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A Comparison of Physical Degradations and Identification of Material between Two Malay Songket Artefacts

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Abstract
This paper discusses the physical deterioration of the two traditional Malay textile Songkets preserved by the Department of Museums Malaysia. The identification of material and degradation were investigated by using visual observation and scientific analysis. The visual observation was carried out to analyse the physical appearance by examining the characteristics, colour visualization, and the degree of deterioration of the textiles with the aid of a handheld optical digital microscope to capture the tangible characteristics and damages on the artefacts. Scientific analysis was carried out by using the FTIR instrument to determine the materials of two traditional Malay textile Songkets. The selections were controlled by the colour selection, type, form, style, and the material of the artefacts. The results show that both artefacts were made from silk and experienced physical deterioration. However, the degree of degradation was even more pronounced for Case Study 2 (CS2) although the material is the same. Furthermore, a distinct poor condition could be seen in Case Study 2 (CS2) in comparison to the condition of Case Study 1 (CS1).

Keywords: malay songket textile artefact; visual analysis; degradation factors; material identification

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1.0 Introduction

Songket belongs to the brocade family of textiles. The textile is hailed as “the cloth of gold” or “the Queen of fabrics” where it remains one of the most exquisite and sophisticated traditional Malay articles. Songket is interpreted as an everlasting fabric worn particularly by the Malays during ceremonial functions or cultural events. The word *songket* originates from the process of ‘sungkit’ which means the art of inserting metallic gold or silver threads in-between the base yarns to create surface patterns (Suhaile Che Ani, 2016). Floral or geometric objects are the source of inspiration in outlining the supplementary weft technique for the songket patterns (Mina Janpourtaher, 2018). The colour of the base woven fabric and the motifs from the shimmering threads composed the overall design layout in situ with accurate calculation. Hence, the uniqueness of the applied patterns and materials upheld its quality as one of the renowned textiles in Malaysia. Those characteristics illustrate the ingenuity of craftsmanship where the Department of Museums Malaysia is obliged to take charge of collecting, preserving and conserving the artefacts for current and future references (Hasma Ahmad, 2021). A continuous research effort is required to enhance the understanding of the fabric’s condition (Mina Janpourtaher, 2018). This is so that its lifespan could be further

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extended. This paper is to investigate on two Malay traditional songket artefacts from the Department of Museums Malaysia in Kuala Lumpur. The analyses were carried out by visual examination aided by a handheld optical digital microscope and Fourier Transform Infrared Spectroscopy (FTIR) technique.

2.0 Literature Review

Ancient textiles represent a significant part of cultural identity that provides rich evidence of social history, international trade and development, artistic trends and influences and technological progress (Garside & Wyeth, 2007). Songket is a Malay heritage textile that is woven by using either silk or cotton (Norwani Nawawi, 2002). The construction of the overall surface involves the addition of supplementary weft woven with gold or silver threads to highlight the design of the motifs. Historically, the songket textile was specially made for the Malay royals and aristocrats and to be worn only on special occasions. The materials such as silk and cotton were imported from China and India to be applied as the base material for the fabric, whereas metallic threads came from the Middle East (Arba'iyah Noor, 2019). These natural fibre yarns and threads hold prominent characteristics to be used for the making of songket. Although these materials were acknowledged in terms of aesthetics and functionality, they also imparted drawbacks to the intrinsic property of the textile. Significant changes could be seen when the textiles were kept for a certain period without proper and constant monitoring (Wyeth, 2005).

Songket like any other historic textile is prone to deterioration due to the nature of the ageing process. It is believed that the historic songket textiles kept in the Department of Museums Malaysia are more than 100 years of age (Zainon Ismail, 1997). As stated by Norwani Nawawi (2002) & Sarawak Museum Department (2020), the songket cloth is difficult to last as a genuine proof of its early existence in the past due to the tropical climate state in Malaysia which is hot and humid. These conditions accelerate the process of deterioration. Dyed textiles were commonly derived from natural organic substances, which are liable to deterioration. These include the natural organic materials used in the making of songket. Enas Amin (2018) and Boersma et al. (2007) indicated that textiles deteriorate through 2 factors: *natural factors* such as photochemical and chemical reaction, thermal effect, biological attack and physical ageing; and *human factors* such as mechanical, poor storage and handling and negligence.

