Development of nonwoven fabric using *Areca catechu* and cotton fiber blends

By

Vanitha. B

15PTF010

A Thesis submitted to the

Avinashilingam Institute for Home Science and Higher Education for Women,

Coimbatore-641 043

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

in

Textiles and Fashion Apparel

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Certified as Bonafide Research Work

Signature of the Head of the Department

Signature of the Guide

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1. INTRODUCTION

Environmental issues have resulted in considerable interest in the development of new composite materials based on biodegradable resources. The thrust on developing innovative and weight less material from locally available, cheaper and renewable sees was of greater interest. Presently the annual production of natural fibers in India was approximately 14.5 million tons. The natural fibers have have been classified into many types such as bast, leaf, seed, fruit and wood fibers. These fibers were traditionally used for various purpose such as rope , roofing , house hold appliance , bandage etc. The main advantages of these natural reinforced composites are high specific strength and modules , availably , low cost , high weight , recyclability , bio degradability, lack of health hazards and nonabrasive nature (Sathis Kumar ,2002).

In the recent years, there has been a growing interest for manufacturing cost effective and ecofriendly products along with the superior properties for utilization in the field of industrial sector (Dhanalakshmi, 2015). In a textiles industry to replace synthetic fiber with natural fiber is increasingly due to environmental corners. Synthetic fibers are commonly used in composite fabrication owing to their excellent mechanical property. The synthetic fibers are non-biodegradable . Hence many attempts are made to find alternative for synthetic fiber. The natural fibber available everywhere (Jawaid and khalil, 2011). The main advantages of natural fibers are cost effective , light weight, safer, abundantly available ,ecological sustainable ,biodegradable , good acoustic properties,etc (jawaid,2017).The application of natural fiber are growing in many sectors such as automobiles ,furniture ,packaging, and construction etc. (Sanjay , 2016)

Softening is generally defined as the process of modifying the handle or feel of textiles for better comfort, better wear or performance under defined condition of use. Softening process are therefore considered for niche application in medical textiles, including implants , protective clothing ,sports clothing and such other select forms of technical textiles . Softening treatment of textiles is carried out by chemical or mechanical means or usually a combination of both .A variety of chemical softeners, classified on the basis of their chemical nature into cationic ,anionic , nonionic or silicon based ,are used . Biochemical methods involving the use of enzymes are also used for to soften or smooth natural textile materials.(Gulrajani,2013). Many advantages of using enzymes in textiles such as nontoxic , save water, energy as well as chemicals , increase the productivity, less hazardous , biodegradable , environmental friendly (Mahabub hasan, 2015).

The use of enzyme on textiles play key role as an alternative process for textile processing and have become an integral part of the textile processing industry. The process of use of enzymes is energy saving and does not require any special equipment for heat and resistance, pressure or corrosion .Their efficiency high biodegradability and the mild conditions of working mark their use in a wide range of industrial applications . Enzymes work only on renewable raw material .The 7000 enzymes known, only about 75 are used in the textile industry (Shrimali, 2013).

Blending of different fibers is a very common practice in the spinning industries. The blending is primarily done to enhance the properties of resultant fiber mix and to Optimize the cost of the raw material. The properties of blended of fibers are primarily

depend on the properties of the constituent fibers and their compatibility. Moreover, the Proportion of fibers in the blend also plays a significant role (Majumdar, 2011). All fibers are combined of good, fair and poor characteristics. Blending enable technicians to combine fibers so that good qualities are emphasized and poor qualities are minimized (Ola and Pant, 2000).

The machinery parameters, the quality of fibers and the quality of nonwoven to be produced, obviously the machinery process depends upon on the way to consolidate the fibers structure which can be mechanical, chemical or thermal consolidation (Russell, 2005). The nonwoven mechanical properties are mainly depended on the machinery parameters particularly for mechanical consolidation by needle punching. The needle gauge, the needling density, the needle penetration and the passage number present also an important effect on the nonwoven thickness, weight, density, tensile properties (Ramaswamy 2003).

Nonwoven fabrics are engineered fabrics that may be a limited life, single use fabric or a very durable fabric. Nonwoven fabrics provide specific functions such as absorbency, softness and strength, flame retardancy, cushioning and filtering. These properties are often combined to create fabrics suited for specific jobs, while achieving a good balance between the product use – life and cost (Subhash, 2012)

Needle punched nonwoven fabric production line is one kind of methods for producing nonwoven fabrics. In the process of producing, instead of using the traditional weaving process of the fabrics, the needle punch bond method uses triangle needle punching in the web to make the fibers directly tangle each other together, controlling the density, intensity and function of the fabrics by needle density, needle depth, needle number and other physical elements. No water, air, heat and chemicals are needed at all. It is a kind of pure physical and mechanical bonding method, saving energy and non-pollution .Finished products maintain 100%yield from raw material. It is the best green products for environmental protection .and finally it still can be 100%recyeled by physical disposal and can be reused .(www.academia.edu).

All the natural fibers reinforcing materials, areca fibers appear to be a promising material because it is inexpensive, abundantly available and a very high potential crop. It belongs to the species *Areca catechu* under the family of palmecea and originates in the Malaya peninsular, east India (Akhila rajan .2005). Major Indian cultivation is in east India and other countries in Asia. In India, areca cultivation is coming up in a large scale basis with a view to attaining self-sufficiency in medicine, paint chocolate, chewable guta , etc. The fiber could be used for making value-added items such as thick boards, fluffy cushions, thermal insulators and non-woven fabrics (Arifulla 2007). Areca husk fibers are predominantly composed of hemicelluloses and not of cellulose. The fibers adjoining the inner layer are irregularly lignified group of cells called hard fibers and the portions of the middle layer contain soft fibers. Areca fiber with some other important natural fibers. Areca fiber is highly hemicellulose and is much greater than that of any other fibers. (Mohan kumar,2008).

The husk of the areca constitutes about 60–80% of the total weight and volume of the fresh fruit. The husk fiber is composed of cellulose with varying proportions of hemicelluloses, lignin, pectin and protopectin . The average filament length (4 cm) of the areca husk fiber is too short compared to other bio fibers. Mainly two types of filaments are present – one very coarse and the other very fine. The coarse ones are about ten times as coarse as the jute fibers and the fine are similar to jute fiber. (Srinivasa, 2011) .The *Areca catechu*fiber traditionally used as a housing insulation material and fabrication of value added products such as cushion, hand craft and nonwoven fabrics (lazim, 2014)

These fibers adjoin the inner layers are irruguraly lignified group of cells called hard fiber. The portions of the middle layer below the outer most later are soft fibers, which are very similar to the jute fiber (Rasheed, 2003).The areca fiber also composed of cellulose with varying proportions of hemicellulose, lignin, pectin, and protopetin (Ramachandra, 2004)

Lignin is the main constituent of *Areca catechu*fiber, responsible for hardening of plant cell wall and the reason for the fiber stiffness (Mathew 1964). *Areca catechu*fiber is a hard fibrous portion covering endosperm, mainly composed of hemicellulose (Padmaraj, 2013).

Cotton is the most popular natural fiber, accounting for around 90%of all natural fibers. Cotton is one of the most important natural textile fiber crops, both from the agricultural and manufacturing sector .It is biggest source of clothing as well as being used to produce apparel, home furnishing and industrial products. Cotton is soft, absorbent strong and machine washable (Sinclair, 2015).

The application of cotton fiber in the areas of weaving and knitting is well established as far as the conventional application are concerned. The newer fields of application in nonconventional areas are centered on nonwoven technique of fabric manufacture. The importance of natural fiber for specific end use products made from nonwoven, highlighting the potentiality of this fiber in various field of application (Rakshit, 2002).

Therefore an attempt has been made to study on ‘’**Development of nonwoven fabric using *Areca catechu* and cotton fiber blends ‘’.**

OBJECTIVES:

- To collect *Areca catechu* fruit and extract fibers from the fruit.
- To select natural softening sources to optimizing suitable parameters for softening process
- Blend *Areca catechu* fiber and cotton fibers for fabric formation by nonwoven needle punched method.
- Study the properties of the needle punched fabrics by subjective and objective method.

2. REVIEW OF LITERATURE

The review of literature pertaining to the study ‘’**Development of nonwoven fabric using *Areca catechu* and cotton fiber blends ‘’** is discussed under the following heading.

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2.1 Introduction to natural fiber

The wide range of textile fiber are available in the market. They very not only in chemical type but also in physical characteristics, reflecting the wide verity of applications. Many people relate textile to apparel and materials for domestic uses such as carpets, bedding and soft furnishing, (Mather, 2011).

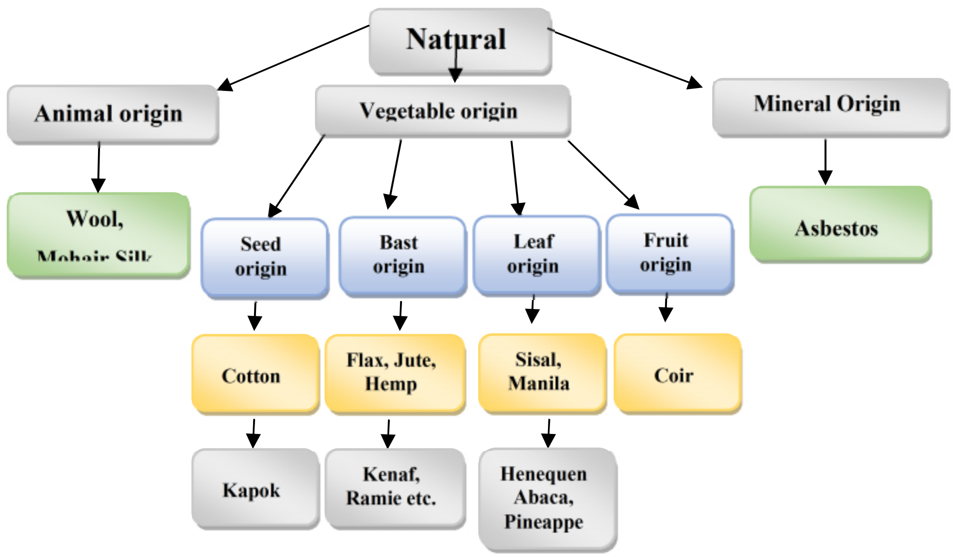
The different kinds of cloths made from different kinds of fibers or fine filaments .These are made by the method knitting, weaving, and nonwoven (Singh, 2007).The word of fiber creates mental picture of long, thin, and hair like objects and indeed textile fiber are like that in general physical shape. Not all fibers though are suitable for textile purposes because a textiles fibers must possess sufficient length, fineness, strength and flexibility to suitable for manufacture into fabrics (Mahadevan, 2001).Fiber are natural or chemical structure that can be spun into yarns. The fiber properties and behavior are directly related to fabric performance and care. Fiber characteristics will help you to understand the fabric better. Four major natural fibers and twenty three manmade fibers are available (Kaplan, 2002).

