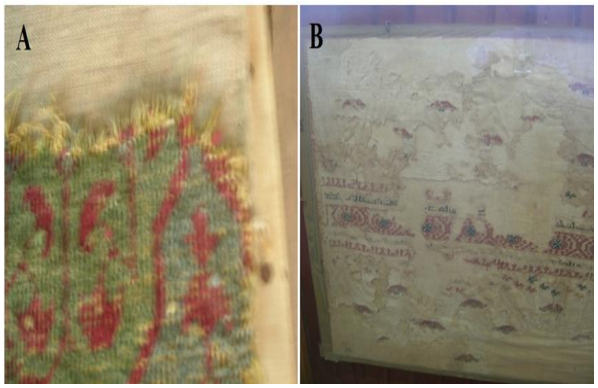

Fig.1. show the missing parts from historical carpet in museum of faculty of Archeology by insect deterioration (A). Show the missing parts from historical textile in museum of faculty of Archeology by insect deterioration (B).

2. Alum, Iron III chloride FeCl3 and Copper sulfate CuSO4.5H2O were purchased from Fluka.
3. Madder dye, Turmeric dye ware obtained from Wild Colours, Birmingham, UK. www.wildcolours.co.uk
4. Aromatic oils; Cloves oil. Camphor oil, one can see that the words (eucalyptus oil and camphor oil) are the same. These oils were purchased from Kato Flavors & Fragrances Company (KFF) at Saqqara Touristic Rd., El Harraneya, Giza, Egypt.
5. Insect; banded black carpet beetle Attagenusfasciatus (Thunberg) (Dermestidae: Coleoptera). Insects were obtained from Pest control lab at Center of Research and Conservation of Antiquities, Ministry of antiquities
6. **Insect culture:**

The culture of the black carpet beetle (Attagenusfasciatus) was obtained from Pest control lab at Center of Research and Conservation of Antiquities, Ministry of antiquities. The insects were reared in their rearing media for several generations under laboratory conditions (50-55% RH and 27-30 °C).

7. **Volatile oils:**

Two commercially available volatile oils Clove oil (Syzygiumaromaticum, F: Myrtaceae) and Eucalyptus oil (camphor oil) are the same.. (Eucalyptus globulus, F: Myrtaceae). These oils were purchased from Kato Flavors & Fragrances Company (KFF) at Saqqara Touristic Rd., El Harraneya, Giza Egypt. Different concentrations of the oils (1, 2, and 3 %) were prepared by diluting the pure extracts in acetone (cloves oil and camphor oil) were tested in this study. All the tested oils were purchased as pure oil (Branded in Egypt). The oils were extracted from the dried plants by steam distillation.

2.2. Methods

2.2.1. Dyeing Process

1. Extraction of color: drenching the dyestuff within the water for 12 hours. At that point warming for 1.5 hours at 70 °C and strainer and isolating the strong parts from the color solution.
2. Planning silk fabric: dousing the Silk fabric in water with common soap for 12 hours and after that bubble for 1 hour and wash to induce freed of wrapping up materials.
3. The coloring prepare put the silk fabric within the color arrangement with delicately string at temperature 70°C for 1.5 hours.
4. Stringent shower: break up the mordant in the water at that point colored silk samples from the previous step will put within the mordant bath for 30 mins at temperature 60°C. After that, the colored textiles will flush water [16-20]

2.3. Examinations and Analysis

2.3.1. Fumigation test:

Series of concentrations of the volatile oils were prepared using acetone as a solvent. Filter papers (Whatman No.1) were treated with 1 ml of the concentrations of each oil concentration and placed fit on the inner surface of the cover of 80 mm Petri-dish. 25 larvae were put in the Petri-dish and finally the dishes were made air tight. Controls were treated with acetone only. The treatments and control was replicated four times. After 48 hours of fumigation, larvae mortality was recorded.

2.3.2. Data analysis:

Mortality data were corrected using Abbott's formula (Abbott 1925).

The observed data were subjected to probit analysis according to probitvb6.