Furthermore, the deterioration is also often due to a combination of these factors and interrelated causes that led to the damage and degradation of textiles (Lennard et al., 2010). Landi (1996) and Foekje Boersma et al., (2013) highlighted the degradation process affects the tensile strength of the natural fibres, which shortens the lifespan of textile, especially in tropical climates. Fourier-Transform Infrared Spectroscopy (FTIR) is one of the appropriate techniques used in identifying the material used and evaluating the level of deterioration for the artefacts as only a small quantity of samples requires for the testing (Carbó et al., 1996).

3.0 Methodology

Two types of procedures; visual analysis and scientific analysis were applied as part of the criteria for the experimental research methodology. Two songket textiles were chosen as case studies, where Case Study 1 (CS1) is sourced as artefact E645.1963.C4.13 and Case Study 2 (CS2) sourced as artefact E1985.1963.CEW.50. Both are in the same category: a maroon traditional Malay Songket *kain lepas* from Malaysia. The age of the textile is unknown. However, both artefacts' acquisition year was 1963 and their lifespan in the museum is 58 years. The textiles are most probably made from silk due to their texture and feel. The source of the dye used is unknown. Small fragments of broken threads or loose fibres were taken from the artefacts to further understand the conditions. Section 3.1 and Section 3.2 describe the detailed procedures.

3.1 Visual Analysis

Visual examination is the first step of the approach to studying the condition of the textile. It is to determine the characteristics of the material and the object's history based on the evidence of its physical condition. This observation will be aided by a handheld optical microscope with magnification of 20x and 200x. Other tools are a general light, acid-free paper, hand-magnifying lens, colour control ruler, measuring tape and a tweezer, which are placed on a clean table. A camera is essential for photographic documentation. The observation was recorded in a condition report form that has been designed specifically for this research.

3.2 Scientific Analysis

Fourier-Transform Infrared spectroscopy (FTIR) is a common tool used in identifying artefact materials (Badillo-Sanchez et al., 2019; Koperska *et al*., 2014). It is also used to evaluate the condition and degradation of the object for artefact conservation (Akyuz et al., 2015; Koperska *et al*., 2014).

This analysis was performed on the fragment samples from the two case studies along with 100% pure silk thread as a reference sample (Control sample). Fourier-Transform Infrared Spectroscopy (FTIR) was used to identify the selected case study samples' material to support the findings. Samples were studied using a Perkin-Elmer FTIR Spectrum One.

The FTIR spectroscopy in reflectance mode was applied to the samples and the pure silk thread (Control sample). Spectra were acquired over the range of the instrument from 4000 cm^{-1} to 650 cm^{-1}. A total of 16 scans were accumulated with a resolution of 4 cm^{-1}.

The spectra obtained were compared to the reference spectra. This analysis is to identify whether the characteristic peaks are similar and to confirm the material used on the textile artefacts. The FTIR assists in identifying the material degradation that occurs on the samples.

4.0 Findings

The findings of each case study are discussed based on the background information of the artefact obtained from the registration record from the museum. The descriptions are based on the characteristics, form, style, colour and conditions of the textiles.

4.1 Visual Analysis Findings

The artefacts' observation results and descriptions are estimated based on the composition of their appearance, character and texture. As the textiles were examined, similar visual degradation characteristics such as insect holes, the apparent fading of dyes, as well as fraying fibres, tears and folds and gilt colour loss could be seen on their surfaces. The degree of defects and damages are distinct and apparent.

