The development of using pesticides for the preservation of historical parchment manuscripts and leather artifacts: An article review

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Abstract: Museums have great importance in preserving our cultural heritage that including the historical organic collection. Historical protein and cellulosic manuscripts are one of the most widespread and important in museums which represent the precious remains of our history. Unfortunately, these artifacts exposed to the most dangerous type of degradation (biological deterioration) that may lead to the loss of these historical manuscripts. Hence the importance of using pesticides appears, but our local museums lack the use of the criteria and standards required to be applied when using such pesticides in order to preserve the historical manuscripts from degradation, also to protect any one who is dealing with these treated manuscripts, and secure the environment protection. Consequently, there is an important role of the highly aware conservators when using different types of pesticides. This study made a survey of the historical development of the pesticides used in the field of the parchment manuscripts and the leather artifacts, explained the different types of pesticides that can be used in museums, also Criteria that governing the selection of pesticides used in historical manuscripts, Criteria should be taken under consideration in handling pesticides in museums, Application techniques of pesticides of leather and parchment manuscripts, First aids of dealing with pesticides, and how to get rid of pesticide residues in museums without harming the surrounding environment and other matters related to pesticides through useful-in-depth theoretical study of pesticides used in the field of historical parchment manuscripts and leather artifacts in museums.

I. INTRODUCTION

The use of pesticides in museums began in the eighteenth century and continued until nowadays. Indeed, some institutions were using arsenic substances as late as the 1960s. Today most museum professionals are aware of the danger of this toxicity, but not all museum are properly equipped or have criteria that ensure the safety of their staff or whoever be in contact with these historical objects and also the historical objects themselves. Consequently, the important role of conservators appears. But conservators need to know a lot of important things bout pesticides. This study shed some light on how ware conservators should deal with the pesticides under scientific criteria in museums and put some standards in order to preserve the historical parchment manuscripts and leather artifacts under a suitable safety also every person found in the museums. That is through a historical survey of developing using the common pesticides for preservation of historical parchment and leather artifacts (since the materials containing arsenic or mercury until nowadays' materials of new pesticides).

II. Historical background

2.1. Historical development of using pesticides:

Historical parchment and leather artifacts are found in most of museums. These organic materials are exposed to inappropriate temperature and humidity conditions, light, ultraviolet radiation, and pollutants. However damage from these agents is slow compared to biological damage (complete Collections can be disappeared within a few years as a result of pest activity) (Réaumur, 1748). Hence appears the importance of using pesticides. But our local museums are lacking to the criteria or standers in dealing with these pesticides especially with all that development in pesticides field. Pesticides that used in museums through the ancient age till now can be in the form of chemicals compounds or natural extracts of botanical origins. Some pesticides were useful in the field of historical parchment manuscripts but some of them have a lot of disadvantages that made them prohibited. The traditional pesticides used largely for many years ago; most of them are sensitive to the conditions of application also their toxic properties and poor biodegradability led to their limiting (Rother, 1995; Lindner, 1998). The historical development of pesticides can be described as the following:

The first use of a pesticide recorded dates back to 2500 B.C. when the Sumerians used sulfur compounds on their bodies to control insects in belief that this material would repel the pests. Ancient Egyptians also were experimented with pesticides. The Ebers' Papyrus, the oldest known medical document (dated around 1550 B.C.) describes over 800 recipes containing recognizable substances that were used as pesticides (Eric L. Taylor, 2007).

Arsenic trioxide compounds begin to be used in the 1940s, in the U.S. as general museum insecticides (Shepard 1951).

Mercury salts were not used as popular as arsenic salts. The most common are (calomel, mercuric chloride, and mercurochrome) that still used for the recent times (Brady and Clauser 1991, Goldwater 1972, Windholz et al. 1983).

The historical use of arsenic and mercury salts as a pesticides for preservation of museum objects provide long-term protection against pests but approved health risks of humans who contact with them (Hawks and Williams 1986, Hawks and Von Endt 1990, Williams and Hawks 1987).

