UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES EFFECT FOR NEW COMPOSITION OF EPOXY RESIN REINFORCED KENAF FIBER THROUGH TORSION AND IMPACT ANALYSIS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of manufacturing Engineering Technology (Maintenance Technology) with Honours

by

EIDDI NOOR AZIZI BIN JUWAHIR

B071410836

930813015527

FACULTY OF ENGINEERING TECHNOLOGY

2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Experimental Investigation On Mechanical Properties Effect For New Composition Of Epoxy Resin Reinforced Kenaf Fiber Through Torsion And Impact Analysis**

SESI PENGAJIAN: **2017/18 Semester 1**

Saya **EIDDI NOOR AZIZI BIN JUWAHIR**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.

☐	SULIT	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TERHAD	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☑	TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:

NO 12 JALAN 4H/KU4,
TAMAN DAGANG KG RANTAU
PANJANG, 42100 KLANG SELANGOR

Cop Rasmi:

Tarikh: _____

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "**Preliminary study of mechanical properties for composite reinforce kenaf fiber through torsion and impact analysis**" is result of my own research except as cited in references

Signature :

Author's Name : EIDDI NOOR AZIZI BIN JUWAHIR

Date : 15/1/2018

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Maintenance Technology) with Honour. The member of the supervisory is as follow:

……..

(Project Supervisor)

Mr. Mohd Afdhal Bin Shamsudin

ABSTRAK

Serat adalah salah satu daripada unsur-unsur dengan fasa gabungan matriks untuk menjadi struktur bahan baru yang dipanggil komposit. Kombinasi kedua-dua jenis memberi fungsi tertentu di mana gentian sebagai tetulang dalam komposit adalah untuk menyediakan kepada kekuatan keseluruhan rencam. Dalam pengeluaran sumber komposit pada masa ini, gabungan elemen yang digunakan mesti mempunyai arah persekitaran teknologi yang lebih mesra, di mana ia boleh memberi kesan kepada kadar rendah pencemaran untuk jangka masa panjang. Antara jenis yang dipilih ciri akses gentian yang memerlukan lebih mesra alam adalah serat semula jadi. Dalam kajian ini, gentian kenaf bercampur dengan resin epoxy untuk membentuk gentian ber tetulang komposit polimer yang meningkatkan kekuatan komposit. Kemudian, serat kenaf akan disusun dalam kedudukan selari. Kelakuan serat semula jadi atau polimer komposit akan menganalisis dan dibandingkan dengan bersamaan sintetik untuk membuat kesimpulan sama ada serat semula jadi teknikal berkelayakan untuk menggantikan serat sintetik. Hasil yang dijangka dalam kajian ini adalah kenaikan peratusan berat kenaf akan meningkatkan nilai modulus ketegaran. Hasil keseluruhan kajian menunjukkan bahawa unsur-unsur yang menjejaskan ke arah peningkatan hasilnya adalah serat yang baik terikat antara, kekuatan pengagihan yang betul, dan penyerapan tenaga.

ABSTRACT

Fiber is an element to make a matrix combination phase to become a new material structure that called as a composite. These combinations of these matrix will give specific function where the fiber react as the reinforcement in the composite which is to provide the strength to the overall of the composite. Recently, the developments of green products in composite field have gained attention. However, the usage of synthetic materials has been confined in some mechanical engineering sector. Although natural fibers are highly preferred in features, but the strength of natural fiber polymer is lower than synthetic fiber. However, some treatment can be done to the natural fiber to improve the strength of polymer composites when reinforcing natural fiber in different conditions. The objectives of this project are to fabricate new composition of epoxy resin reinforced kenaf fiber and to test and analyse kenaf fiber specimen through impact and torsion test. The methodology has been used to complete this experiment based on material selection which used kenaf fiber and epoxy resin and make as composition. This experiment was followed ASTM D6110 for impact test and D1043 for torsion test. From the result, the impact test was recorded at the composition in range 55 wt.% kenaf fiber was recorded the high value modulus of rigidity meanwhile composition in range 70 wt.% was recorded the high value of energy absorption. As a conclusion, these composition are suitable being used in the industry as a replacement of the existing fiber.