4.1.1 Case Study 1: Sourced as Artefact E645.1963.C4.13

Based on the museum repository record found, the nature of accession was a gift to the museum. The place of origin is unknown and there is no information on the previous owner. The accession number is E645.1963.C4.13. It is kept in the repository room since 1963 under a controlled environment in which the temperature is at 18^{o}c – 22^{o}c with relative humidity (RH) range between 48% - 55%. The songket is stored in a roll technique sandwiched between acid-free papers due to its large size.

4.1.1.1 Description of Case Study 1

The artefact is a traditional long seamless songket also known as *Kain Lepas Songket*. The object's measurement is 232.5cm in length and 88.5cm in depth (Figure 1). It is a dark maroon songket with heavily interlaced with gold metallic thread. The textile is composed of intricate Malay design motifs namely, *tampuk manggis, pucuk rebung lawi ayam* and *bunga bintang pecah lapan*. These motifs are derived from the abstract representation of flora and fauna objects which can be found in Malaysia. The motifs are relatively captivating and beautify the body and the border of the songket.

Figure 1: The overall image of the songket artefact E645.1963.c4.13 and the characteristics – (a) body (badan kain) (b) the end of the cloth (punca kain)

The main characteristic of the kain lepas songket is that it is divided into three sections; the body section, known as *badan kain*, the "end of the cloth" section, known as *punca kain* and the feet section, which is called *kaki kain*. The *badan kain* is placed in the centre of the fabric that was heavily decorated with intricate repetitive motifs, whereas the *punca kain* is placed on the two sides of the fabric. The *punca kain* was decorated with a few combinations of motifs that are also in a repetitive manner. The *kaki kain* is also a repetitive motif that represents borders. The motifs are equally decorated on both sides (front and back) of the textile.

The primary colour of the overall textile is maroon and the secondary colour is the gold gilt thread. The colour scheme could be seen in Figure 2 with a magnification of 200x. Through visual and touch observation, it is evident that the artefact from Case Study 1 is found thicker in dimension when compared with Case Study 2.

Figure 2: Microscopic image of the artefact's colour scheme with a magnification of 200x

4.1.1.2 Condition of Case Study 1

The overall condition of the artefact is fair. There are several areas of defects found in the textile where the major defects are found as tears on the edges. There are also slight tears discovered on the *badan kain* (Figure 3). These tears are most probably due to improper handling and poor storage from the previous owner. Fibre breakage and brittleness can also be seen through the folded lines of the songket. The investigation also discovered that the textile fibre experienced thermal behaviour conditions where it lost some of its moisture. This led to the slight brittleness of the material. Most likely it is due to inappropriate temperature and humidity during the usage of the item. When the fibre becomes brittle, it loses its flexibility which subsequently weakens the natural properties and finally breaks into tears.

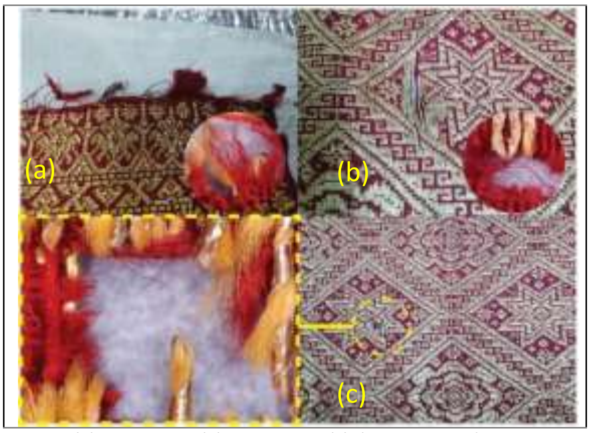

Figure 3: Tears found on the (a) edges and (b) centre and (c) 1 insect hole found with a magnification of 200x

There is only one insect hole found on the textile (Figure 3). The insect hole is a biological attack that is probably due to cockroach or cloth moth infestation attracted to protein fibres, especially on silk.

4.1.1.2 Case Study 2: Sourced as Artefact E1985.1963.CEW.50

The artefact was donated to the museum. The donor and the place of origin are unknown. The accession number is E1985.1963.CEW.50 and was also obtained in 1963. The artefact is kept in a roll technique sandwiched between acid-free papers in the same condition as the CS1.