Chemicals of botanical origin started to be used the 19th century, such as strychnine, camphor, perfume of lemon, thymol, menthol, cedar oil, and tobacco were used with the museum historical collections (Goldberg, 1996; Makos and Dietrich 1995). But their insecticidal properties were not understood totally as the discovery of synthetic chemicals such as naphthalene (Kidd, 1821). Naphthalene was used for pest control by 1889 in museums as a pesticide (Abbott 1935, Arnold 1953; Goldberg 1996).

Diazinon Dichloro diphenyl trichoroethane (DDT) was credited in 1940s, used extensively during World War II to control the insects and eliminating the disease in many parts of Europe. DDT was banned in 1972 because the direct human health hazards and its effects on the environment (Cristol and Haller 1945).

Ethylene oxide was first reported in 1859 by the French chemist Charles-Adolphe Wurtz, who prepared it by treating 2-chloroethanol with potassium hydroxide (Wurtz, 1859).

Methyl Promide and Lysol are used also as pesticides. The first Lysol disinfectant was produces in 1889 by Dr. Gustav Raupenstrauch to help end cholera in Germany. Methyl Promide is manufactured by reacting methanol with hydrogen bromide. In 1999, synthetic methyl bromide was used for fumigation purposes.

Preventol in Ethanol (7%) the Bayer Group Company started a production of antimicrobial active ingredients (preservative based on benzoic acid) in 1907 and in 1932 produced Preventol. Preventol has a broad spectrum of activity against microorganisms. It works best in an acidic, neutral or weakly basic environment. It is used in combination with ethanol or isopropanol (Luanne, 2014).

Ethyl alcohol (70% ethanol) ethanol is naturally produced by the fermentation of sugars by yeasts by the 14th century. Alcohol kills microorganisms by dehydration and protein denaturation, (Haw, Stephen G., 2006; Chisholm, et al., 1911).

Thymol was first isolated by the German chemist Caspar Neumann in 1719. But the Ancient Egyptians used thymol or carvacrol in the form of a preparation from the thyme plant (a member of the mint family) to preserve mummies also Ancient Greece used it in sacred temples (Mathela et al., 2010).

Paranitrophenol (PNP) and pentachlorophenol (PCP) p-Nitrophenol (PNP) is used in the manufacture pesticides (Spain & Gibson, 1991). It is the major metabolite resulting from the degradation of parathion (Mulbry & Karns, 1989). Pentachlorophenol (PCP) is produced in the 1930s, marketed under many trade names and used as a pesticide and a disinfectant (Fiege, et al., 2000).

Dichlorophene and Myacide SP. Dichlorophen is an antimicrobial agent. It is used in combination with toluene and 2,4-Dichlorobenzyl alcohol (Myacide SP.) is a mild antiseptic, able to kill microorganisms (Ostergaard, 1994).

Orthophenylphenol (OPP) was discovered in 1834 by Friedlieb Ferdinand Runge, who extracted it (in impure form) from coal tar. The antiseptic properties of phenol were discovered by Sir Joseph Lister (1827–1912; Smith, 2007).

Copper naphthenate is a copper carboxylate made with naphthenic acid, which occurs naturally in petroleum. It has been used for over 50 years in the United States in pesticides applications (Grove, 1987).

Formaldehyde (Formalin) was first reported in 1859 by the Russian chemist Aleksandr Butlerov (1828–86) and was conclusively identified in 1869 by August Wilhelm von Hofmann. Formaldehyde is produced industrially by the catalytic oxidation of methanol (Mangum, 2008).

Fumigation chambers in the 20th century there is rapid evolution of pesticides and several changes in museums based on synthetic organic compounds fumigants developed for historical objects and applied in museums as fumigation chambers (Brown 1951; Williams et al. 1986, Williams and Walsh 1989a, 1989b). That applied to historical collections storage especially with highly toxic gases (Anderson and Choate 1974). Methyl bromide (Bromomethane) is a colorless, odorless, and nonflammable gas that was used extensively as a pesticide by most countries in the early 2000s (Gribble, 1999).

The heterocyclic compound 2-(thio cyano methyl thio) benzo thiazole (TCMTB) considered one of the newer chemical biocides used in the historical parchment manuscripts preservation. Also used in the leather industry in the last 20 years as antifungal agent (Orlita, 2004).