2.3.3. Morphological Study

It is an exceptionally critical step to ponder the proportion of distortion within the fiber after the treatment. Diverse filaments taken from distinctive ranges of the treated textiles samples and explored beneath HITACHI-SU-1500 Checking Electron Magnifying instrument (SEM) [21]

2.3.4. Color Measurement

The CIE Lab values of the treated samples were measured employing a double beamOptimatch spectrophotometer (Datacolor double Spectraflash SF450-UK). The literary works allude to the (L*) comparing to the brightness (100 = white, = dark). Whereas the (a*) to allude to the red–green arrange (positive sign = red, negative sign = green). In expansion, the (b*) to the yellow–blue arrange

(positive sign = yellow, negative sign = blue) [22, 24].

2.3.5. Fourier Transform Infra-Red Spectroscopy (FTIR)

Alter happening within the chemical useful bunches of an matured treated silk fabrics were observed by BRUKER'S VERTEX 70— Fourier Transform Infra-Red Spectroscopy with Weakening Add up to Reflection (FTIR-ATR) with the resolution of 4 cm-1 [25].

2.3.6. Mechanical Measurements

Mechanical properties of untreated and treated silk fabrics such as Tensile strength and elongation were tried utilizing Shimadzu Universal Tester of type S-500 Japan. The estimations are carried out concurring to ASTM 2000, D 3822-96 standard test strategy for tensile properties of a single fabric [26-27].

2.3.7. Photographic techniques by using ultraviolet (UV) wavelengths

In this section non-destructive examination and photographic techniques, using ultra-violet (UV) wavelengths was used. This method was achieved by using inexpensive equipment to produce relevant results. Photographic techniques by using ultra-violet (UV) wavelengths help to study and examine the change in historical textiles [28, 29].

3. Results and Discussions

3.1. Evaluating of the insect damage

Initially, experimental work is done to study the damaging effect of insect on silk textiles. The culture of the black carpet beetle (Attagenus fasciatus) was obtained from the Pest control lab, Center of Research and Conservation of Antiquities, Ministry of Antiquities. Figure 2 shows the mechanical damage and missing parts of silk textiles resulting in the insect effect.

3.2. Effectiveness of Clove oil and Eucalyptus oil

The samples retained the distinctive aroma of Clove oil and Eucalyptus oil for a considerable period of up to 3 months.

3.3. Susceptibility of A. fasciatus Larvae to Plant oils

The obtained results revealed that the toxic effects of the selected tested oils against the black carpet beetle4th instar A. fasciatus larvae, According to the LC50 values clove oil was most effective volatile oil than eucalyptus (Table 1), the LC50values ranged between 0.99% and 1.42%.

From the obtained results, the maximum toxicity was recorded in the larval treatment with 3% clove oil. Among the two tested oils, eucalyptus oil exerts an extremely low toxic activity against A. fasciatus larvae. Pinniger and Harmon (1999).[1-3] reported that the toxicity of the plant oil extracts depends on several factors among which are the chemical composition of the crude oil and insect susceptibility.

The mortality increased by increasing the concentration of the tested oils and vice versa. According to Casida (1990) [1-3], the effectiveness of the insecticides depends upon the sitting of the treatment and the type of formulations. Our study demonstrated that both tested volatile oils were effective against the black carpet beetle without direct contact. These results indicated that the mode of delivery of the oils was largely caused by action in the vapor phase: they may be toxic through penetration via the respiratory system.

3.4. Effect of cloves oil and eucalyptus oil on silk fiber morphological

Scanning Electron Microscope (SEM) examination appears the signs of harm to silk fabrics after Cloves oil (2%) and Eucalyptus oil (2%) application as shown in Fig 3 , which no one can see the exposed eye. By other words, SEM utilized to survey fiber break designs and the harmed perspectives on these filaments. One can see that Fig 3(A and B) appears the ordinary morphology of the silk strands; it shows up the extreme articular shape of the silk strands. In expansion, the surface of silk strands shows up smooth with homogeneous before and after application by using Cloves oil. While, Fig 3 (C and D) appears the ordinary morphology of the silk strands, it shows up the extreme articular shape of the silk strands. In expansion, the surface of silk strands shows up smooth with homogeneous before and after application by using Camphor oil. It is clear that the silk fibers were not affected by using cloves oil and camphor oil. No fiber deformation or breakage was noticed of silk fibers after using cloves oil and eucalyptus oil.