ACKNOWLEDGEMENT

Alhamdulillah, all thanks should be praise to Allah as He help and ease me so much to complete this project successfully. This research project won't be complete without people surrounding me who give a lot support and help.

Respect, love and thanks to my family members - my father, my mother who gave so much moral support throughout this process. Not forgotten for my siblings who encourage me a lot. Thanks for your understanding and support.

I would like to thanks my supervisor, Mr Mohd Afdhal bin Shamsudin who guide me and help me throughout this whole process of completing this research project. He has helped me so much and gives his best despite having lot of works and responsible to deliver. Without him, I do believe that this project won't complete.

I would like to also thank all my friends who help me by discussing this project. All gratitude for all people who get involved with this project. I do wish this research would be beneficial for future reference. Thank you.

TABLE OF CONTENT

CHAPTER 3: METHODOLOGY

CHAPTER 4: RESULT AND DISCUSSION

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 Introduction

Nowadays, there has been rising interest in the use of natural fibers in composites applications (H.M.Akil et.al, 2011). Before this, most of research and engineering more interest to fiber-reinforce polymer-based composited than used traditional monolithic materials. This is because these composites have advantages such as high strength to weight ratio, high fracture toughness and noncorrosive property (Ammas W et.al, 1998). However, due to advantages, they also have disadvantages such as health risk when inhaled (Pickering KL et.al, 2016), nonrecycleable (Shah AA et.al, 2008), high energy consumption in the manufacturing process (Vroman I et.al, 2009) and non-renewable (Mohanty AK et.al, 2000).

According to the disadvantages of synthetic fiber, the replacement of synthetic fiber should be found to overcome the disadvantages. Natural fiber should be the best replacement of synthetic fiber due to low cost, low weight and less damaged characteristics compared to synthetic fiber, and most of sector such as furniture, construction, automotive and packing prefer to use natural fiber than synthetic fiber (Yousif et.al, 2009). Unstable of world economy also will be the reason why natural fiber will be highly preferred among the sectors above. Although natural fibers are highly preferred in features, but the strength of natural fiber polymer is lower than synthetic fiber (Chin CW et.al, 2008).

In this project, natural fiber that will be used is kenaf. Kenaf is belongs to the genus *hibiscus cannabinus* and family *Malvaceae* obtained from stem s of plants which also includes cotton (*Gossypium* spp.) and okra (*Abelmoschus esculentus* L. Moench.) and there have 300 species (Salleh Z et.al, 2012). Furthermore, kenaf is an economically herbaceous plant that can be growth at variety weather conditions in

Malaysia especially. Kenaf fiber also has better characteristics compared to other natural fiber, such as long fibre, small diameter and high interfacial adhesion (Meona MS et.al, 2012).

However, the usage of original natural fiber in production industries seems impractical because there have some disadvantages of natural fiber such as poor moisture resistance and low strength compared to synthetic fiber (Zhang Y et.al, 2013). But, this disadvantage can be solved through some treatment on the natural fiber to improve their strength. The purpose of treatment is to increase the mechanical properties due to the disadvantages of natural fiber or kenaf is weakness mechanical properties compared to synthetic fiber.

While conduct this project, the treatment has been applied on the kenaf fiber due to weakness of mechanical properties. Kenaf reinforced with composite will be bio composite and it is suitable to replace or reduce the usage of synthetic fiber. In this project, the Epoxy reinforced kenaf fibre that will be investigate through impact and torsion test with 5% increament start from 0% until approximately 55% of kenaf. The specimen will be testing through torsion testing to calculate the modulus of rigidity and impact testing to get the toughness of fiber after the experiments. This experiment will use hand lay-up mould technique. The potential of kenaf fiber will be observe through this project. This project will used suitable mould that has been pattern before. Sample prepare by using ASTM mould size.