4.1.1.3 Description of Case Study 2

The artefact is a long seamless songket cloth also known as *Kain Lepas Songket.* The dimension is 285cm long and 106cm in width (Figure 4). The textile has a two-tone dark red interweaving with gold and silver metallic thread. The full arrangement of the *kesemak, pucuk rebung* and *bunga bintang pecah lapan* motifs evidently composed the overall design layout of the textile. The motifs are delicately woven and smaller in terms of size.

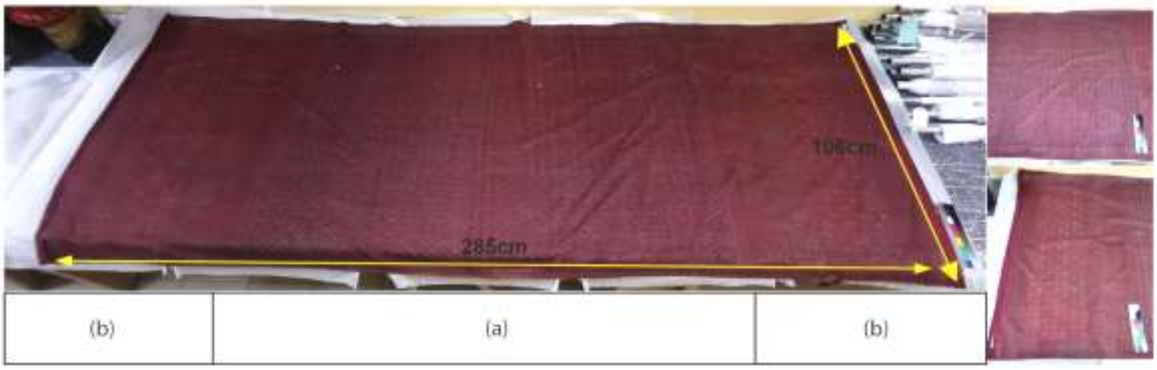

Figure 4: Overall view of songket artefact E1985.1963.cew.50 and the characteristics - (a) body (badan kain) (b) the end of the cloth (punca kain)

The artefact is also divided into three sections: the *badan kain*, *punca kain* and *kaki kain* (Figure 4). The identified primary colour used on the songket is lighter maroon for the end of cloth (*punca kain*) and darker maroon for the body songket (*badan kain*). Silver and gold gilt threads were used as the secondary colour. The colour schemes are presented together with the magnified images (magnification of 200x) of the threads in Figure 5.

Figure 5: Microscopic image of maroon, red and silver gilt thread (magnification 20x & 200x)

4.1.1.3 Condition of Case Study 2

The condition of the textile in Figure 6 is in a poor state. The fabric is brittle which makes it fragile for handling. Several tears are found around the artefact: at the object's edges and centre part. The tears are severe; more so when the fibres were touched during the observation. They are easily broken, which is most probably due to thermal factors such as inappropriate humidity and temperature condition. Another factor contributing to the tears is most likely caused by negligence and poor care given to the textile.

Figure 6: Tears (a) and holes (b) found at the middle and edges of the songket with a microscopic image (magnification 200x)

Insect holes were found on the textile artefact (Figure 6) with a microscopic image of the hole. There are small and large sizes ranging from 0.3cm to 2.5cm in various areas mostly on the *badan kain* and *punca kain.* It is probably a biological attack due to insect infestations such as cockroaches or cloth moths. There was a lack of proper care given by the previous owner to ensure the safeguard and preserve the textile's lifespan.

The core yarn of the silver-gilt thread has become visible due to the mechanical damage over the years of flexing and straining the fabric (Figure 7). It experiences colour fading on the front part of the textile most likely due to a photochemical reaction. There is colour shift or colour loss on the silver and gold gilt due to ageing and thermal reaction. The textile also experiences powdering which is probably caused by physical ageing and thermal factors such as unsuitable humidity and temperature. This made the fibre becomes brittle and fragile.