3.5. Effect of cloves oil and Eucalyptus oil on silk fabric mechanical properties

The study of the effect of cloves oil and eucalyptus oil on mechanical properties such as the tensile strength and elongation of historical textiles is a very important step in judging the validity of the use of these materials in historical textile maintenance.

Table.1 shows the mechanical properties of dyed silk fabric before and after cloves oil and camphor oil application. It is clear for the reader that there are very slightly decrees of tensile strength and elongation of silk fabric after cloves oil and camphor oil. For example, one can see that the tensile strength and elongation of silk dyed with turmeric mordanted with iron was 38.96 and 22.85 respectively. It is become 38.19 tensile strength and 22.37 elongation after treatment by using cloves oil 2% and become tensile strength 38.41 and elongation 22.30 after treatment by using Camphor 2%.

Plant oils	Concentration	mortality	LC50	LC90	Slope function	Toxicity index
Clove	1%	25%	1.231	4.011	2.514	85.619
	2%	67%				
	3%	92%				
Eucalyptus	1%	19%	1.502	5.984	2.224	69.773
	2%	53%				
	3%	89%				

Table (1): Toxicity of plant Oils extracts to 4rd instar larvae of A. fasciatus

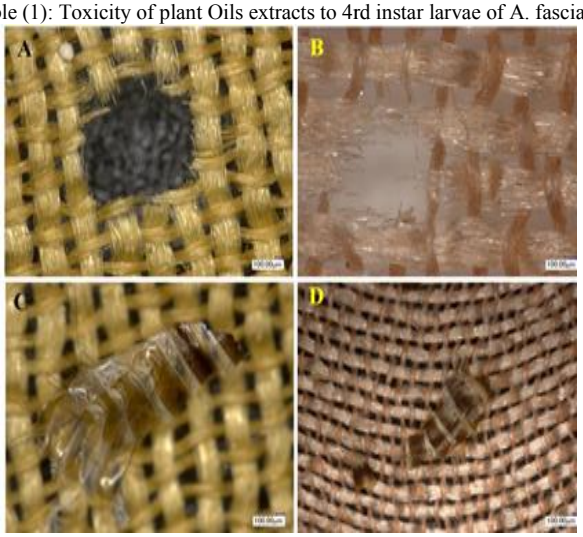

Fig.2. show the digital microscope image of missing part in silk samples by insect effect. Furthermore, one can see the dead bodies of the insect at magnification of x 200

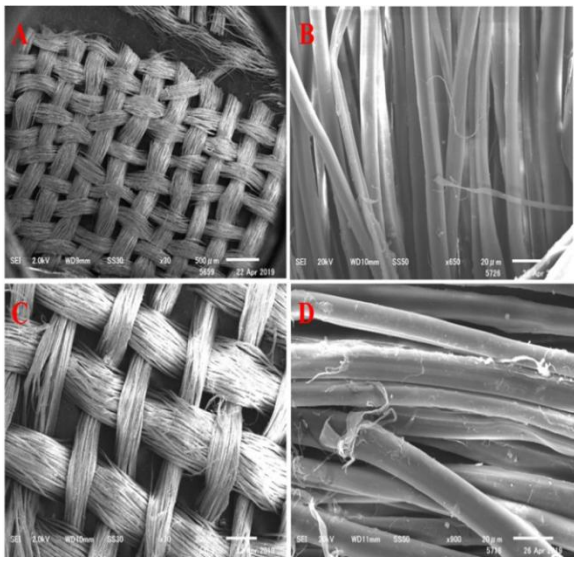

Fig.3. Show the effect of the application of Cloves oil with concentration of 2% on the silk fabric (A and B). Show the effect of application Camphor oil with concentration of 2% on the silk fabric (C and D).