The annual production of natural fibers in India was approximately 14.5 million tons compared to world production of 45.5 million tons. The natural fibers were traditionally used for various purpose such as rope, roofing, household appliance, bandage etc. The main advantages of these natural fiber reinforced composites are high specific strength and modules , availability , low cost ,light weight ,recyclability ,biodegradable ,lack of health hazards , and nonabrasive in nature (Sathishkumar ,2013). They found that the long thin fibers produced by plants and animals could be twisted together to from a thread. These threads could then be interlaced to provide a flexible, warm and supremely comfortable material and to discover a cloth (Cook, 1993).

Fiber are fundamental units used in fabrication of textiles yarns and fabrics. Fibers are obtained from natural sources and also are manmade (Gupta,and Garg, 2008).Usage of natural fibers in the composite circuit is obiquitous as they become bear fruit due its in born qualities such as lignocellulose, natural annually renewable and biodegradable fibers. These are being used for automobiles, aerospace, domestic and packaging applications. Nowadays the usage of natural fiber is increasing in fabric or value added products such as upholstery, furnishing, decorative and secondary apparels because of its user use friendly these fiber have gone one step ahead as it become substitute for synthetic counterparts. The demand of natural fibers will be increasingly day by day in the years to come (Kumar, 2011).

2.1.2Classification of Natural fibers (Anandjiwala, 2004)

Figure 1



Vegetables fibers are generally comprised mainly of cellulose e.g.: cotton, jute, flax etc. Cellulosic fibers serve in the manufacture of paper and cloth (Meenakshi rastogi, 2009). The major types of vegetable fiber are seed fiber, bast fiber, vascular fiber and other types of fibers (Thomas, 2006).

All animal fibers are complex proteins. They are resistant to most organic acids and to certain powerful mineral acids such as sulphuric acid. Protein fibers are damaged by mild alkalies and may be dissolved by strong alkalis such as sodium hydroxide e.g.; silk, wool, rabbits hair (Jefferson 2009).

Mineral fibers are in organic materials shaped into fibers and are mainly used in the fire proof fabrics. Asbestos is practically the main natural mineral fiber. This is used more for industrial purposes than for clothing or house hold fabrics (Gupth, 2005).

2.1.3 Properties of natural fiber

Dimensional and physical characteristics:

- **Fiber length**

  It is a one of the most important property .The other factors being equal , the longer the fiber , the stronger the yarn .The lower limit of length in coarse of commercial textile fiber should not be less than 1 cm , cannot be spun economically.

- **Fineness**

  In a fiber, the ratio of length to width or cross sectional area is expressed as its fineness. In coarse fiber length is about 700 times more than the width. Only fine fibers can produce fine yarns. Fineness has much role to determine properties and characteristics of particular fiber. It also determine the end use of fiber to some extent.

- **Crimp**

  Crimp is the waviness of a fiber. It is natural quality of wools. It is measured by the difference between the length of the crimped fiber at rest and the length of the length of the same fiber. When it is perfectly straight .It is expressed as percentage of the un starched fiber length.

- **Density**

  Density is the mass or weight of material per unit volume generally expressed in grams per cubic centimeter (gm/cc).

  Mechanical properties:

- **Strength**

  Strength is also one of the most important characteristics of textile fiber. Weak fibers cannot produce a strong yarn. Individual fiber must have sufficient strength to withstand normal mechanical strain in the processing.

- **Elasticity and elongation**

  The elastic limit is the maximum load or stress to which a fiber can be subjected without the formation of a permanent set when the load is removed .The amount stretch or extension that a fiber will accept is referred to as elongation . Breaking elongation is the amount of stretch that a fiber can undergo before its breaks.

- **Uniformity**

  Uniformity means the evenness of the individual fibers in length and diameter. A fiber processing this property can produce reasonably even threads. This is also important in connection with the strength of the resulting yarn. The more uniform the yarn the stronger the yarn.

- **Absorbency**

  Most of the textile fiber absorb moisture from it is important. The amount of moisture present is expressed as a percentage of the original weight (moisture content) fibers or its oven dry weight (moisture regain). The fiber that absorbs moisture are more comfortable than those with low absorbency especially in hot humid weather when perspiration is removed.

- **Resiliency**

  Resiliency is the springing back of recovery of a fiber when it is released from a deformation. Resiliency is also a desirable property of fiber fillings for pillow and matters and some types of wearing apparel.(Jindal,2007).

2.1.4 Advantages of natural fiber

- Cost effective
- Light weight
- Safer
- Good acoustic properties
- Good thermal insulation
- Ecological sustainable (Jawaid, 2017)
- No emission of harmful substance
- No allergic effect (except wool)
- Biodegradable
- Renewability
- Air permeability

  (Kozlowaski, 2012).

2.1.5 Disadvantages of natural fiber

- Expensive .material produced by natural fiber are generally expensive synthetic fibers can be made easily by manufacturing
- Shrink. Natural fibers might shrink due to aggressive washing (Oksman ,2003).

2.2 Introduction to *Areca catechu* fiber

Areca husk is more commonly known as the areca palm or betel nut palm. The palm tree can attain heights up to 20 meters tall and is cultivated throughout the tropical parts of the Indian sub-continent, including Bangladesh (Barman, 2011). Areca appears to be a promising material because it is inexpensive, abundantly available, and very high potential perennial crop. In India ,areca cultivation is coming up in a large scale with a view to attaining self-sufficiency in medicine , paint , chocolate , chewable gutka ,etc (Srinivasa ,and Bharath ,2011).

The areca nut husk fibers are traditionally used as housing insulation material and fabrication of value added products such as cushion, hand crafts, and nonwoven fabrics (Lazim, 2014). The areca nut husk fibers are predominantly composed of cellulose and varying proportions of hemicellulose, lignin, pectin and protopection. The total hemicellulose content varies with the development and maturity, the mature husk containing less hemicellulose than the immature ones. The lignin content proportionately increase with the development until maturity (Kumar, 2015).

Mainly two types of fibers are present the one is very coarse and the other is very fine. The coarse ones are about ten times as coarse or then jute fibers and the finer are similar to jute fiber .The fiber could be used for making thick boards, fluffy cushions and nonwoven fabrics (Akhila, 2005).

2.2.1 History of *Areca catechu* fiber

Areca belongs to the species *Areca catechu* under the family of palmecea and originates in the Malaya peninsular, East India, major Indian cultivation is in east India and other countries in Asia .In India areca cultivation is coming up in a large scale basis with view to attaining self-sufficiency in medicine, paint, chocolate chewable gutka etc. (Venkateshappa ,2010).

India is the largest producer of areca nut in the world. Among all the natural fibers areca nut fibers, a type of nut shell fibers, are more promising because it is in expensive, abundantly available and very high potential perennial crop but have limited applications. The husk fiber of areca contain the chemical constitutes about 60-80%of the total weight and volume of the fresh fruit .The average fiber length 4 cm .The lighten of areca husk fiber is too short compared to other bio fiber (Srinivasa, 2010). The husk fiber is composed of cellulose with varying proportions of hemicellulose (35-64.8%), lignin (13-26%), pectin and protopectin (Kaleemullah, 2002).

2.2.2Uses and application of *Areca catechu* fiber in textiles

The areca husk is a hard fibers materials covering the endosperm and constitutes about 60-80% of total weight and volume of the areca fruit (Sampathkumar, 2014). About 150000 tons of dry husk can be estimated annually in India. It is now everywhere in India being largely wasted excepted for being used as an inferior fuel, mulching, and in manure .It was used in Indochina and Philippines for herbal tooth brushes. The fiber content could be used for making such items as thick board, fluffy cushions and nonwoven fabrics. Another possibility is that it can be used as raw material for preparing readymade toys, flowers, garland and decorative ornaments and many types of show case pieces (www.tssindia.in).

2.3 Introduction to Cotton

Cotton is fiber that grows from the surface of seed in the pods, or bolls, of brushy mallow plant. It is composed basically of a substance called cellulose (Corbman, 2007). The Sanskrit word ka'rpa'sa'-I', usually rented "cotton "is connected with the Greek and Latin karpasos and carbasub, but meant originally Spanish flax. The English word cotton came from the Arabic word qutun, or kutun (Brown, 2002).

Cotton fabric is extensively used across the globe and is called as "king of fiber". Cotton fiber obtained from a plant named "gossypium hirsutum" (Arora, 2010). It is member of the mallow family. The fiber are single plant cells that develop elongation of the outer layer of cells of the cotton seed .These seed hair are called lint. A secondary growth much shorter fiber accompanies the growth of cotton lint. These fiber which are too short to be spun into yarn are called linters (Tortora, 1982).

Cotton is the back bone of the world's textile trade. Many of our everyday textile fabrics are made from cotton. Fabrics that are hard wearing and capable of infinite variety of weave and clothing. It is not produced by the plant as part of its Skelton structure, as are the bast and leaf fibers. The fiber serve probably to accumulate moisture for germination of the seed. (Cook ,1993)

2.3.1 History of cotton

Cotton is the most common use and also it has a commercial importance. In the textile world 5th Century B.C. The Greek historian Herodotus reported that among the valuable products in India was the wild plant that bears fleece as its fruit. In the flowering century alexander the great introduced cotton from India into Greece (Thomas, 2006).

There is a evidence that it was cultivated in India and Pakistan and in Mexico and peru 5000yers ago. Until the mid-18th century, cotton was not manufactured in England, because the wool manufactures there did not want it to complete with their own product. They had managed to pass a low in 1720 making the manufacture or sale cotton cloth illegal. When the laws was finally repeated in 1736 , cotton mills grew in number .In the united states though , cotton mills could not be established as the English would not allow any of the machinery to leave the country because they feared the colonies would compete with them . But a man named Samuel Slater, who had worked in a mill in England, was able to build an American cotton mills in 1790 (Kaplan, 2002).

2.3.2 Types of cotton

The cotton fibers are classified into three. Types such as short staple fiber, inter mediate staple fiber, long staple fiber

- Short staple fiber :3/8 -3/4''in length short fibers come from Asiatic species of cotton that are both short and coarse
- Inter mediate staple fiber: 13/16-1 ¼''in length .The verity known as American upland is of intermediate length and coarseness. The variety of cotton makes up by far the largest quantity of cotton fiber grown in the United States.
- Long staple fiber: 1 ½ -2 ½ ''.this includes verities known as sea lands ,Egyptian ,and pima all of which are used for good quality cotton fabric.(Tortora,1982)

2.3.3 Properties of cotton

Cotton is by far the most commonly used textile fiber. Cotton fibers are mainly made of cellulose which constitutes 88-90% of the total weight .In an additional to this, water form 5-8%and the rest of weight is contributed by other natural impurities including wax. Cotton fibers have low resiliency and hence wrinkles easily unless finishing is done. It is not affected by friction, express (Gupta 2003).