1.2 Problem statement

Recently, the developments of green products in composite field have gained attention. However, the usage of synthetic materials has been confined in some mechanical engineering sector. The exchange on the use of natural fibers in the world for the production of green composites has been reported (Jacob et.al, 2008). In additional, suitable comparator for synthetic fiber is natural fiber in ecological characteristics but in mechanical strength synthetic fiber still higher than natural fiber. Due to low cost, low weight and less damaged characteristics compared to synthetic fiber, most of sector such as furniture, construction, automotive and packing prefer to use natural fiber than synthetic fiber (Yousif et.al, 2009).

Although natural fibers are highly preferred in features, but the strength of natural fiber polymer is lower than synthetic fiber (Chin CW et.al, 2008). However, some treatment can be done to the natural fiber to improve the strength of polymer composites when reinforcing natural fiber in different conditions (Dittenber Db et.al, 2012). According to the researcher before, the treatment will produce different strength in these composites compared to synthetic composites. The different orientations will make value of rigidity composite be difference and stronger comparable to those of synthetic fibers (Faruk O et.al, 2012). The different orientations will make value of rigidity composite be difference and stronger comparable to those of synthetic fibers (Faruk O et.al, 2012). Kenaf fiber also has better characteristics compared to other natural fiber, such as long fiber, small diameter and high interfacial adhesion (Meona MS et.al, 2012).

Besides that, from several studies about mechanical properties have reported natural fiber reinforced highly depends on the interface adhesion property between the fiber and polymer matrix (Franco PJ et.al,2004, Sapuan SM et.al, 2006, Wambua P et.al, 2003, Shinji, 2008). For more information, according to S. Kasiviswanathan et.al, 2015, natural fibers contain cellulose, hemicelluloses, pectins and lignin and rich in hydroxyl 1 groups; natural fibers tend to be strong polar and hydrophilic material while polymer materials are a polar and exhibit significant hydrophobicity (Kasiviswanathan et.al, 2015).

1.3 Objective

Objectives of this project as follows :-

i. To fabricate new composition of epoxy resin reinforced kenaf fiber.
ii. To test and analyse kenaf fiber specimen through impact and torsion test.

1.4 Scope

Scope of the project are :-

i. Fabricating new composition of epoxy resin reinforced of kenaf fiber using hand lay-up mould technique.
ii. Testing the kenaf fiber through impact test by using pendulum impact machine.
iii. Testing the kenaf fiber through torsion test by using torsion testing machine.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

At the initial stage of the project, literature review is previous research that included accumulation information from other sources such as the internet and the resources that associated with the project. Accumulation information from literature study is very important, especially as the initial step of the study. It also identifies main problem that related with the project. Fibres is like a thread, or more precise, like hair which has a continuous filamentous nature. These can be rotated into threads and strings that are stronger or may be made to other structures such as sheets or papers by dragging them together using different techniques. Besides that, these threads and sheets can be used in the production of various complicated materials such as fabrics. For an example, the textile industry is currently broadening its search an alternative green fibers or natural fibers with the aim of providing healthy, comfortable clothing which at the end of its lifetime, will be fully recyclable and biodegradable. There is one example important of natural fiber in textile sector. Besides that, there have some sector used natural fibers as their main materials to replace existing fiber such synthetic fiber in automotive sector.

2.2 Comparison natural fiber and synthetic fiber

There have two categories of fibers which is natural fiber and synthetic fiber. Natural fibers are taken from plants and animals, whereas synthetics are usually entirely or at least partly man-made. In this experiment, natural fiber will be used to replacing the existing fiber which is synthetic fiber. Common in the industries will used synthetic fiber as their main material especially in textile or automotive sector. However, due to highly cost if they remain using synthetic fiber as main material it

will give effect to their cost spending and profit especially. So, the replacing of synthetic fiber should be found to reduce the cost in material especially and the solution of this problem is used natural fiber to replace existing fiber. Moreover, natural fiber is low cost, low weight and less damage compared to synthetic fiber (Chin CW et.al, 2009).