3.6. Effect of cloves oil and eucalyptus oil the color change of silk fabric

Table.2 and Fig 4 show the effect of cloves oil and eucalyptus oil on change of optical properties such as the brightness value, red- green value, and yellow-blue of treated dyed silk fabrics. It is notice, a very slight change on brightness value (L) of silk dyed with turmeric dye and madder dye mrdantent with alum, cupper, and iron mordents. For example, the change of silk dyed with turmeric dye mordanted with alum is (Δ1.3) after cloves oil 2% application, and the total difference is (Δ1.52) after eucalyptus 2% application. In addition, one can see a very slight change on red-green value (a) of silk dyed with turmeric dye and madder dye mrdantent with alum, cupper, and iron mordents. For example, the change of silk dyed with turmeric dye mordanted with alum is (Δ -0.52) after cloves oil 2% application, and the total difference is (Δ -0.83) eucalyptus 2% application. By other side, a very slight change on yellow-blue value (b) of silk dyed with turmeric dye and madder dye mrdantent with alum, cupper, and iron mordents. For example, the change of silk dyed with turmeric dye mordanted with alum is (Δ 0.41) after cloves oil 2% application, and the total difference is (Δ -2.37) eucalyptus 2% application.

Effect of cloves oil and Eucalyptus oil on the chemical structure of silk fabric

FTIR spectra is very useful for dedication any change any chemical structure of organic materials. FTIR- ATR spectra of dyed silk fabrics appear retention groups allude to the peptide bonds (-CONH-) that demonstrate as amide I, amide II, and amide III. Amide I is happens within the run of 1,700–1,600 cm-1, and it is primarily related with the C=O extending. Amide I is vital to consider the alter of the secondary structure of the proteins. It is clear that the bands at 1,650 cm-1 random coil) and 1,630 cm-1 show to the protein materials (β-sheet) for

Silk Fabrics dyed with natural dyes before application						
No	**Samples**	**Color parameters**			**Mechanical Properties**	
		L	**a**	**b**	**Tensile St**	**Elongation**
1	**Silk + Turmeric + Alum**	73.71	12.26	79.72		
2	**Silk + Turmeric + Cupper**	64.98	11.36	67.07		
3	**Silk + Turmeric + Iron**	56.22	14.56	39.09	38.96	22.85
4	**Silk + Madder + Alum**	70.47	22.26	25.06		
5	**Silk + Madder + Cupper**	55.86	18.75	20.37		
6	**Silk + Madder + Iron**	56.42	13.18	28.27	39.24	23.48
Silk Fabrics dyed with natural dyes after cloves oil 2% application						
9	**Silk + Turmeric + Alum**	75.01	11.74	80.13		
10	**Silk + Turmeric + Cupper**	64.68	11.59	65.93		
11	**Silk + Turmeric + Iron**	55.31	15.34	40.86	38.19	22.37
12	**Silk + Madder + Alum**	77.22	20.54	24.25		
13	**Silk + Madder + Cupper**	54.02	18.88	19.61		
14	**Silk + Madder + Iron**	55.92	13.00	27.70	39.16	23.07
Silk Fabrics dyed with natural dyes after Camphor 2% application						
17	**Silk + Turmeric + Alum**	75.23	11.43	77.35		
18	**Silk + Turmeric + Cupper**	64.69	11.09	65.77		
19	**Silk + Turmeric + Iron**	62.7	12.12	38.17	38.41	22.30
20	**Silk + Madder + Alum**	71.23	21.03	24.52		
21	**Silk + Madder + Cupper**	56.09	17.82	18.54		
22	**Silk + Madder + Iron**	57.1	12.85	29.15	39.07	23.15

Table (2): show the color parameters and mechanical properties of silk dyed fabric before and after and after application by oils with different concentration.

amide I. Whereas Amide II is happening within the extent of 1,540–1,520 cm-1, and it is allude to the N–H bending and C–N stretching vibration. Amide III is within the run of 1,430–1,450 cm-1, and it comes about from C–H bending vibration. Fig 4 show the FTIR of dyed silk fabric by madder dye and turmeric dye before and after of cloves oil and camphor oil application. It is clear for the reader that are not change in in β –sheet structure. No change in the OH band at 1650 or no formation of carbonyl compounds after cloves oil and camphor oil application, which would absorb in the 1,650–1,750 cm-1 region as shown in Fig. 5.