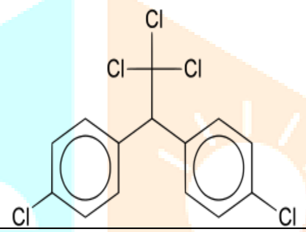
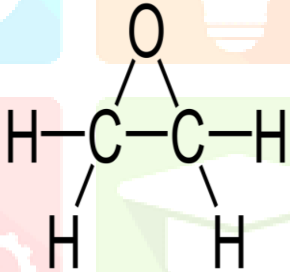
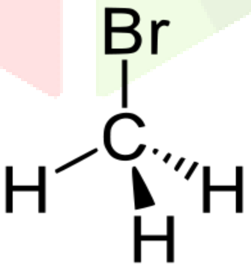
Nowadays applying appropriate environmental conditions is considered one of the latest pest controls (cleanliness, good storage, using low heat or freezing, controlled atmospheres and exhibit furniture that keeping pests away) are effective techniques for museums nowadays and applied in North American museums (Jacobs 1995).

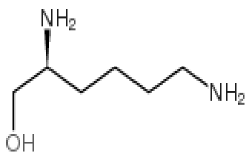
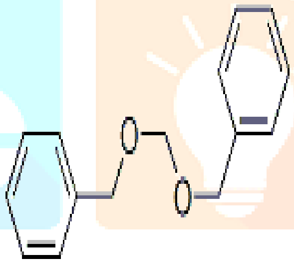
III. Types of pesticides:

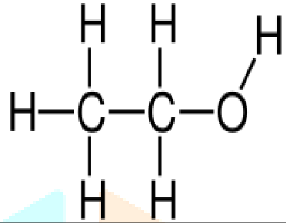
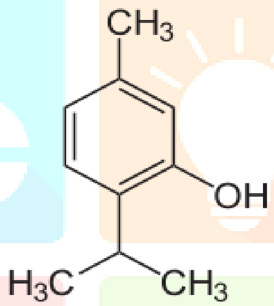
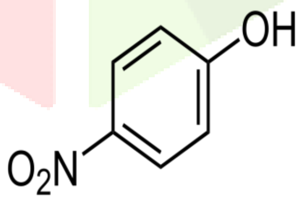
A pesticide is a substance or mixture of substances intended for preventing, destroying, repelling, or lessening the damage of any pest. There are many different types of pesticides, each is meant to be effective against specific pests can be divided as follows: Antimicrobials control germs and microbes such as bacteria; Bio-pesticides are made of living things found in nature; Desiccants are used to dry up living tissues; Disinfectants control germs and microbes such as bacteria; Fungicides are used to control fungal degradation (molds, mildew, and rust).; Herbicides kill or inhibit the growth of microorganisms; Insecticides are used to control the growth and reproduction of insects; Miticides and Rodenticides control mites and rodents that feed on historical objects in storages of museums (Tosoon, 2001, npic@ace.orst.edu).

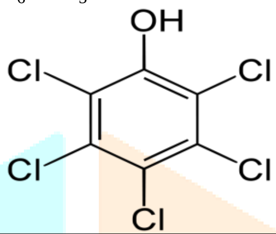
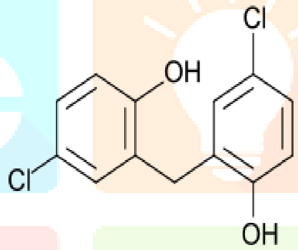
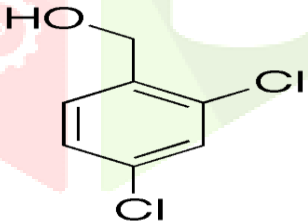
IV. The common pesticides used on parchment manuscripts and leather artifacts:

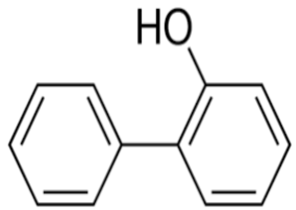
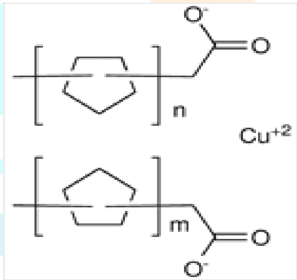
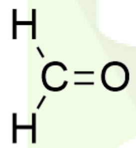
Table 1 The common pesticides used on parchment manuscripts and leather artifacts