As information, natural fibers have been an important role in human society since approximately 7000 BC. In additional, natural fiber is completely biodegradable and their production does not generally damage the ecosystem (Ryder, M.L, 1965). Natural fiber has gained better attention lately due to the exclusive properties like low specific weight, high specific strength, high stiffness and biodegradability and it is also eco-friendly nature (Lee et.al, 2009). However, while there have benefits, natural fiber also has some disadvantages compared to synthetic fiber such as poor moisture resistance and low strength. Besides that, natural fibers have limited usage when compared to synthetic fiber. Meanwhile, the synthetic has most disadvantages compared to natural fiber. Fabric mostly made of natural fibers because natural fiber generally more comfortable than synthetic fiber. In synthetic fibres, spinnerets are used to produce the filaments whereas, in natural fibres, it is naturally made. The most important thing is natural fibers are biodegradable hence environmentally friendly unlike synthetic fiber.

The discovery of synthetic fibers reduces the popularity of natural fibers because of its environmentally friendly and durability. However, due to rising prices for petroleum and petroleum products and also due to rising environmental concerns, the need to use natural fibers has returned. Dying facilities, high demand in human clothing, the cheapest and eco-friendly price can be seen as the advantages of synthetic natural fibers. Synthetic fibers are widely used in many industries, and even in human clothing. Synthetic fibers are increasingly popular because of their desired nature in natural fibers especially when it comes to strength and durability. The authenticity of the synthetic fiber chemicals is believed to be far above natural fibers as it does not contain undesirable dust and particles as in natural fibers.

These fibers are almost entirely made by humans using petrochemical products, and are forced through fiber materials to form spinneret. Therefore, the filaments are made artificially. It is therefore possible to change the chemical structure of the fibrous material if needed to provide a better nature, which is

unlikely when using natural fibers. Compared to natural fibers, synthetic is also easy to wash and maintain. However, it is difficult to color synthetic fibers with dyes because absorption is not as fast and easy as with natural fibers. The main disadvantages of using synthetic fibers are heat sensitization and are not environmentally friendly. Table 2.1 shows a general comparison between natural fibers and synthetic fibers.

Table 2.1: General comparison between natural fiber and synthetic fiber

Properties / Type of fiber	Natural fiber	Synthetic fiber
Availability	Limited	Unlimited
Cost production	High	Low
Life expectancy	Short-Medium	Long
Chemical treatments	Less	High

2.3 Natural fiber

Natural fibres are mainly used in the production of fabrics due to the comfort of the materials. Some commonly known includes cotton, silk and wool. But other natural fibres are used in various industries, to produce ropes, aerofoils, bags and brushes. Most natural fibers can be taken from lignocellulosic fibrous plants such as flax, jute, hemp, kenaf, sisal, ramie, abaca, curaua, cabuya, pineapple and bamboo (Franck et.al, 2005). Figure 2.1 shown the classification of natural fiber and synthetic fiber. The usage of each different type of fibre (K-Chart) depends on its own characteristics such as strength, breathability etc. As mentioned above, natural fibres can come from both animals and plants, where plant fibres have a more cellulose nature and the animal fibres have a protein nature. Plant fibres are usually collected from various parts of the plant such as fruits, leaves, seeds, stalks, straws etc. Fibres from animals are mainly collected from fibre secreting glands (silk from the silk worm), animal hair (wool from sheep, cashmere from goats) and from bird's feathers.

Natural fibers are generally characterized by their most important properties such as air permeability, hygroscopicity, ability to release moisture, the fact that they do not release any substances harmful to health or cause allergic reaction and by their biodegrability and lower flammability in comparison to man-made fibers (synthetic fiber) (Kozlowski R.M et.al, 2010). According to the K-Chart, the natural fibers can be classified into 3 which is animal, cellulose/lignocellulose and mineral. In animal classification, it can be classified into 3 there is silk fiber, wool fiber and animal hair fiber meanwhile cellulose can be classified into 7 class according to the K-Chart provided. There is bust, leaf, seed, fruit, wood, stalk and grass/reeds. Then, in mineral there have asbestos. All of these class are under natural fiber that can replacing existing fiber but need to identify all their characteristic such as mechanical properties whether fully covered all the criteria required before made a decision to select these fiber. The grouping of different categories for natural fibers can be divided based on their origin, derivations of plant, animal and mineral types (Bledzki AK. et.al, 2002). Classification of different natural fiber shown in Figure 2.1.