Figure 7: Colour fading comparison between front and back, colour gilt loss and powdering transfer on the glove (magnification of 200x)

4.2 Scientific Analysis Findings

Figures 8 and 9 show the FTIR analysis results between pure silk thread (Control Sample) and Case Study 1 and Case Study 2 artefact samples. Both artefact samples show similar characteristic peaks of silk material. Pure silk fibres showed the characteristic peaks at 3273 cm^{-1} that is because of hydrogen stretching, a peak at 1617 cm^{-1} from carbonyl stretching and a peak at 1514 cm^{-1} from hydrogen bending of Tyrosine. Other specific peaks are 1440 cm^{-1} bending in alanine and 1229 cm^{-1} stretching in peptide bonds that link the amino acids of proteins together (Boulet-Audet *et al*., 2015; Koperska *et al*., 2014). The difference between both FTIR spectra is in their fingerprint region, which is probably due to the presence of natural dye applied to the artefacts.

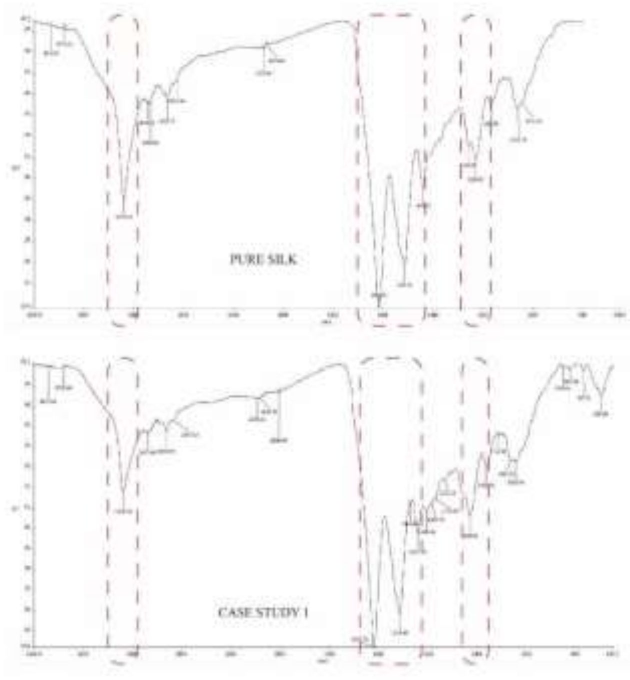

Figure 8:Comparison between pure silk thread (Control Sample) and CS 1

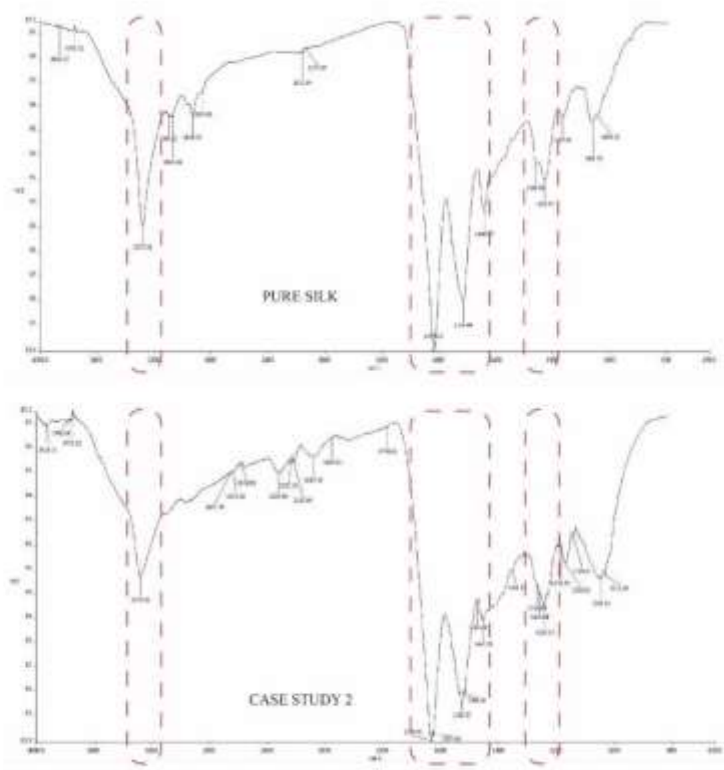

Figure 9: Comparison between pure silk thread (Control Sample) and CS 2

5.0 Discussion

Table 1:Comparison of visual observation between CS 1 and CS 2

VISUAL OBSERVATION						
	Overall	**Fragility**	**Powdering**	**Tear(s)**	**Insect Hole(s)**	**Fading**
CS 1	fair	moderate	minor	edges	< 2	no
CS 2	poor	poor	severe	Several areas	Several areas	yes

Bands in this region could link to deformation vibrations of -C-H groups in free amino acids, or -C-H symmetric bending found in bicarboxylic acids.

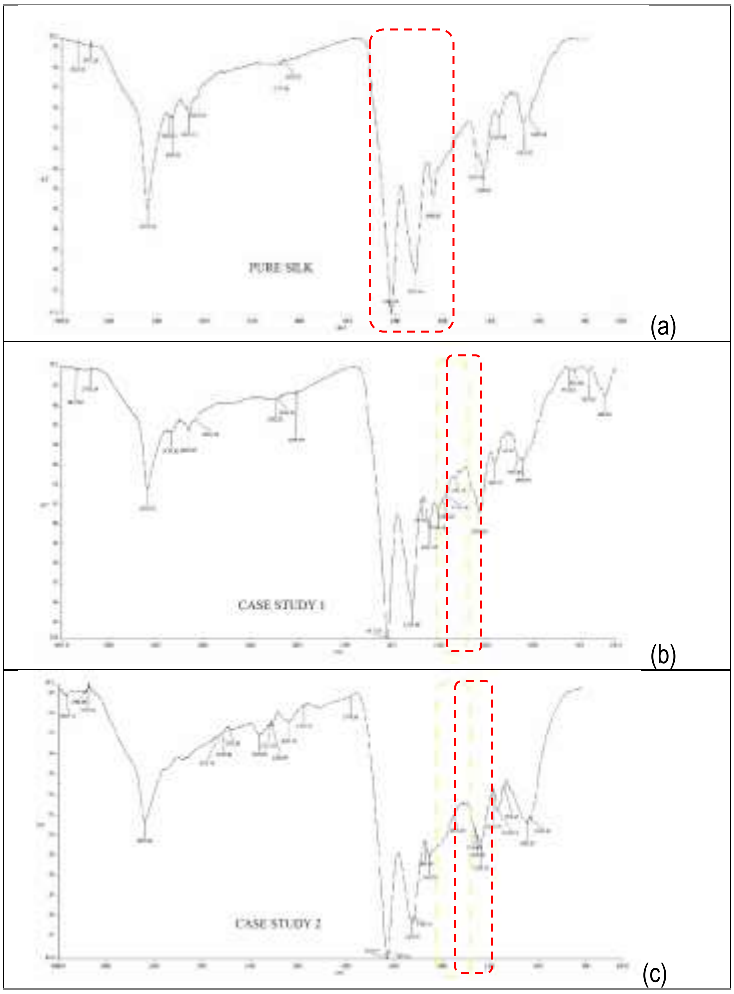

Figure 10: (a) Pure Silk Spectra, (b,c) New Peak Assigned For The Bicarboxylic Acid