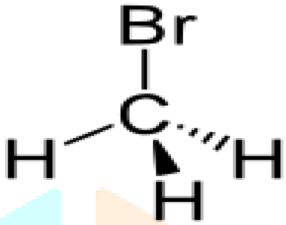
The IUPAC name	The trade name	The chemical structure	Properties	Advantages and disadvantages
1-Diazinon Dichloro diphenyl trichoroethane 1, 1'-(2,2,2-Trichloroethane-1,1-iyl) bis (4-chlorobenzene)	DDT	$C_{14}H_9Cl_5$ 	**Melting point:** 108.5 °C (227.3 °F; 381.6 K) **Boiling point:** 260 °C (500 °F; 533 K) (decomposes) **Solubility in water:** 25 µg/L (25 °C)	DDT has a miraculous ability to control disease-bearing insects, but has been banned in using because it is a persistent organic pollutant that is readily adsorbed to soils and sediments, which can act both as sinks and as long-term sources of exposure affecting organisms and carcinogen to human cells (Conis and Elena, 2017).
2-Ethylene oxide Oxirane, 1,2-Epoxy ethane	epoxyethane, ethylene oxide, dimethylene oxide, oxacyclopropane	C_2H_4O 	**Melting point:** −112.46 °C (−170.43 °F; 160.69 K) **Boiling point:** 10.4 °C (50.7 °F; 283.5 K) **Solubility in water:** Miscible (Petrov *et al.*, 2002).	It was useful as a pesticide, in treatments it needs special vacuum chambers and must be executed by specialists because of the toxicity, but it cause a color change in the materials. Also it is proved carcinogen. But when copared with dimethyl formamide liquid caused more yellowing during aging than the yellowing of the dry control, Hexan, pyridine, and benzine, seem slightly harmful, and methylene chloride and tetra chloro ethylene seem worse (Banik, 2005).
3-Methyl Promide Bromomethane	Brom-O-Gas- TM; Celfume-TM; Dowfume-TM; Embafume-TM; Kayafume-TM; Meth-O GasTM; Terr-O-Gas	CH_3Br 	**Melting point:** (−93.66 °C (−136.59 °F; 179.49 K) **Boiling point:** 4.0 °C (39.2 °F; 277.1 K) **Solubility in water:** 17.5 g L^{-1}	Methyl Promide and Lysol proved to have a negative impact on the colors of the archaeological materials. Hydrogen peroxide is a quite harmful to paper, and has relatively little bleaching effect on the parchment paper (Koastler and Parreira, 1993).

Lysol benzalkonium chloride	Lisko-lysol	$C_6H_{16}N_2O$ 	**Melting point:** Not available **Boiling point:** 18.6ºC at 760mmHg **Solubility in water:** complete liquid phase	
4- Preventol in Ethanol (7%) Preventol D2; Bis (benzyloxy) methane	Preventol o Extra, Preventol BP	$C_{15}H_{16}O_2$ 	**Melting point:** 0.1 mbar **Boiling point:** 327 ºC **Solubility in water:** 0.5 g/l, 3000 g/l (ethanol)	Preventol in Ethanol (7%) gave good results in parchment. Preventol is a family of leather preservatives for protecting leather against mold and fungi. Preventol is a family of leather preservatives for protecting leather against mold and fungi. It can be used from the soaking to the final finishing stage in leather manufacturing. It is recommended for soaking, pickling, chrome tanning, dyeing and also in the finishing of leathers as a Long term preservation of leathers. Furthermore, when compared with other pesticides that were the results: Thymol, 3-hydroxyl-p, cymene can be used as pesticides in parchment manuscripts also Pentachlorophenol (pcp), p-chloro-m-cherosol (cmc), orthophenylpheonl (oop), N-phenylsaliccylanilide, preventol, doweide and shiman (Nitterus a, 2000).
5-Ethyl alcohol (70% ethanol) ethanol	alcohol, ethyl alcohol	C_2H_6O	**Melting point:** −114.14 ± 0.03 °C (−173.45 ± 0.05 ° F; 159.01 ± 0.03 K) **Boiling point:** 78.24 ± 0.09 °C **Solubility in water:** miscible	Methanol (methyl alcohol or wood alcohol) is not recommended because it is an ineffective pesticide and is toxic to humans. Isopropanol (rubbing alcohol) is an effective fungicide but is more toxic than ethanol if the vapors are inhaled. Also solutions containing ortho phenyl phenol, and solutions containing sodium ortho phenyl phenate can be used as effective pesticides on museum