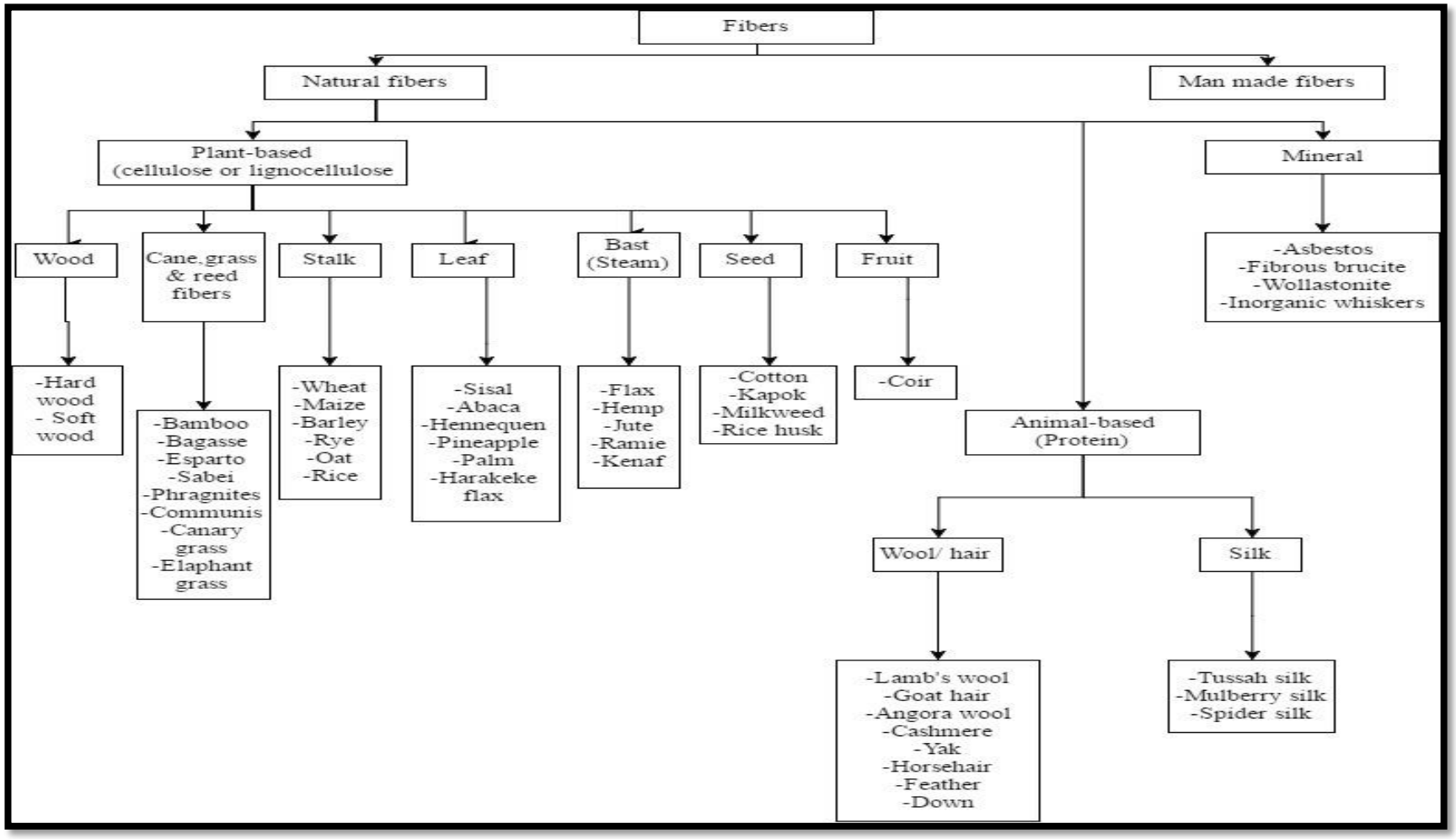

Figure 2.1: The classification of different natural fiber (Mei-po Ho and Hao Wang, 2012)