Cotton fibers has extensive applications in apparel ,as well as in related industrial sector and technical sector, owing to its outstanding properties , such as excellent properties of air permeability , bio degradability, no static electricity , etc .(Guesmi,2013).

2.3.4 Advantages of cotton

There are many benefit to cotton clothing, but some of the most commonly cited are the materials hypoallergenic nature and its moisture wicking properties. Fabrics made of cotton are naturally resistant to dust and dust mites, and are also non irritating even in people who are prone to skin problems like rashes or eczema. The fabric can tolerate very hot water so it's easy to sterilize, and it can be used for almost any sort of clothing (www.wisegreek.com)

The cotton is a natural product and because of the way it is designed and manufactured into clothing, it has many advantages, such as its ability to control moisture, insulate, provide comfort and it is also hypoallergenic , weather proof and is a durable fabric (www.livestrong .com)

2.3.5 Uses of cotton

It is cultivated and produced in over 30 countries across the world and is a major source of export income for several countries (Singh, 2010).Cotton has high value due to aesthetic properties . It has pleasant texture and matte look,because of its high capacity to absorb, hold and dry moisture. Cotton offers maximum comfort under extreme heat humidity, comfort, good heat and electrical conductivity, launder ability, absorbency, ease of finishing and dyeing, strength. It is preferred fabric for children and for anyone who has a sensitive skin and is allergic to other fiber, since cotton is non allergic.A wide range of fabric construction methods can be employed including weaving, knitting, as well as nonwoven techniques .Cotton is used universally for a verity of apparel (both inner and outerwear) it finds extensive usage in home textiles. The products include towels, sheets, pillowslips, bed spreads, upholstery and table linen. The fiber also has innumerable industrial application including medical, surgical, and sanitary supplies (Sekhri, 2011).

Cotton is blended with other manmade fiber like polyester, viscose, acrylic etc. to be used for verity of purpose. It can also be used in industrial applications as tyre cords, bags, shoes and medical supplies and equipment's (Jindal, 2007)

2.4 Introduction of fiber softening

Softness is today an acceptable property in a textile fiber, for tapestry, upholstery and other purpose it is often an advantage that the textile fibers used shall be stiff and resilient, but for garments, and epically under wear, it is softness that is most desired for baby wear extreme softness is instead upon. The reasons it is a good thing for a fiber to be naturally soft .But nowadays a number of softening agents are available and some of them are extremely efficient .If a textile fiber has other useful properties. It could still be utilized even if it naturally lacked softness. The luster of a fiber is important for in these days the appearance of a fabric or garment is a deciding factor in its appeal to the public. With the softness handle various finishing process are available for changing the natural luster of fiber. (Vidyasagar, 2000).

2.4.1 Advantages of softening

- Easy handling
- No color shade change
- No toxic
- Easily biodegradable
- Dermatological harmless
- No restriction for transport and storing (www.slideshare.net.com)

2.5 Enzyme

Today enzyme have become an integral part of the textile processing .Though enzyme is used in desizing application was established decades ago. In recent years only the application has widened with new products introduced (Subramanian, 2011). Enzyme have been used increasingly in the textile industry since the late 1980’s many of the enzymes developed in the last 20 years are able to replace chemical used by mills (www.oecotextiles.wordpress .com) .

Enzyme is a Greek word ‘enzymes ‘meaning ‘in the cell’ or ‘form the cell’. They are the protein substance made up of more than 250 amino acids based on specific they are grouped. The concept of treating fabrics with enzymes to improve their surface properties it was first developed in Japan in the year of 1989 (www.textile learner.blogspot.in).

Enzymes were discovered in the second half of the nineteen century, and since then have been extensively used in several industrial process. It was generally globular proteins and like other proteins consist of long linear chains of amino acids that fold to produce a three dimensional product. Each unique amino acid sequence produces a specific structure. Which has unique properties. They are extremely efficient and highly specific biocatalysts .commercial sources of enzymes are obtained from three primary sources that is animal tissue, plant and microbes. The enzyme has become an integral part of the textile processing. There are two well established enzyme application in the textile industry firstly, in the preparatory finishing area amylases are commonly used for desizing process and secondly in the finishing area cellulose are used for softening, bio stoning and reducing of pilling propensity for cotton goods. At present application of pectinases, lipases, proteases, catalases, xylanases etc, are used in textile processing (Mojsov, 2011).

2.5.1 Classification of Enzyme

- Amyalases
- Lipases
- Pectinase
- Cellulose

- **Amylase:** It convert amylose or amylopectin polymeric commonly referred to as starch into water soluble shorter chain sugars. It is isolated from bacteria, fungi, pancreases and malt.
- **Cellulase**: Cellulases enhance the effect of pectinase to a certain extent and added softness to the cotton fabric .They often accompany pectinases in small amount. If used for scouring, cellulases hydrolyze cotton cellulose, lifting off non cellulosic impurities in the course of reaction.
- **Lipases:** Cotton waxes consistent of various hydrocarbons, fatty alcohol and acids, and their respective esters. These fats and waxes are the reason for the hydrophobic nature of un scoured cotton fiber .Lipases hydrolyses fat and oils into alcohol and organic acid (textile learner.blogspot.com).
- **Pectinase**: Pectinase are a mixture of enzymes, which along with other such as cellulose, are widely used in the fruit juice industry. Enzyme in this pectinase group include polygalacturonases ,pectin methyl esterase and

pectin lyases .These pectinase enzymes act in different ways on the pecans ,which are formed in the primary cells walks of cotton and jute (Subramanian,2010).

2.5.2 Features of Enzyme application in textile processing

- Extremely specific nature of reactions involved, with practically no side effect.
- Low energy requirements, mild conditions of use, safe to handle, non-corrosive in their application.
- Enzymes under unfavorable condition of P^H or temperatures chemically remain in same form but their physically configuration may get altered .They get ‘denatured ‘and lose their activity.
- Compatibility with ionic surfactants is limited and must be checked before use. Nonionic wetting agents with appropriate cloud points must be selected for high working efficiency as well as for uniformity of end results.
- High sensitivity to p^H , heavy metal contaminations and also to effective temperature range. Intense cautions are required in use (Subramanian, 2010).

2.6 Introduction of Fabric formation

The textile fabric may be defined as an assembly of fiber, yarn or combination. There are several ways to manufacture a fabric, each manufacturing method is capable of producing a wide variety of fabric structure that depends on the raw material used, equipment and machinery employed and the setup of control elements within the processes involved. Fabric selection for a given application depends on the performance requirements imposed by the end use, with consideration for cost and price. Fabric are used for many applications such as apparel, home furnishing and industrial. The most commonly used fabric forming methods are weaving, bradding knitting and nonwoven manufacturing (Adanur2001).

Woven fabric are the end products of spinning and weaving, but they also the raw material materials for clothing (Jinlian ,2004).Knitting is the most common method of interlocking and is second only to weaving as a method of manufacturing textile structure(David, 2000).The nonwoven fabrics was applied to new modern techniques , which were totally based on new principle .Nonwoven fabric are made of parallel laid , cross laid or randomly laid webs bonded with application of adhesive or thermoplastic fiber under application of heat and pressure (Patel,2008).

2.6.1 Introduction to Nonwoven

Weaving, knitting, braiding, lace and felt manufacturing are considered to be conventional method of fabric formation .These systems have been known to man for hundreds years (NIIR Board,2006).

Nonwoven fabrics is a fabric like material made from long fibers bonded together by chemical, mechanical ,heat or solvent treatment . The term is used in the textile manufacturing industry to denote fabrics, such as felt, which are either woven or knitted (Naik, 2013).

The major advantages of nonwoven manufacturing is that it is generally done in one continuous process directly from the raw materials to the finished fabric. In fiber processing it is common to make first a thin layer of fiber called a web and then to lay several webs on top of each other to form a batt, which goes to directly to bonding . There are a number of different bonding methods which have an even bigger effect on the finished fabric properties (Horrocks and Anand, 2000).

This is fast growing area with applications ranging from industrial textiles to fabrics for Avant grads fashion. Nonwoven can be made from many fibers, natural, regenerated and synthetics. The structure of a nonwoven has a cross hatching of fibers going in all directions with the fibers being bonded together, often by heat and pressure or needle punching. Nonwovens do not fray, so they can be perforated or subjected to complex cutting, including by lasers for extremely fine , lace like textiles (Clarke and Mabony, 2005)

Nonwoven fabrics have been commonly preferred for many technical application over woven and knitted fabrics due to their lower cost, disposability, simple production process and high efficiency during manufacturing. These fabric have certain functional properties , such as strength ,extension , bending , rigidity , air permeability ,absorbency ,abrasion resistance , liquid repellency , filtration , and compression properties etc., according to their application areas (Erdem koc and Emelcincik, 2011).

2.6.2 Application of nonwoven

Nonwoven find numerous applications ranging from baby diapers to industrial high performance textile. Some of the important areas where nonwoven are treated as primary alternative for traditional textiles as geo textiles materials for building, thermal and sound insulating materials, hygienic an health care textiles and automotive industries. Nonwovens are also used in cover stocks, agriculture, aerospace, and home furnishing (Overholser, 2013).

2.7 Selection of fabric formation

2.7.1 Needle punching

The process of needle punching also known as needle felting and it was originally developed to produce mechanically bonded nonwoven fabrics from fibers that could not be felted like wool. The fibers are mechanically entangled to produce a fabric by reciprocating barbed needles (felting needles) through a moving batt of fibers in needle loom (Russell, 2007).

The needle punching industry around the world is exciting and diverse trade involving either natural or both natural and synthetic fibers (textile learner .in). Needle punched nonwovens are produced by mechanically interlocking the fibers of carded, air laid, or spun bonded web using a needle loom , early needle looms operated at relatively low speeds of up to 100 strokes per minute (www.textille world .com).

It has a periodic regions in their structure that are caused by interaction of fiber with needle barbs. Fiber segments are re orientated and migrated from the surface of the web towards the interior of the fabric and become perpendicular to the plane. Needle marking caused by the punching effect of needles is frequently visible on the fabric surface. The shape and number of holes depends on the number of needles in the needle board, the size of the needles, advances per stroke, punching density and fiber types (Erdemkoc and Emelcincik, 2012).