3.7. Studding invisible remaining of oil by UV images

Fig .6 show UV images of silk dyed with madder and turmeric dye mordanted with iron, cupper and alum after insect damage, As well as, treated silk samples with camphor oil and cloves oil. This images techniques help to study and examine the change of samples before and after insect damage as well as after treatment by camphor oil and cloves oil. Ultraviolet imaging is used to screening and examines the exact holes caused by the impact of insect damage, which may not be seen by the human eye as shown in Fig.6 (J and K). This technique is also used in the study of the possible residues of oil treatment on the surface of textiles that are not visible to the human eye. The study reported that there were no remnants of treatment on the surface of the textiles as shown in Fig 6 (M – P).

4. Conclusion

The use of cloves oil and eucalyptus oil are giving great effectiveness anti-insects and get rid of them permanently. It is characterized as a safe way to health workers. There was no change in the morphology of the silk fiber after applying the cloves oil and eucalyptus oil. There has been no marked change in the mechanical properties of silk fiber after cloves oil and eucalyptus oil after application. Color

change of dyed silk fabric is also invisible to the human eye. There has been no significant change in the chemical structure of silk fiber after cloves oil and eucalyptus oil after application. The use of these materials is very suitable to resist the impact of insects in the maintenance of historical textiles

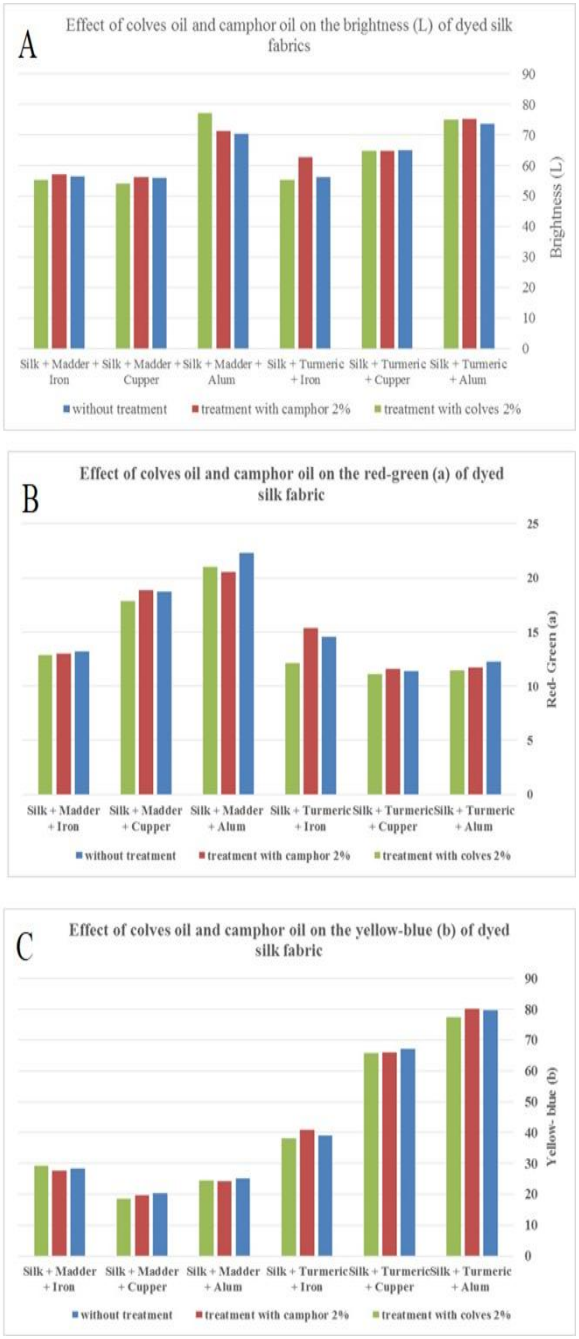