2.3.1 Animal

There have various types of animal's hair fibers that are generally referred to as luxury fibers. These fibers are produced by animal which inhabit inhospitable mountainous regions, covering a range of altitudes and extreme climates, where a highly insulating and protective fibrous coat is essential for survival. The hair and fiber tend to be medullated, which combines good insulation with lightness. Due to the extremes of temperatures they encounter, most of these animals have developed two distinctly different coats which is firstly an outer coat consisting of course medullated guard hairs, produced by the primary follicles, which offers protection from the sun, rain and dust and secondly a finer and shorter down hair or fiber (undercoat or inner coat), produces by the secondary follicles, which provides outstanding insulation against extremes in temperature (Stoves J.L et.al, 1976).

2.3.2 Silk

Silk is one of the oldest fibers known in the world. Silk is an animal fiber produced by certain insect to build their cocoons and webs. Even though many insects produce silk, only filament produced by the mulberry silk moth, Bombyx mori and a few in the same genus is used by the commercial silk industry (Jolly et.al, 1979). The silk produced by other insect especially spiders, is used in a small cross-hairs and other optical instruments (Spring and Hudson, 2002). In additional, silk has been a highly valued textile fiber. Its qualities of strength, elasticity, softness, absorbency, affinity for dyes and adaptability to various forms of twisting continue to satisfy various market demands. Even though they face tough competition from man-made fiber, silk has maintained its supremacy in the production of luxury apparel and specialized goods of the highest quality (Robson, 1998).

Silk has been used as a textile fiber for over 4000 years due of its high tensile strength, lustrate and ability to bind chemical dyes, silk is still considered a premier textile material in the world today (Zarkoob et.al, 2000). The main reasons for this long-term success are the unique lustre, tactile properties, durability and dyeability of silks. Silk fibers are remarkable material displaying unusual mechanical properties such as strong, extensible and mechanically compressible (Matsumoto et.al, 2006).

Silk is rightly called the queen of textiles for its lustre, sensuousness and glamour (Reddy, 2009). Moreover, silk's natural beauty and properties of comfort in warm weather and warmth during colder season have made it useful in high-fashion clothing especially. Besides that, silk fiber have outstanding natural properties which rival the most advanced synthetic polymers, yet the production of silk does not require harsh processing conditions and hence widespread investigation are being undertaken even for artificial synthesis of silk fiber (Chen et.al, 2003).

2.3.3 Wool

Wool fiber is natural, sustainable and biodegradable, all of which are highly valuable properties in the textile industry. The environmental advantage provided by these properties is an increasingly popular requirement for textile fiber, but wool has many other inherent benefits, which have earned it a reputation for quality from global manufacturers and consumers. Wool is one of the earth's most sustainable resources. It is also eco-friendly due to its ability to biodegrade without harm to the environment, and it can be recycled. These inherent advantages continue to support wool's heritage as the best natural eco-fibe (Zahn et.al, 2003).

2.3.4 Hair

The main speciality animal hair fiber covered can be grouped into the following three families or groups :-

- Goat (Capra Hircus)
  - Cashmere (Capra hircus laniger)
  - Angora (Capra hircus aegagrus)
  - Cashgora
- Camel (Camelid/Camelus)
  - Alpaca (Lama pacos)
  - Bactrian camel (Camelus bactrianus)
  - Guanaco (Lama hunchus or Lama guanicoe)
  - Vicuna (Vicugna vicugna)