2.7.2 Needle punching process

The preparation of needle punched woven fabric was performed in four steps. In the first step , the openers ensure the raw material opening ,cleaning and blending and supply regularly the carding machine .The fiber mixtures were run through the opener two times in order to improve the homogeneity of the blend . In the second step, blended fibers were carded .In others cases in order to remove to dirt particles, fiber alignment and web formation. The consolidation of the nonwoven fabric is provided by needle punching method. This method consist of mechanically interlocking fiber by repeatedly punching through the fiber web with an array of barbed needles, typically needling is used to consolidate a fibrous structure (Russell .2006)

The parameters involved in manufacturing this type of fabric in addition to the web characteristics are needle size, needle penetration, number of barbs per needle, fabric feed, needling speed and the needle density on the board. The latter three parameters determine the number of per punches per unit area which is very important in affecting the properties of the fabric produced (NIIR Board, 2006).The application of needle punching,

- Filters
- Tennis court surface
- Automotive carpeting
- Padding
- Blankets
- Shoe felts
- Interlining
- Space shuttle exterior tiles
- Wall covering
- Geo textiles
- Automobile textiles

  Industrial application(Madhulika parmar, 2013).

2.7.3 Advantages of needle punched fabric

- Short process
- Low production cost
- Recyclable
- Eco friendly
- Save energy
- Disposable
- Non pollution
- Diverse material source (wen –pei sung,2014)

3. EXPERIMENTAL PROCEDURE

The experimental procedure adopted for the present study ‘’**Development of nonwoven fabric using *Areca catechu* and cotton fiber blends ‘’** is discussed under the following headings.

3.1 Selection and collection of sources

3.2 Extraction of areca fiber

3.3 Selection of softening sources

3.4 Selection of softening process

3.5 Selection of fiber blending

3.6 Fiber carding process

3.7 Web formation

3.8 Selection fabric formation

3.9 Fabric formation needle punching

3.10 Evaluation of needle punched fabric

- 3.10.1 Fabric weight
- 3.10.2 Fabric thickness
- 3.10.3 Fabric stiffness
- 3.10.4 Abrasion resistance
- 3.10.5 Wicking test
- 3.10.6Bursting strength
- 3.10.7 Air permeability
- 3.10.8 Pore size analysis
- 3.10.9 Scanning Electron Microscope

3.11 Statistical analysis

3.12 Nomenclature

3.1 Selection and collection of sources

In majority of places the *Areca catechu* shells are wasted which become a breeding ground for mosquitoes used as fuel. All natural fibers are mostly used for reinforcing material Areca appears to be budding fiber as it is inexpensive, abundantly available, and very high potential perennial crop. So the researches utilized the study. The areca husk were collected from Palakkad in Kerala. Many varieties of areca husk are available in they varieties depend on cultivated places, soil and climatic condition. About two kilograms of dried areca husk was collected.

3.2 Extraction of *Areca catechu* fiber

The fiber extraction of *Areca catechu* was done in retting method. The cold water retting process was selected for the extraction of fiber from *Areca catechu*. The dried *Areca catechu* empty fruit husk were soaked in a cold water, for required number of days. The soaking process loosened the fibers and fibers were extracted easily and quickly. *Areca catechu* fibers were removed from the fruit and separated. Finally, the fiber were washed again with water and dried. Thus the areca nut fiber were extracted.

3.3 Need and selection of softening sources

Areca catechu fiber is a strong, stiff, and natural fiber. The fibers contain lignin and hemicelluloses .There are responsible for the dark color and harshness .The spinning properties of the fiber was less because of poor elongations and high flexural rigidity .Hence the present study confirms aim to soften the fiber using eco friendly method and make the fiber suitable for fabric formation .Natural enzymes used for fiber softening selectively remove the lignin content without the .The properties of fiber like color softness are improve by using natural enzymes.

Pectin and other pectin substances are complex polysaccharides present in plant cell walls as a part of the middle lamella .Pectinases use a complex group of enzymes involved in the degradation of peptic substances. Pectin's are mainly produced from plants. Environmental all issues natural enzyme was selected for softening process hence the fiber was taken for softening the fiber. Three plant sources (papaya peel, potato peel and cabbage peel) were selected for enzyme preparation for the softening of *Areca catechu* fiber. The softening was find out the visual evaluation .The papaya peel gave good result than the other in softening process. Hence the investigator select of natural papaya peel which is rich source of pectinase for softening *Areca catechu* fiber.

Plate I

***ARECA CATECHU* FRUIT**

Plate II

***Areca catechu* shells**

Plate-III

Cold water retting process

3.4 Selection of softening process

Based on the pilot study, the papaya peel was selected for softening process. The papaya peel was cleaned and weighed. The weighed sources were grained with water. It was filtered. The given fiber weighted and rinsed and immersed in 50 ml of enzyme. To kept and distributed for two over's sample is taken out rinse well and dried after drying *Areca catechu* fiber is weighted and weight loose is calculated them . To maintain room temperature. After treatment on comparing three treatments. I got better fiber softening from papaya peel. From the selected natural enzyme the treatment of cold water and hot water at two over's were carried out. Among the two treatment I got the best result from cold water and it is carried out further process.

The softening treatments which make the fabric more flexible and important the impression of softness are known as softening. In a textile industry has mainly focused on fabric softening techniques many types softening process was continuously followed on textile industries.

3.5 Selection of fiber blending

Cotton is the world's most used fiber .It is cool, soft and comfortable and principle clothing fiber of world (Singh,2009). The fiber short and fine .Cotton fiber is composed primarily of cellulosic, it is very absorbent good drape ability (Mishara,2002). Hence the investigator select cotton fiber for blending with *Areca catechu* husk fiber .The *Areca catechu* husk fiber was short fiber and does not have crimp .Fibers were blended to give good properties of the fabric. The proportion of 50:50 ratio, *Areca catechu* fiber and cotton fiber.

3.6 Carding process

Carding is a process to individualize and parallelize to the fiber .The carding process was the final step in individualizing fibers before they were collected from a web like state into the silver strand. The main purpose of the carding machine is fiber individualization , which is absolutely essential for the uniform placement of fibers during the formation of a high quality web .The process are provides the ultimate cleaning of the fiber mass by elimination of the remaining impurities of even the smallest size ,such as dust (Batra ,2012).

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Plate-IV

Fiber softening process

Natural enzyme (papaya peel)

Enzyme process

The process of parallelization and to deliver the fiber in the form of web. The carding is a mechanical action. In which the fibers are held by one surface while the other surface combs, the fibers causing individual fiber separation (Clifton G. overholser, 2013). The carding process with *Areca catechu* fiber and cotton fiber is blend with 50:50 ratio.

3.7 Web formation

Nonwoven manufacture starts by the arrangement of fiber in a sheet or web. The staple fibers packed in bales .There are several ways to form the web. It can be done in term of mechanical, thermal and chemical methods (http://textechdip.wordpress .com).The choice of method for forming web is determined by fiber length. The methods for the formation of web from staple length fibers were based on the textile carding process (www.techanical textile .net .com).

The formed web with 50:50ratio of fiber *Areca catechu* fiber and cotton fibers using for carding machine .The machine opened up and the individual fibers are placed on the opening area .The machine was removed by the impurities and cleaning of the fibers. After doing the carding process .Only six web are formed and taken by needle punching process and all web are maintained same width formation.

3.8 Selection of fabric formation

The selected fabric formation by a process called needle punching. Needle punching is process of bonding nonwoven web structures by mechanically interlocking the fibers through the web. Barbed needles, which are mounted on a board, punch fibers into the web and are then withdrawn, leave in the fiber entangled. The needles are spaced in a nonaligned arrangement and are designed to release fiber as the needle broad withdrawn. This mechanical interlocking is achieved by 1000 of barbed felting needles repeatedly passing into and out of the web (kiekens, 2002).

The separated soft fiber was converted into fabric using for needle punching technology. Web formation and after production of needle punched nonwoven fabric. To decide to selected cotton fiber for blending with areca husk fiber. As the *Areca catechu* husk was short fiber and dos not have crimp. It is blend with cotton or another fiber. To form needle punched fabric. The blending ratio was selected is 50:50 grams of *Areca catechu* and cotton fiber.

3.9 Fabric formation of needle punching

Needle punching is a method of bonding fibers fleeces mechanically. The fiber are mechanically entangled to produce a fabric by reciprocating barbed needles through a moving batt of fibers in a needle loom .The needle punching process is well suited to produce medium and heavy weighted nonwoven from 300 GSM to 3000 GSM (Subhankar maity, 2012).

The needle punching system is used to bond dry laid and spun laid webs. The needle punched fabrics are produced when barbed needles are pushed through a fibrous web forcing some fibres through the web, where they remain when the needles are withdrawn. If sufficient fibres are suitably displaced the web is converted into a fabric by the consolidating effect of these fibres plugs or tufts. This action occurs in needle punching occurs around 2000 times a minute. Needle punched fabrics finds its applications as blankets, shoe linings, paper makers felts, coverings, heat and sound insulation, medical fabrics, filters and geo textiles (Patel and Bhramhatt, 2010)

The DILO Germany needle punching machine was used for the production of needle punching fabric. The web was feed into machine for formation of needle punched fabric. Two boards are used for punching of the web, one is upward anther one is downward. Commonly barbed needles are inserted to the needle boards and fit into the needle beam, when needle beam was placed on the needle board. There are two needle boards was used one is top and second is bottom.

The web was placed on the feed rollers, which the web pass through the loom. The needle are carry bundles of the fiber through the bed plate holes. Fibers from the needle after the materials comes out through the needle loom. The needle punched fabric is drawn out from the machine by taken up rollers.

The machine speed was 0.50 m/mins and the feed is 30% for the formation of 6mm of the needle punched fabric. The machine was used as 225 strokes per minute. The density of the boards are the top board gap is 10.0 m and bottom board gap is 20.m m. The needle punched fabric formation process was carried out of PSG foundry, Neelambur Coimbatore.

Plate-V

Carding process

Plate- VI

Web formation

Plate - VII

Needle punching process

Unsoftened needle punched fabric Softned needle punched fabric

3.10 Evaluation of the needle punched fabric

3.10.1 Fabric weight

The weight of a fabric can be expressed in weight per unit area or the weight per unit length. The term that was in use before the arrival of the GSM (grams per square meter) was 1b/100yard. This expression is used by the British standard for measuring this there is a template and a quadrant balance .The template area is 1/100square yard. The GSM cutter is used to cut the fabric and weight is measured using a balance (Amutha ,2016).

The GSM cutter on the test sample and rotate the knob of the cutter .The blades provided on the cutter will cut the fabric. The sample of 100 cm and weighted the electronic balance to obtain the grams per square meter. The readings was recorded .

3.10.2 Fabric thickness

Determination of thickness of fabric samples in laboratory is usually carried out with the help of a precisian thickness gauge. In this equipment, the fabric thickness is to be determined is kept on a flat anvil and a circular pressure foot is pressed onto it from the top under a standard fixed load. The dial indicator directly gives the thickness in MM (textilelearners.blogspot.in).