				artifacts (Thomas, 1991; Katherine, 1972; Di Pardo, 2007).
6-Thymol 5-Methyl-2-(propan-2-yl) phenol 2-Isopropyl-5-methylphenol	thymol	$C_{10}H_{14}O$ 	**Melting point:** 49 to 51 °C (120 to 124 °F; 322 to 324 K) **Boiling point:** 232 °C (450 °F; 505 K) **Solubility in water:** 0.9 g/L (20 °C)	Thymol [Thymol (5-Methyl-2-(1-methylethyl) phenol) is frequently used in conservation as a fumigant for fungi on paper museums and archives in heated fumigation chambers. But it is not registered for use as a fumigant in Canada nowadays, but only as a material preservative and disinfectant. Thymol and pentachlorophenol are used to prevent the historical manuscripts from the growth of fungi and pests infestation but not all concentrations are useful on parchment manuscripts on contrary of paper manuscripts. The results also show that thymol is better than pentachlorophenol in all properties investigated as 1% concentrations of thymol are good with all properties but in pentachlorophenol it has affected the "a value" in color change (Abdel-maksoud, 2002).
7-Paranitrophenol (PNP) (4-Nitrophenol) **pentachlorophenol (PCP)**	(p-nitrophenol, para-Nitrophenol, 4-Hydroxynitrobenzene, PNP) (Santophen, Pentachlorol,	$C_6H_5NO_3$ 	**Melting point:** (113 to 114 °C (235 to 237 °F; 386 to 387 K) **Boiling point:** 279 °C (534 °F; 552 K) **Solubility in water:** (10 g/L (15 °C),11.6 g/L (20 °C),16 g/L (25 °C) **Melting point:**	Paranitrophenol (PNP) has been specified for use in the manufacture of leathers. But the strain of *Stenotrophomonas* sp. is capable of degrading the high concentrations of PNP. The degradation ability was retained from 4 °C to 35 °C (Hauber and Germann, 1997; Didato and Yanek, 1999; Adminis et al., 2001). Pentachlorophenol (PCP) was widely used in the past for surface disinfection in paper, leather, and other organic materials. Pentachlorophenol is

(2,3,4,5,6-Pentachlorophenol)	Chlorophen, Chlon, Dowicide 7, Pentacon, Penwar, Sinituho, Penta)	C_6HCL_5O 	(190 to 191 °C (374 to 376 °F; 463 to 464 K)) **Boiling point:** (309–310 °C (588–590 °F; 582–583 K) (decomposes)) **Solubility in water:** (0.020 g/L at 30 °C)	highly toxic through inhalation or skin contact caused degradation of cellulose, and discoloration of pigments. Sodium pentachlorophenate (a water-solublesodium salt), pentachlorophenol laurate, and otherchlorophenols are no longer considered suitable for museum use (Jedrzejewska, 1968).
8-Dichlorophene (4-Chloro-2-[(5-chloro-2-hydroxyphenyl)methyl]phenol) **Myacide SP.** ((2,4-Dichlorophenyl)methanol)	(Dichlorophen) (Dybenal, Rapidosept, Myacide SP)	$C_{13}H_{10}C_{l2}O_2$  $C_7H_6Cl_2O$ 	**Melting point:** (177.5 °C (351.5 °F)) **Boiling point:** -- **Solubility in water:** (0.003 g/100 mL (20 °C)) **Melting point:** (57 to 60 °C (135 to 140 °F; 330 to 333 K)) **Boiling point:** (150 °C (302 °F; 423 K) 25 mmHg) **Solubility in water:** --	Dichlorophene and Myacide SP. were used incorporated into oil or wax formulations at concentrations of 0.25%, 0.50% and 1% with vegetable-tanned leather treated with lubricants is essential especially when they are stored for a long time. These pesticides play an important role in the protection of lubricants from the bio-deterioration by micro-organisms (Abel-maksoud, 2006).
9-Orthophenylphenol (OPP) biphenyl-2-ol ortho-biphenylol,	OPP	$C_{12}H_{10}O$	**Melting point:** 40.5 °C (104.9 °F; 313.6 K) **Boiling point:** 181.7 °C (359.1 °F; 454.8 K) **Solubility in water:** 8.3 g/100 mL	Orthophenylphenol (Dowicide A, Topane WS) is one of the used pesticides. It is almost insoluble in water, but is soluble in most organic solvents. The preferred solvent for orthophenylphenol is 70% ethanol with 30% water because it has low