Fig.4. Show the effect of cloves oil and camphor oil on the brightness value (L) change of dyed silk fabric (A). Show the effect of cloves oil and camphor oil on the red-green value (a) change of dyed silk fabric (B). Show the effect of cloves oil and camphor oil on the yellow-blue value (b) change of dyed silk fabric (C).

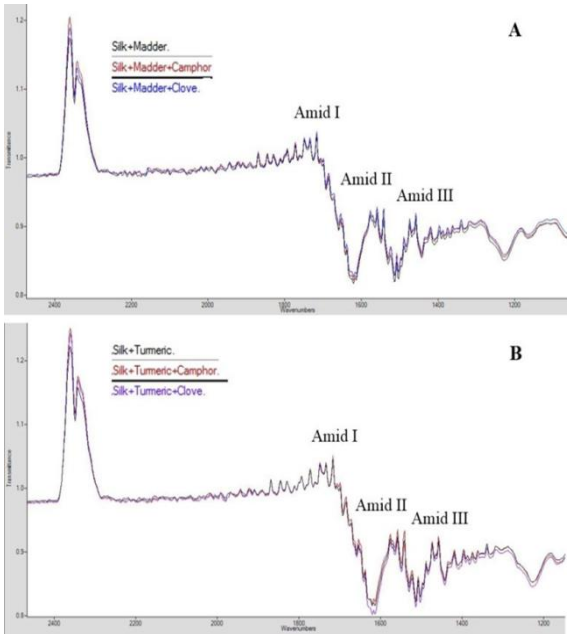

Fig.5. Show the effect of cloves oil and camphor oil on the chemical structure of dyed silk fabric with madder dye (A). Show the effect of cloves oil and camphor oil on the chemical structure of dyed silk fabric with turmeric dye (B).

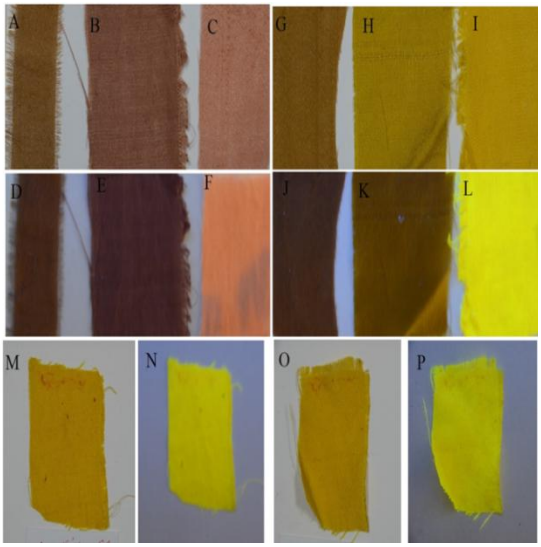

Fig .6 show silk dyed with madder dye mordanted with iron, cupper and alum after insect damage (A, B and C). While D, E and F show UV images of silk dyed with madder mordanted with iron, cupper and alum after insect damage. Show silk dyed with turmeric dye mordanted with iron, cupper and alum after insect damage (G, H and I). While (J, K and L) show UV images of silk dyed with madder mordanted with iron, cupper and alum after insect damage. Show silk dyed with turmeric dye mordanted with alum treated with cloves oil (M). While (N) show UV images of silk dyed with turmeric dye mordanted with alum treated with cloves oil. Show silk dyed with turmeric dye mordanted with alum treated with camphor oil (O). While (P) show UV images of silk dyed with turmeric dye mordanted with alum treated with camphor oil.

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6. Conflicts of interest

There are no conflicts to declare of this article

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