The eureka thickness gauge was used for the measurement of the fabric thickness. The sample is placed in anvil plate and the lower of the pressure foot is release very slowly. Pressed slightly on the sample. The reading were taken then mean value was calculated.

3.10.3 Fabric stiffness

A bending test measure the severity of the flexing action of a material. The bending length is a measure of the interaction between fabric weight and fabric stiffens in which a fabric bends under its own weight. The stiffness of a fabric in blending is very depend on its thickness .The thicker the fabric is stiffer (Jinalian Hu,2008).

The test is carried out using Shirley stiffness tester. A rectangular strip of fabric, six inch to one inch is mounted on a horizontal plat form in such a way that it overhangs. The fabric is bends downward from the length one and the angle 0, a number of value are determined .The samples were tested both in warp and weft direction to determine the stiffness of the sample. The reading are noted and the mean value was calculated.

3.10.4 Abrasion resistance

Abrasion resistance is the ability of a fiber or fabric to withstand surface wear and rubbing. According to the ASTM D 4966-98 standard test method for abrasion resistance of textile fabric (Jinlian ,2008).

The sample are cut in circular size. After the original weight was noted in weighting balance. The force of 200 gm weight was applied to the top of the sample to hold it abrading was rotated in a backward and forward. 50 rotation was taken out abradent .The tear fabric taken out to weighted .The original and reduced weight of the sample was calculated.

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3.10.5 Wicking

A strip of fabric (30cm, 20cm) was suspended vertically with its lower edge in reservoir of distilled water. The rate of rise of the leading edges of water was then monitored .To detect the position of water line. To the water in 30 minutes, the rise in the water line was noted. The measured height of rise in 30 mints was taken as direct indication of the test fabric and recorded in centimeters.

3.10.6 Bursting strength

Burst test is the modern techniques to measure the strength of the fabrics and textile material by providing the stress on the material from all the directions equally at the same time. It is widely used the testing procedure for certain types of fabrics such as knitted material, nonwoven filters etc. Where it is important to stress them in a resilient manner.(www.prestogroup.com)

The Eureka Bursting Strength Tester for testing samples. The sample is held between clamp under the tripod, drawing the specimen taut across the plate and started the machine which allow rubber diaphragm to expand against by a hydraulic pressure. The pressure increased at a controlled rate till the specimen bursts. The burst strength is the maximum pressure up to the point of burst. Then the reading was noted for both the samples and the mean value was found.

3.1.7 Air permeability test

The air permeability of a fabric is a measure of how well it allow the passage of air through it .The ease or otherwise of passage of air is of impotence for a number of fabric end use (textilelearner.blogspot.in). Air permeability is defined as the volume of air in millimeters which is passed in one second through 100 s mm^2 of the fabric at a pressure difference of 10 mm head of water (Tugrual ogulata, 2006). The air permeability is mainly do pant upon the fabrics weight and construction (thickness and porosity). Air permeability of a fabric is the volume of air measured in cubic centimeters passed per second through 1 $cm^2$of the fabric at a pressure of 1 cm of water (Jewel, 2005).

3.10.8 Pore size analysis

The structure in a nonwoven may be characterized in term of the total pore volume (or porosity), the pore size distribution and the pore connectively. Porosity provides information on the overall pore volume of a porous material and is defined as the ratio of the nonsolid volume (voids) to the total volume of the nonwoven fabric (Sinclair, 2015).

Pore size and the pore size distribution of nonwoven fabric can be measured using optical methods, density methods, gas expansion and adsorption, electrical resistance, image analysis, porosimetry and promoter. The apparent pore opening (or opening pore) size is determined by the passage of spherical solid glass beads of different sizes 50µm to 500µm through the largest pore size of the fabric under specified condition. The pore size can be measured using sieving test method. The opening pore size are important for determine the filtration and clogging performance of nonwoven geo textiles (Berlin, 2016).

3.10.9 Scanning Electron Microscope analysis (SEM)

The scanning electron microscope is used to find the appearance of the needle punched fabric and to find the interlocking of the fiber. SEM is a method for high resolution imaging of surface. The SEM uses electrons for image that are more than 0.2µm in diameter, much as a light microscope uses visible light .The electron lenses used to focus the beam on the specimen. The advantages of SEM over light microscope includes much higher magnification (>100,000x) and greater depth of field up to 100 times that of light microscope (Reed, 2005).The nonwoven sample of *Areca catechu* fiber and cotton fibers was tested under the SEM. The SEM photo graphs were taken in various resolution in both longitudinal and crosswise direction.

3.11 Statistical analysis

The finding of needle punched untreated and enzyme treated, fabric properties were analyzed using mean, standard deviation .The results shows the difference between the both samples.

3.12 Nomenclature

The nomenclature of the samples were shown in the table and the fabric samples were present in the appendix.

TABLE I

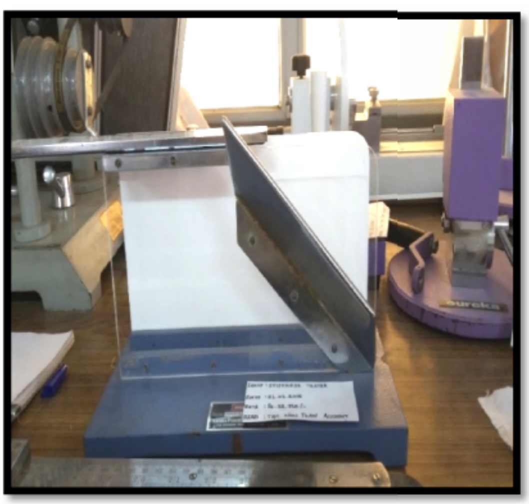
Nomenclature of needle punched fabrics:

S.NO	NOMENCLATURE	PARTICULARS
1	OACF	Original *Areca catechu* Needle punched fabric
2	SACF	Softened *Areca catechu* Needle punched fabric

PLATE VIII

FABRIC TESTING

Fabric weightFabric thickness



Fabric stiffness **Abrasion resistant**

4. RESULT AND DISCUSSION

The results of the present study on ''**Development of nonwoven fabric using *Areca catechu* and cotton fiber blends** '' presented in results and discussion are as following headings.

4.1 Visual inspection of softened fiber

4.2 Fabric weight

4.3 Fabric thickness

4.4 Fabric stiffness

4.5 Abrasion resistance

4.6 Wicking

4.7 Bursting strength test

4.8 Air permeability test

4.9 Pore size analysis

4.10 Scanning Electron Microscopic analysis

4.1 Visual Inspection of Softened Fiber

The results of the sample evaluation of the *Areca catechu* fiber was done through visual inspection of the fibers. The extracted fiber was softened by using papaya peel enzyme. After enzyme treated the *Areca catechu* fiber evaluated by the visual inspection method. In these method the fiber appearance texture, and brilliancy of color are evaluated. So it is compared to OACF with SACF for the process are given Table II and Figure 2.

Table II

Visual Inspection of Softened Fiber (%)

S.No	Sample	General Appearance			Texture			Brilliance of color		
		E	G	F	S	M	R	H	M	L
1	**Un softened *Areca catechu* fiber**	80	20	0	75	20	5	70	20	10
2	**Softened *Areca catechu* fiber**	85	15	0	90	10	0	90	5	5

E-Excellent, **G**-Good, **F**-Fair, **S**-Soft, **M**-Medium, **R**-Rough, **H**-High, **M**-Medium, **L**-Low

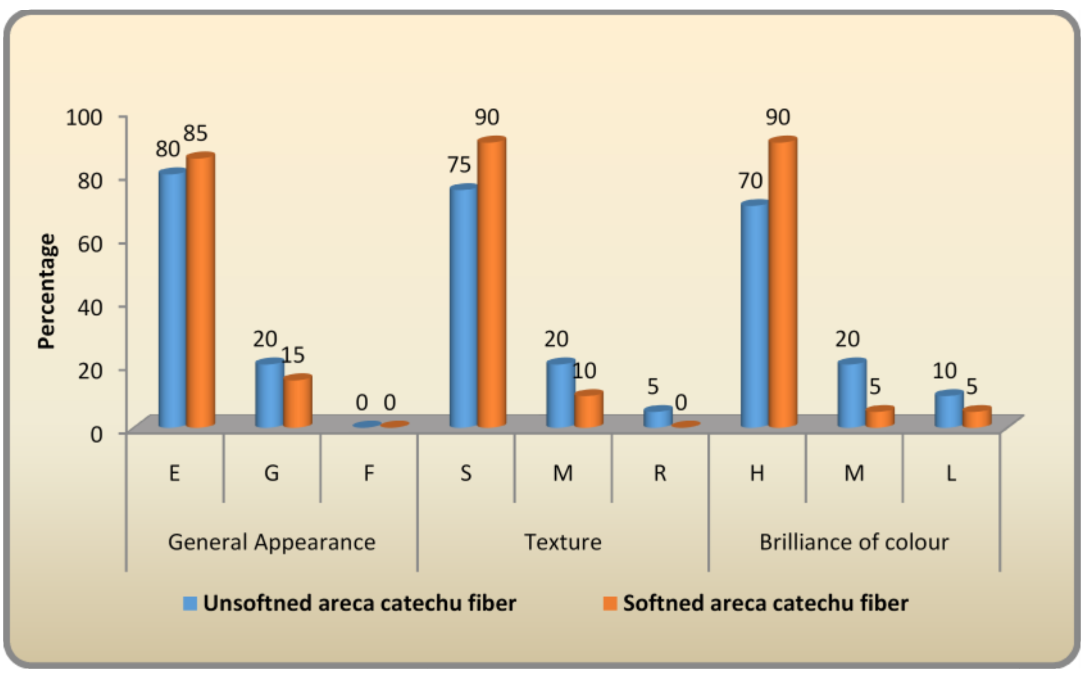


Figure 2

Visual Inspection of Softened Fiber (%)

From Table II and Figure 2, this study shows that 85% of the samples were evaluated the appearance is excellent when compared with its OACF. The fiber texture comparison made with the untreated fiber. Ninety percentage of the judged in opines that it was excellent in texture. Similarly the color brilliancy of the softened fiber compared with its OACF. The evaluate expressed that 90%of the judges rated excellent in the brilliancy of the color comparison

4.2 Fabric Weight

The fabric weight and analysis of variance of the sample OACF and SACF are shown in Table III and Figure 3.