ortho-phenylphenol, ortho-hydroxybiphenyl, 2-hydroxybiphenyl			(20 °C)	toxicity and good pesticide action. Orthophenylphenol is slowly volatile and reported to discolor paper documents. Aqueous solutions of sodium orthophenylphenate can be used where organic solvents are undesirable. However, it must be present in higher concentrations to be effective but it would be carcinogen material (Baynes-Cope, 1971; Sax, 1984; and Wainwright, 1986)
10-Copper naphthenate copper naphthenate	Cunapsol; Troysan; Copper uversol; Chapco Cu-nap	$2(C_{11}H_7O_2)Cu$ 	**Melting point:** > 100 °C **Boiling point:** 149°C **Solubility in water:** insoluble	Copper naphthenate is registered as pesticides that provide good protection in organic materials. Copper naphthenate is green and permanently colors the organic materials (leather artifacts) and reported to accelerate the degradation of cellulose fibers (paper manuscripts) (World Health Organization, 1986). Copper naphthenate is an EPA registered general use wood and fabric preservative that can be used with a high degree of safety. It is not considered a hazardous waste, it is non-corrosive, non-conductive, nonblooming, and it has low mammalian (e.g. human) toxicity (Grove, 1987; Leech, 1999).
11-Formaldehyde Formaldehyde, Methanal	Formalin, methanol, Methyl aldehyde, Methylene glycol, Methylene oxide, Formalin (aqueous solution), Formol, Carbonyl hydride	CH_2O  Formaldehyde	**Melting point:** −92 °C (−134 °F; 181 K) **Boiling point:** −19 °C (−2 °F; 254 K) **Solubility in water:** 400 g dm^{-3}	Formalin has been used to control micro-organisms in historical manuscripts. But it is carcinogenic material. Also made the protein materials suffer more hardness so it limited to be used as a fungicide on museum artifacts (Zuckerman, 1970).
12-Methyl bromide Bromomethane	Methyl bromide	CH_3Br	**Melting point:** −93.66 °C (−136.59 °F; 179.49 K) **Boiling point:** 4.0 °C (39.2 °F; 277.1 K) **Solubility in water:**	Methyl bromide was not and still is not considered an acceptable fumigant for a number of materials likely to be found in ethnographic collections (Dow 1938, Dawson and Strang 1992), which has limited its use in many museums. For example, at

			17.5 g L^{-1}	the California Academy of Sciences, Edolan U was used for both types of collections (Funk and Sherfey 1975).

V. Criteria that governing the selection of pesticides used in historical manuscripts:

The application of pesticides is necessary and useful in the preservation of parchment manuscripts and leather artifacts in museums, libraries, storages rooms and excavation areas. Controlling the micro-organisms and pests depends on some basics concepts: protection-prevention and Curative-therapeutic (Thomas, 1991; Tosoon, 2001). There are some standers for selecting the suitable pesticides as the following:

- The pesticides used should be highly efficient against insects and microorganisms in small doses;
- The pesticides used should has a residual effect;
- The pesticides used should preferably not to be volatile;
- The pesticides used should be non-hygroscopic;
- The pesticides used should be non-flammable;
- The pesticides used should be available in large quantities and cheap prices;
- The pesticides used should be can mixed with diluted materials, whether in the form of powder or liquid without interacting with it;
- The pesticides used should not has a foul smell;
- The pesticides used should not has any color which changes the color of the surfaces that treated with;
- The pesticides used should has a low in toxicity towards the environment;
- The pesticides used should not affected by the length of the storage period;
- The pesticides used should not affected any of the materials that used in the historical manuscripts;
- The pesticides used should be easy handled and stored (Angus, *et al.*, 2005).