The result shows in Table 1; the CS 1 overall condition appears to be in a fair state compared to the overall condition of CS 2 which is in poor shape. Fragility is more visible in CS 2, whereas CS 1 appears to be the sturdier and more acceptable condition. The textiles experienced powdering where the metallic gilt threads are flaky. However, CS 2 is noticeably severe, as well as tears were found with a greater form. It became weakened when exposed to natural factors such as high heat, temperature and humidity. This is because textiles are very prone to ageing causes photochemical degradation to vulnerable dyes and fibre mainly due to oxidation (Cybulska & Wrzosek, 2007). The change of tensile properties of natural fibre due to physical and chemical degradation which can cause bonds to break that damage the structure of the material (Cakan et al., 2015; Koperska et al., 2014). Furthermore, the artefacts experienced a biological attack by insects such as cockroaches and cloth moths which can be seen in the characteristics of the holes on the artefacts. A cloth moth typically creates large holes which are bigger than 1cm in diameter, whereas a cockroach creates small holes less than 1cm in diameter (Pinniger & Winsor, 2004). However, the holes are more apparent in CS 2, where they can be seen all around the artefact. The insect threat is greater in tropical climates because of the high temperature and humidity, which is in favour of growth (Child, 2007; Querner, 2015). Visually, CS 2 experiences colour fading when compared between the front and back of the textile. The fading was caused by environmental factor due to the light exposure during usage. The location of the faded area from the textile frontal part suggests that the fading seems to be prone to light exposure whereas, the inner part appears to be darker indicating of non-contact to light. Therefore, this example suggests that environmental parameters of light exposure could have been involved in the degradation of the dye(Costantini et al., 2019). Additionally, poor handling also affects the durability and the degree of deterioration.

The microscopic image reveals that both artefacts are woven through traditional weaving techniques. The weave pattern of fabric could affect its thickness condition and durability. The FTIR analysis confirms both artefacts used silk base fibre to weave the textiles. Figure 10 (a) shows the FTIR spectrum for pure silk. The characteristic peaks for pure silk were observed at 1617cm^{-1} assigned for the carbonyl functional group. The outcome was also observed in the presence of new peaks at 1318cm^{-1} for both FTIR spectra of artefact CS 1 in 2 (Figure 10 b, c). The peak at the range between 1420cm^{-1} – 1300cm^{-1} is assigned for bicarboxylic acid, which is formed upon peptide bond breaking during the degradation of the sample. This finding is in agreement with Koperska *et al*. (2014) and Akyuz *et al*. (2015). It is mentioned that the degradation of silk might be due to prolonged exposure to water vapour and oxygen. The peak assigned for the bicarboxylic acid in the FTIR spectra for CS 1 and CS 2 evidently shows the occurrence of degradation in both artefact samples.

There had been greater awareness of the need for preventive conservation for cultural heritage safekeeping, resulting in the demand for more specialised conservators (Foekje Boersma *et al*., 2013). The analytical science approach is able to play an important role in ensuring the appropriate analysis of the necessary preservation and continuous enjoyment of such cultural heritage (Garside & Wyeth, 2007). It requires expert knowledge to understand the degradation process for preventive conservation (Foekje Boersma *et al*., 2013).

6.0 Conclusion and Recommendations

In conclusion, the study provides evidence that the selected artefacts are from animal-based fibre; silk. The obtained results provide first-hand information on material degradation changes of the songket artefacts observed at the Department of Museums Malaysia in Kuala Lumpur. Furthermore, the FTIR instrument is a suitable technique for quick, easy and non-invasive analysis of textile samples. It was shown that the spectra of degradation of artefact silk textiles based on FTIR analyses can be detected and described.

Nevertheless, the research could only provide results from material identification where certain criteria are restricted. Hence, the outcomes are unable to provide a detailed characterization of the samples. The information is not sufficient to yield a whole characterization of the artefact such as the colour properties, the method used, degree of degradation, age and conditions. This information would be ideal for the conservation field to understand the preservation work in depth. The preliminary outcomes from the executed methodology could be further extended in other textile research experiments in the future.

To maintain this textile cultural and historical heritage, in-depth research into material identification and material degradation is necessary prior to restoring and preserve the artefacts. In verifying the textile material, this finding could help to understand the reactions that deteriorate the fibre materials. The outcomes will assist museum conservators, material scientists and art historians establish a detailed data record to evaluate and understand the artefact's condition.

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