Table III

Fabric Weight (GSM)

Samples	Mean ± SD	Loss/gain	Percentage of Loss/gain	't' value
OACF	2.36 ± 0.50	0.78	33	4.629**
SACF	3.14 ± 0.01			

** - Significant at 1% level (p<0.01)

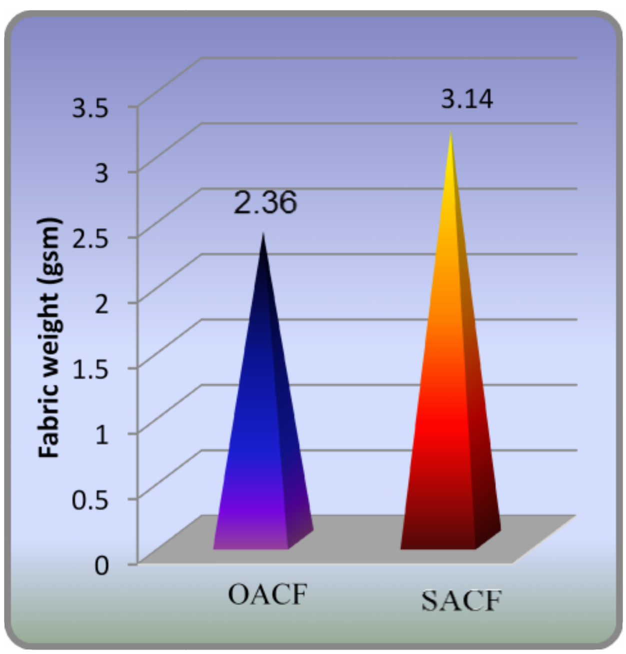


FIGURE 3

Fabric Weight

From Table III and Figure 3,it is evident that the mean weight of the SACF was increased 3.14 when comparison made with OACF. There was 33% of weight gain in SACF due to the enzyme treatment. To make the fiber more soft and closer the fiber each other. Statically analysis also proved that there is a significant difference at 1%level between the samples, OACF and SACF with the “t’ value of 4.629.

4.3 Fabric Thickness

The thickness and analysis and of variance of the sample of OACF and SACF are shown in Table IV and Figure 4.

TABLE IV

Fabric Thickness (mm)

Samples	Mean ± SD	Loss/gain	Percentage of Loss/gain	't' value
OACF	2.63 ± 0.36	1.14	43.3	7.591**
SACF	3.77 ± 0.17			

** - Significant at 1% level (p<0.01)

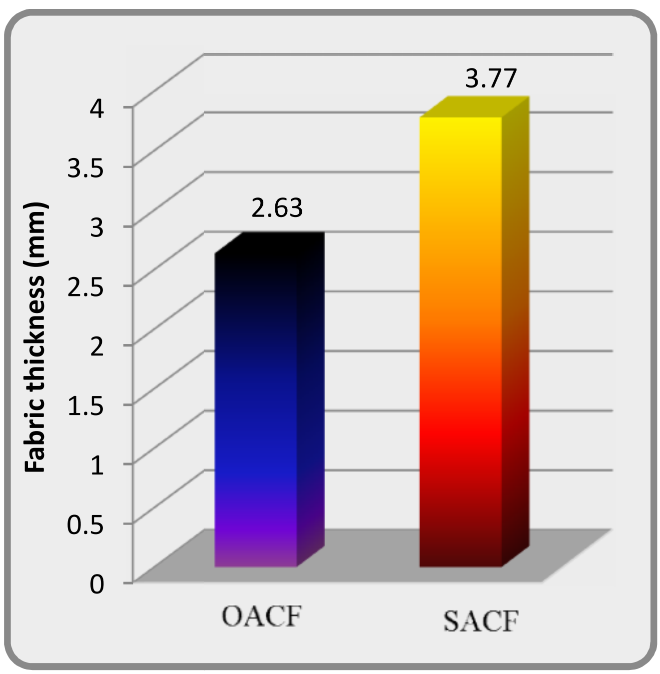


Figure 4

Fabric Thickness

From Table IV and Figure 4, It is evident that the mean value of the SACF was increased in 3.77.When comparison made with OACF .There was 43.3 percent of thickness increased in SACF due to the enzyme treatment to make the fiber softened and closer to each other .So the thickness was increased in SACF sample. Statistically analysis also prove that there is a significant difference among the sample at 1%Level with t' value of 7.591.

4.4 Fabric Stiffness

The stiffness and analysis of variance of OACF and SACF are presented in the Table V and Figure 5.

TABLE V

Fabric Stiffness

Samples	Mean ± SD	Loss/gain	Percentage of Loss/gain	't' value
OACF	2.23 ± 0.20	0.5	28.9	5.929**
SACF	1.73 ± 0.25			

** - Significant at 1% level ($p<0.01$)

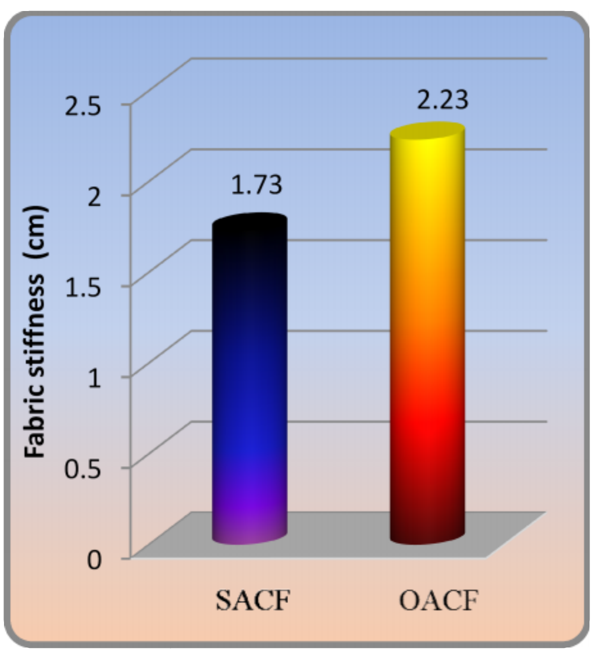


Figure 5

Fabric Stiffness

From Table V and Figure 5 ,it is clear that the mean value of stiffness of the SACF was decreased in 2.23when comparison made with OACF .There was 28.9 percent of stiffness decrease in SACF due to the enzyme treatment to make the fiber more soft .Hence the fiber rigidity reduced due to enzyme softening treatment Statically analysis also prove that there is a significant difference among the sample at1%level with 't' value of 5.92.

4.5 Abrasion Resistant

The abrasion resistant and analysis of variance of OACF and SACF are presented in the Table VI and Figure 6.

TABLE VI

Abrasion Resistant

Sample	Mean ± SD	Loss/gain	Percentage of loss/gain	F ratio Value
OACF	0.29 ± 0.05			2.9021*
OACFA	0.26 ± 0.06	0.03	10.3	
SACF	0.36 ± 0.05	0.07	24.1	
SACFA	0.31 ± 0.04	0.02	6.8	

* - Significant at 5% level (p<0.05)2

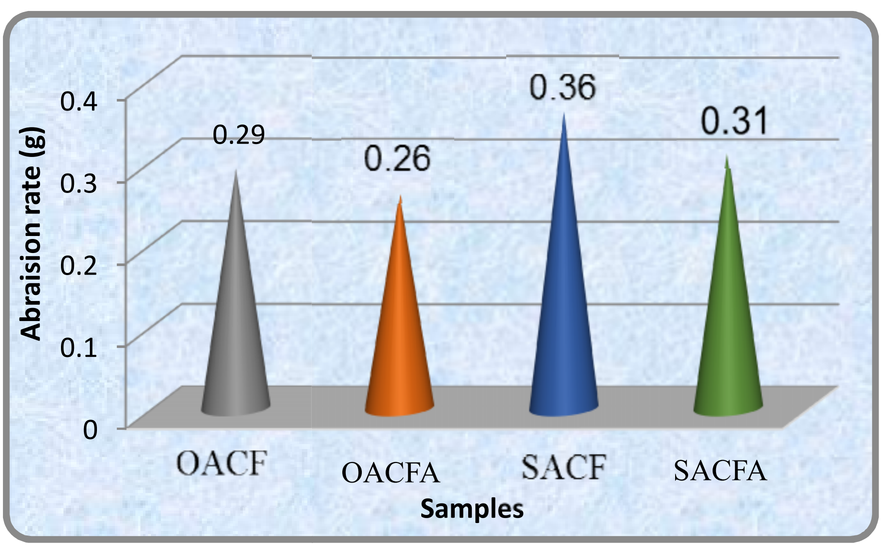


Figure 6

Abrasion Resistant

From Table VI and Figure 6, it is proved that the abrasion resistances of the samples are decreased to compare with the original weight of the sample and compared to the abrasion resistant. Tested sample weight abrasion resistance of the both sample of SACF and OACF with stand up to 50 revolutions .The weight loss difference was noted for each sample .The sample weight in 10.3% after abrasion resistance of OACF. The SACFA is decreased in the sample weight of 6.8%. When comparison made with the sample of SACF It is found that the sample softened fiber needle punched fabric has good abrasion resistance.

Statistically analysis also prove that there is a significant difference among the sample at 5% level with 'f' value of 2.9021.

4.6 Wicking

The wicking and analysis of variance of OACF and SACF are presented in the Table VII and Figure 7.

Table VII

Wicking

Sample	Mean ± SD	Loss/gain	Percentage of loss/gain	t value
OACF	0.980 ± 0.148	0.24	24.4	1.7527*
SACF	0.740 ± 0.230			

* - Significant at 5% level

From Table VII and Figure 7,it is clear that the mean value of wicking of the SACF was decreased in 0.74 when comparison made with OACF .There was 24.4 percent of wicking decrease in SACF due to the enzyme treatment to make the fiber more soft .Hence the fiber rigidity reduced due to enzyme softening treatment Statically analysis also prove that there is a significant difference among the sample at5%level with 't' value of 1.7527.

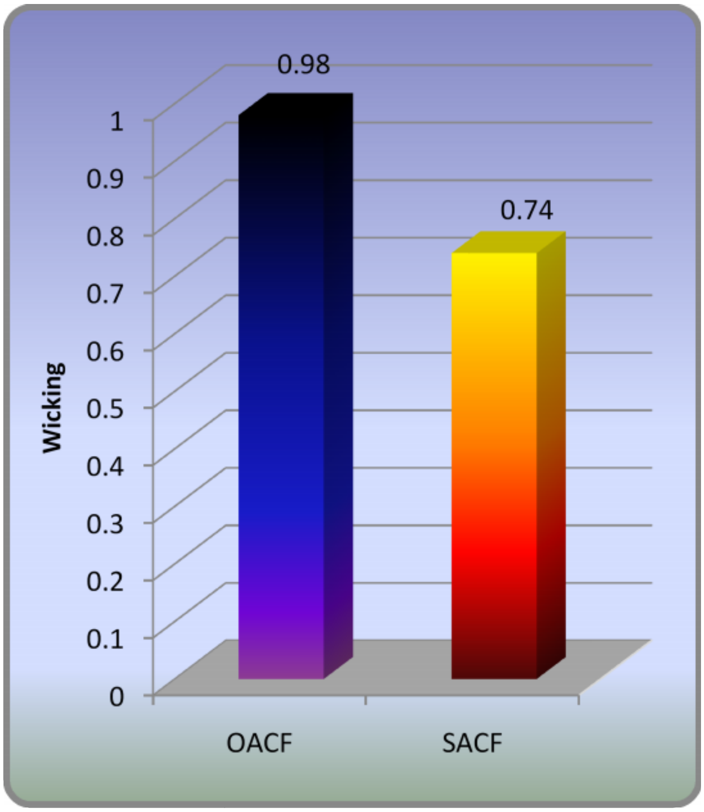


Figure 7

Fabric wicking

4.7 Bursting strength test

The bursting strength was analysis of variance of the sample for OACF and SACF are shown in the Table VIII and Figure 8.