VI. Criteria should be taken under consideration in handling pesticides in museums:

Most of chemicals that routinely used in museums are known to be carcinogens with no safety for whoever deals with the historical collections. Even collections that had been fumigated with gases known to be toxic were not regarded as safe for handling till aired for some period. But the new generation of museum conservators concentrates on the human safety beside collections care (Renshaw Beauchamp 1978, Dawson 1981). Most of pesticides are developed not to persist in the environment for long periods of time. Rainwater, sunlight, microbial action and oxidation decrease their bad effectiveness and presence in environment (Nol, 2001). There are primary factors that conservators in museums should know: Which objects have been treated before, with which material, also which pesticides are suitable for using to ensure continued safety, what is the health risk associated with using these pesticides, also if there are harmful residues of these pesticides to the conservators or historical objects in museum. The criteria in handling pesticides are as follows:

•Conservators should clean objects using a HEPA-vacuum to remove contaminants;
• prefer to use a fume hood or trunk;
• The staff of Spraying should be provided with at least two uniforms to allow for frequent changes;
• Washing simple tools with sufficient water and soap temporarily;
• All working clothes must be removed at the end of each day's operations to be washed regularly and sterilized especially contaminated gloves as it can be more dangerous than not wearing gloves at all;
• Eating, drinking and smoking during work must be strictly forbidden;
• When work involves pesticides of high toxicity, the hours of work must be arranged so that exposure to the material is not excessive;
• It is necessary to have first aid kit in the work site (World Health Organization, 2006).

VII. Application techniques of pesticides for leather artifacts and parchment manuscripts:

Pesticide application refers to the practical way in which pesticides, (including herbicides, fungicides, insecticides, or nematode control agents) are delivered to their biological targets (e.g. pest organism, crop or other plant). But the techniques of application should be a highly efficient in order to minimize their release into the environment and human exposure. The application method depends on: the nature and habits of the target pest, characteristics of the target, and properties of the pesticide formulation, the suitability of the application equipment, cost, and efficiency of alternative methods. There are some common pesticide application methods that can be used generally include the following (Band technique, Broadcast technique, Drench applications, Foliar technique, Soil technique, Space treatment, Spot treatment, and Wiper applicator) (Graham, 2016). But in museums when dealing with historical manuscripts it should be noticed that pesticide application plays an important role in pest management also the equipment used for applying. The main purpose of pesticide application technique is to cover the target with maximum efficiency and minimum efforts to keep the pest under control as well as minimum contamination of the surrounding area in the museum. Also the application of pesticide is very successful when applied at the most susceptible stage of the pest. The most common techniques that could apply in museums are spraying, and dusting. For spraying of pesticides different types of nozzles such as hydraulic, air blast, centrifugal and heat energy type are used. Water is a common carrier of pesticides or air but oils are not preferred to use as carriers not to affect the historical objects. The pesticides can be formulated in liquid form, dust powder or granule forms. The technique of spraying is classified as: high volume spraying; low volume spraying; ultra low volume spraying (The ULV spraying is the method of pesticide application at minimum volume to achieve economic pest control). The dusting powders are low concentration (dry formulations containing 2 to 10% pesticide). The inert material or dry diluents is talc, soapstone, etc., and it is non toxic. The sulfur dust is not diluted with inert material (Matthews, 2008).

VIII. First aids of dealing with pesticides:

All pesticides are toxic to humans to some degree; however, the doses that are acutely toxic to humans are usually far higher than those required for killing pests. The key to safe use of pesticides is to reduce to a minimum the possibilities of unsafe exposure during handling of hazardous chemicals. Different risks associated with pesticides are often classified based on whether they have short-term effects (such as diarrhea, abdominal pain, headaches, nausea, vomiting, etc.) or long-term effects (such as skin diseases, cancer, depression, neurological deficits, diabetes, genetic disorders, or even death). Health effects of pesticides on people with direct exposure included Cancer, Depression or neurological deficits, Diabetes, Respiratory diseases, Women specific disorders, General health, and multiple diseases (Henrik et al., 2014). The conservators should know the Symptoms that can happened with pesticides. Some pesticides tend to cause irritation to the skin, nose, eyes, and respiratory system; others may cause bloody noses and bleeding gums. If something wrong happened when dealing with the pesticides, conservators should know the first aids to apply:

• If dermal exposure has occurred, the first objective is usually to dilute the pesticide and prevent absorption;

• Always have a source of clean water available could be used to dilute the pesticide;

• If inhalation exposure occurs, get the victim to fresh air immediately;

• Remove all contaminated clothing immediately;

• Wash the affected area, including the hair, with water and soap, then rinse well;

• If the skin has chemical burns, cover the area loosely with a clean, soft cloth;

• if the eye contaminated, immediately begin gently washing the eye with a steady drip of clean water; drip the water across the eye (not directly into the eye); continuously rinse the eye for 15 to 20 minutes. If only one eye is involved, be careful not to contaminate the other eye; remove contact lenses, if present, after the first 5 minutes, and then continue rinsing the eye; cover the eye with a clean piece of cloth and seek medical attention immediately

• Do not attempt to rescue someone who is in an enclosed, contaminated area unless you are wearing appropriate suit; immediately carry the victim to fresh air (do not allow the victim to walk or exert themselves); if other people are in the area, warn them of the danger; have the victim lie down and loosen clothing; keep the victim warm and quiet; if breathing stops or is labored, give artificial respiration (Frederick, 2010).

IX. Getting rid of pesticide residues in museums:

The contamination of museum objects with residues from pesticide treatments presents a legal and moral issue for museum professionals. In recent years, great effort has been devoted to devising more efficient ways to monitor and characterize pesticide contaminants on museum collections. Many approaches have been used to remove a variety of contaminants from historical manuscripts surfaces. the Native American Graves Protection and Repatriation Act (NAGPRA) in 1990 established a mechanism for museum conservators working with museum collections should take care with (appearance, smell, texture, stability) of the objects that may include any pesticides residues and affect human health hazards. The following considerations should be reviewed before beginning a pesticide removal process:

• Most museum objects do not have adequate documentation so it is difficult to know which pesticides are present (There are more than 90 reported pesticides and combinations mixtures);
• The chemical and physical properties of pesticides chemicals are depending on the connected museum materials involved (removal of some pesticides residues can be easier or more difficult according to these substrates);
• Determining the protocol for the museum object's examination, testing, cleaning, and documentation require participation of cultural representatives or to Graves Protection and Repatriation Act (NAGPRA) laws;
• Analyses for organic and inorganic residues require different techniques and the detection limits of different analytical methods vary in sensitivity and output format (identifying them is much more difficult);
• Quantitative and qualitative information about pesticides is necessary when considering the human health hazard and getting rid of pesticides residues;
• Determining the detectable amount of pesticide residue on an object requires accurate calculations;
• getting rid of pesticides residues needs experience of medical toxicologist to detect the dosage amount of pesticide residue on an object that can be tolerated by the user/handler;
• Assessing the degree of removal pesticides residues requires determining the detectable amount of pesticide residue remaining on the object and again calculating/evaluating the dosage;
• Pesticide residues can be removed from the treated objects by accurate steps: collected, contained, and disposed of according to criteria (Pool *et al*., 2005).

Removal of pesticide crystals (PDB, naphthalene, DDT, and methoxychlor) has been applied by compressed air cleaning on ethnographic objects at the Danish National Museum (Glastrup 2001; Schmidt 2001).
Also there are other techniques can be used in pesticide removal for example: High-efficiency particulate air (HEPA) or ultralow penetration air (ULPA) filter vacuums have been recommended for removal of pesticide powders such as DDT and sodium hexa-fluorosilicate in archives collections (Altree-Williams et al. 1993; Caldwell 1995; Lundbaek 1995; Odegaard et al. 2003).
Wiping with acetone solvent has been recommended for removal of DDT from books at the Australian Archives (Caldwell 1995; Gustafsson 1993).

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