Table VIII

Bursting strength

Sample	Mean ± SD	Loss/Gain	Percentage of loss/gain	t value
OACF	12.302 ± 0.035	7.528	477.4	81.59**
SACF	4.774±0.181			

** - Significant tat 1% level

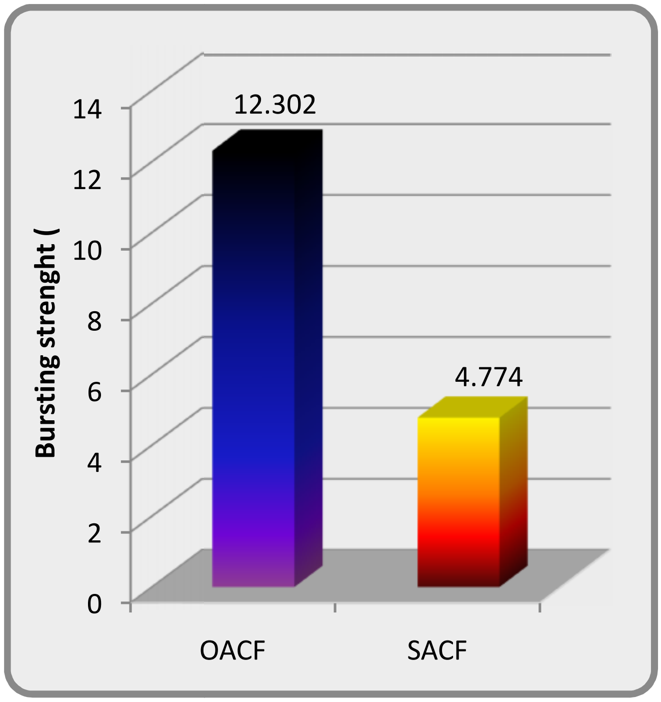


Figure 8

Bursting strength

From Table VII and Figure 8,it is clear that the mean value of bursting strength of the SACF was decreased in 4.774 when comparison made with OACF .There was 477.4 percent of bursting strength decrease in SACF due to the enzyme treatment to make the fiber. Statically analysis also prove that there is a significant difference among the sample at1%level with‘t’ value of 81.59..

4.8 Air permeability test

The air permeability was analysis of variance of the sample for OACF and SACF are shown in the Table IX and Figure 9.

TABLE IX

Air permeability (cm^3’cm^2, sec)

Samples	Mean ± SD	Loss/gain	Percentage of loss/gain	‘t’ value
OACF	75.4 ± 2.782	31.2	41.37	38.520**
SACF	44.20 ± 1.347			

** - Significant at 1% level

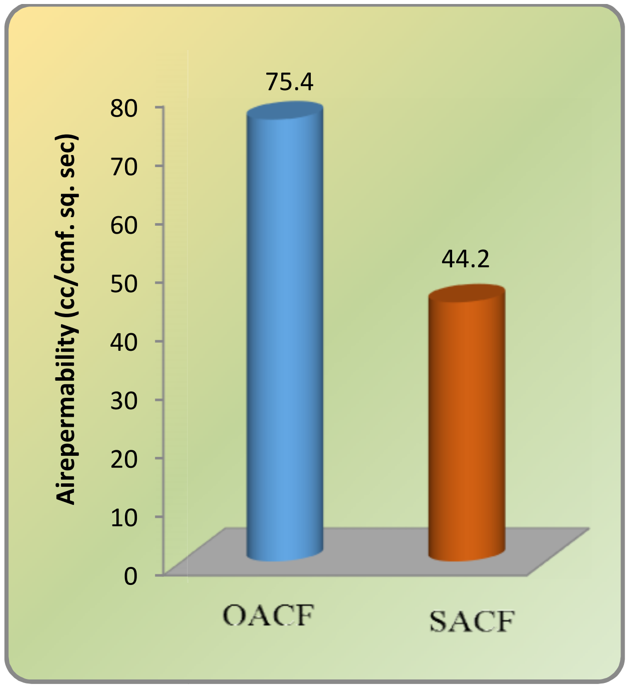


Figure IX

Air permeability

From Table IX and Figure 9, the air permeability is the most important property of nonwoven materials .The results of the air permeability related with the fabric thickness and density .The fabric thickness also influenced the results , for example lofty (less dense) nonwoven had fiber. Air permeability then figure dense fabric. The OACF fiber density less when compared with the percentage of air permeability weight value increased 41.37% when compared with OACF fabric.

Statistically analysis also prove that there is a significant difference among the sample at 1% level with ‘t’ value of 38.520.

4.9 Pore size analysis

The pore size was analysis of variance of the sample for OACF and SACF are shown in the Table X and Figure 10.

Table X

Pore size analysis

Samples	Mean ± SD	Loss/gain	Percentage of loss/gain	't' value
OACF	76.03 ± 4.347	6.13	8.76	8.503**
SACF	69.9 ± 3.273			

** - Significant at 1% level

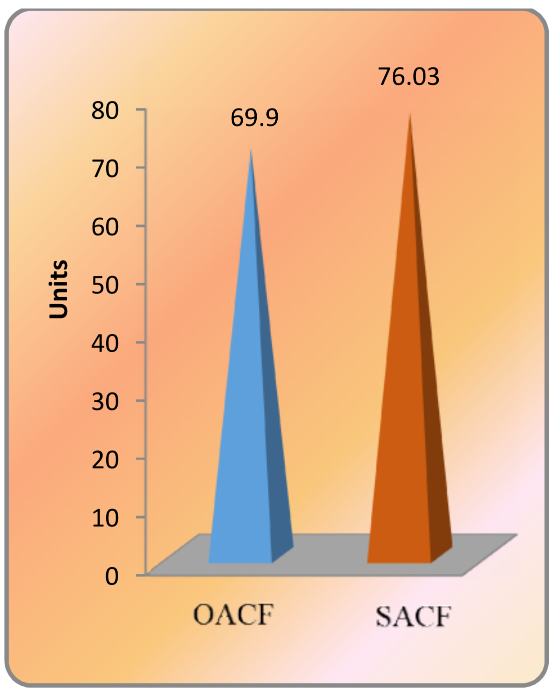


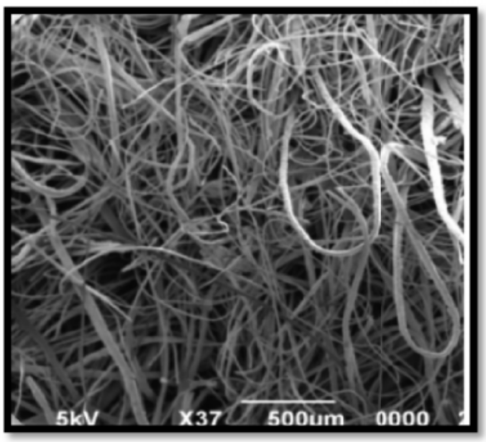
Figure 10

Pore size analysis

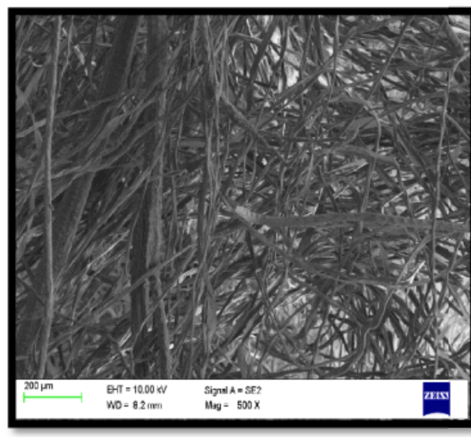
From Table X and Figure 10, it is evident that the OACF has high pore diameter of 76.3 and bubble point diameter of 175.2. Whereas the SACF has pore diameter of 69.9 Microns and a bubble point diameter of 239.1. Because the softening process made the fiber soft and remove the lignin content from the fiber .Hence the fabric formation process make the fiber close to each other .The closeness properties reduce the pore size in the fabric. Statistically analysis also prove that there is a significant difference among the sample at 1% level with ‘t’ value of 8.503.

4.10 Scanning Electron Microscopic analysis

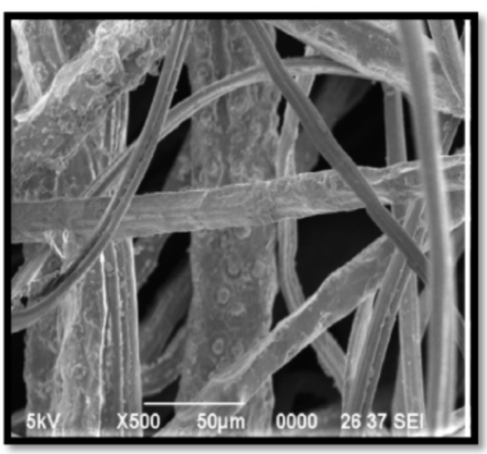
Scanning electron microscopic (SEM) photographs of OACF and SACF samples are obtained. The accelerating voltage of 5kV, 10 kV .The SEM micrographs of OACF and SACF are shown in the image. Changes in the surface modification of the fibers after treatments were studied. The SEM images are evaluated the fabric formation structure of the needle punching. The application of natural enzymes (papaya peel) clearly shown in the image on SACF sample when compare with the untreated original OACF needle punched fabric .The adherence of the enzymes present was clearly observed by the SEM images.



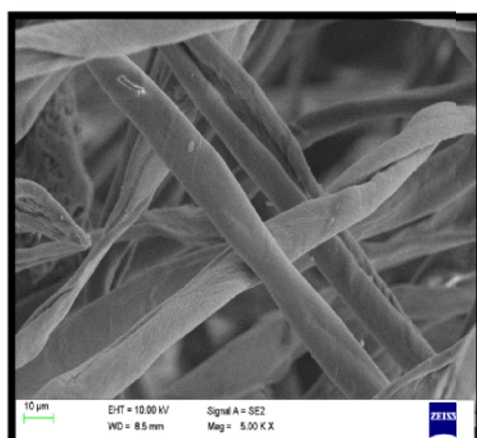
OACF



SACF



OACF



SACF

5. SUMMARY AND CONCLUSION

Technical textiles are the fastest growing area of textile consumption in the world .Nowadays nonwovens have emerged as an alternative to woven in most of the technical applications due to the increased awareness about nonwoven fabrics. Recent times, consumers are very conscious about the environment to ensure safety to their health and life .The ecofriendly products are gaining importance in the market. Natural fibers also favour the 'GO' green technology in composite fabrication system due to their biodegradable and renewable. Natural fibers are advantages when compared to synthetic fibers in terms of low cost, low density, renewability, nonhazardous and easily available.

Natural fibers are the upcoming promising fibers in the area of nonwoven. It had its presence from the Egyptian period of civilization and still popularly used especially in western countries. India has the ability to produce vast amount of natural fibers because of the favorable climate for its growth and its eco system .There are several methods of extracting natural fibers from its sources, but the mechanical way of extracting fibers art the most commonly used. The mechanisms and the design features for extracting fibers should be developed in such a manner that the natural properties of the fiber are not lost and also comprising the cost factor suitable for the present system.

Natural fibers can be considered as naturally occurring nonwoven consisting mainly of cellules fibers embedded in lignin resin .The cellulose fibers are aligned along the length of the fibers ,irrespective of its origin .It is extracted from bark or stem ,leaf or fruit .It is interesting to note that natural fibers such as jute ,coir , banana ,,sisal etc. at present these fibers are used in a conventional manner for the production of ropes ,mats and matting as well as in making fancy articles like wall hanging ,table mates, hand bags and purses.

Areca nut is an important commercial crop in India .The areca nut is the seed of the areca nut palm .The areca nut palms grow under a variety of climatic and soil conditions .The species *Areca catechu* under the family of palmacea. It is inexpensive, abundantly available, and a very high potential perennial crop, in India .*Areca catechu* cultivation is coming up in a large scale with a view to attending self-sufficiency in medicine, paint, chocolate etc. The *Areca catechu* fiber is too short compared to other bio fiber.

The sector of industry that holds a major share in the global pollution is in textile. Therefore use of natural enzyme on textiles play a key role as alternative process for textile processing and have become an integral part of the textile processing industry

Natural fiber contain hemicelluloses, lignin, pectin and protopectin. These constituents make the fiber more rigidity and rough surface of the fiber .This properties dose not suitable for fabric formations. Softening agents make the fiber soft, less rigidity and roughness .These quality give the fibers suitable for fabric formation. Synthetic enzymes again pollutes environment. Hence the investigator to consternated natural enzymes to make the fiber suitable for further processing.

The enzyme are biodegradability and the mild conditions of mark their use in wide range of industrial application .Enzymes are work only on renewable raw materials fruit ,cereals ,milk ,fats ,cotton ,leather and wool are some typical fabrics for enzymatic conversion in industry . So the natural fruit enzymes was selected for the fiber softening process.

Hence the present study ‘’ **Development of nonwoven fabric using *Areca catechu* and cotton fiber blends ‘’.**was carried out with the following objects to:

- To collect *Areca catechu* fruit and extract fibers from the fruit.
- To select natural softening sources to optimizing the suitable parameters for softening process.
- Blend *Areca catechu* fiber and cotton fibers for fabric formation by nonwoven Needle punched method.
- Study the properties of the Needle punched fabrics by subjective and objective method.

Experimental procedure

The areca husk was collected from Palakkad district in Kerala. Many varieties of areca husk are available .The varieties are depending upon to cultivation of places climate condition, and soil from this one variety of areca husk was selected. For extraction *Areca catechu* of fiber, two kilograms of areca nuts was collected dried for the study. Extraction of the fiber are due in many methods. Common methods such as decortication stagnant water retting, running water retting and chemical retting, etc. After analyzing the fiber extraction like quality using visual inspection, quantity, and duration of fiber extraction. The cold water retting process was selected for the extraction of fiber from *Areca catechu*. The dried *Areca catechu* empty fruits was soaked in a water for thirty days. The soaking process loosens the fibers and can be extracted out at easily and quickly. *Areca catechu* fiber were removed from the fruit and separated for further research.

In nature the fiber has medium rough texture. so this properties dose not suitable for fabric formation. Hence the texture has modified with softening process. Environment issues make to concentrate naturally. Hence natural enzyme was selected for softening fiber. The papaya peel sources was collected and the weighted .Then weighted sources were grained with water, after that filtered. The selected fiber put into the filtered juice for two hours. After that the fiber taken out from the solution and wash thoroughly .Now the dried fiber blending with cotton fiber. To blending ratio 50:50 of *Areca catechu* fiber and cotton fibers. Then it was move to nonwoven fabric formation.

The *Areca catechu* fiber length not sufficient to make the fiber into fabric in woven or knitting .The only way to from the fiber is nonwoven fabric .Nonwoven fabric cannot use are fiber, it needs two or more fiber to make the fabric. Hence the investigation planned to blend natural ecofriendly fiber. So the research was made with cotton and *Areca catechu* combination, with the needle punching method.

The first step to preparation of nonwoven fabric for web formation. To blended fibers were mixed manually according to their desired combination. The mixing was passed on machine. The fibers were fed into carding machine .The carding machine hence the web formed was a condensed web.

The separated soft fiber was converted into fabric for needle punching technology. The needle punched fabrics are produced with the barbed needles are pushed through a fibrous web forcing some fibers through the web, where they remain when the needles are withdrawn. Needle punching occurs around 2000 times a minute. Needle punched fabrics finds its applications as blankets, shoe linings, paper makers felts, coverings, heat and sound insulation, medical fabrics, filters and geo textiles.

The needle punched fabrics were assessed for standard test is procedures were used to physical properties of nonwoven fabrics. To measure fabric weight, fabric thickness, fabric stiffness, abrasion test, sinking, wicking, air permeability, pore size analysis, bursting strength, and SEM (Scanning electron microscope). The SEM analysis to find out to the interlocking of fiber.

Finding of the study

Subject evaluation test:

- The visual evaluation was compared with softened *Areca catechu* fibre and un softened *Areca catechu* fibres. The softened *Areca catechu* fibre was 85% excellent appearance where as in the un softened fibres was good appearance.
- The softened *Areca catechu* fibres was soft as expressed by 90%of and medium by 10% with compared to the un softened *Areca catechu* fibre. The 90% softened fibres was improve the colour appearance but the minimum brilliancy in colour was un softened *Areca catechu* fibre.
- The softened *Areca catechu* fibres was soft as expressed by 90%of the judges and medium by 10%of the judges, with compared to the un softened *Areca catechu* fibre.

Objective evaluation:

- Fabric weight of the SACF samples increased when compared to their OACF. In the percent increase in weight was 33%in SACF .It is statistically proved that the significant difference at one percent level.
- The fabric thickness of sample SACF was 28.9 percent higher than the OACF .It is statistically proved that the significant difference at one percent level.
- The fabric stiffness of the SACF is decreased when compared over the OACF. The increase in fabric stiffness was found to be 28.9%of the OACF .It is statically prove that the significant difference at one percent level.
- On comparing to OACF and SACF in abrasion resistant test, the decrease in after abrasion resistance OACF was 10.3%. It is OACFA and original weight of the SACFA is 24.1%in after the abrasion decrease in the sample weight for 6.8%. It is found that the sample SACF has good abrasion resistance; it is with stand the 50 revolutions. It is statistically proved that the significant difference at five percent level.
- The wicking of the sample SACF was decreased when compared over the OACF. The increase in fabric wicking was found to be 24.4 percent of the OACF .It is statically prove that the significant difference at 5 percent level.

The bursting strength of the sample SACF was decreased when compared to the OACF. The increase in fabric bursting strength was found to be 477.4 percent of the OACF. It is statically prove that the significant difference at one percent level.

- The air permeability of the sample SACF was decreased when compared over the OACF. The increase in fabric air permeability was found to be 41.37 percent of the OACF. It is statically prove that the significant difference at one percent level.
- The pore size analysis of the SACF is decreased when compared over the OACF. The increase in pore size analysis was found to be 8.76 percent of the OACF .It is statically prove that the significant difference at one percent level.
- The SEM image of the fabrics, to view that interlocking of *Areca catechu* fibres are blended with cotton fibre.

Conclusion

Environmental awareness, new rules , and legislation are forcing industries to seek new materials that are more environmental friendly. The rise in the level of various kinds of pollutions has created a major awareness among the consumers for using eco-friendly products. Governments of many countries have also imposed limitations on release of pollutants. This in turn has resulted in a rise in demand for green and clean processes. One of the sectors of industry that holds a major share in the global pollution is textile industry. The growing interest for manufacturing cost effective and ecofriendly products along with the superior properties of utilization in the field of industrial sector. In a textiles industry to replace synthetic fiber with natural fiber is increasingly due to environmental issues. Softened areca husk fibre to be utilized for needle punched fabric production selected for research. Areca husk fibre is blending with cotton fibre and it is suitable for nonwoven fabric. The softened needle punched fabric has good physical properties to compare with un softened needle punched fabric. The evaluation of fabric weight, fabric thickness, abrasion resistant was increased in after natural enzyme treatment but the stiffness ,air permeability and pore sizes was decreased because the fibres are closely interlocked after enzyme treatment.

FUTURE RESERCH:

- The similar study can be done using other regenerated fibre like acetate tencel, modal, lyocell ,etc blends with *Areca catechu* fibre.
- Since it has Antimicrobial and Anti allergic property this can be developed for medical textiles product.
- Areca fibre can be used in composite for different technical textile field.

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APPENDIX -1

VISUAL INSPECTION OF SOFTENED FIBER

S.no	Sample	General Appearance			Texture			Brilliance of color		
		E	**G**	**F**	**S**	**M**	**R**	**H**	**M**	**L**
1	**Unsoftened *Areca catechu* fiber**									
2	**Softened *Areca catechu* fibre**									

E-Excellent, **G**-Good, **F**-Fair, S-Soft **,M**- Medium, **R**-Rough, **H**-High, **M**-Medium, **L**-Low

APPENDIX -1

VISUAL INSPECTION OF SOFTENED FIBER

S.no	Sample	General Appearance			Texture			Brilliance of color		
		E	G	F	S	M	R	H	M	L
1	**Unsoftened *Areca catechu* fiber**									
2	**Softened *Areca catechu* fibre**									

E-Excellent, G-Good, F-Fair, S-Soft ,M- Medium, R-Rough, H-High, M-Medium, L-Low

APPENDX - 2

ARECA CATECHU FIBER

Un softened *Areca catechu* fiber

Softened *Areca catechu* fiber

APPENDEX-3

NEEDLE PUNCHED FABRIC

UN SOFTNED NEEDLE PUNCHED FABRIC

SOFTNED NEEDLE PUNCHED FABRIC