PRODUCTION OF LOW COST FEMININE HYGIENE FROM KENAF

WONG WEI DING

BACHELOR OF CHEMICAL ENGINEERING (BIOTECHNOLOGY)
UNIVERSITI MALAYSIA PAHANG

Thesis Access Form

No__________________________Location____________________________

Author : ………………………………

Title : ………………………………

Status of access OPEN / RESTRICTED / CONFIDENTIAL

Moratorium period:____________ years, ending__________/______200____

Conditions of access proved by (CAPITALS): DR BALU RANGANATHAN

Supervisor (Signature)………………………………………………

Faculty: ………………………………

Author's Declaration: *I agree the following conditions:*

OPEN access work shall be made available (in the University and externally) and reproduced as necessary at the discretion of the University Librarian or Head of Department. It may also be copied by the British Library in microfilm or other form for supply to requesting libraries or individuals, subject to an indication of intended use for non-publishing purposes in the following form, placed on the copy and on any covering document or label.

*The statement itself shall apply to **ALL** copies:*

This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

Restricted/confidential work: All access and any photocopying shall be strictly subject to written permission from the University Head of Department and any external sponsor, if any.

Author's signature……………………………………….Date: ………………………………

users declaration: for signature during any Moratorium period (Not Open work):
I undertake to uphold the above conditions:

Date	Name (CAPITALS)	Signature	Address

PRODUCTION OF LOW COST FEMININE HYGIENE FROM KENAF

WONG WEI DING

Thesis submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Chemical Engineering (Biotechnology)

Faculty of Chemical & Natural Resources Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2014

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Chemical Engineering (Biotechnology).

Signature	:
Name of main supervisor	: DR. BALU RANGANATHAN
Position	: SENIOR LECTURER
Date	: 22 JANUARY 2014

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature	:
Name	: WONG WEI DING
ID Number	: KE10041
Date	: 22 JANUARY 2014

Dedication

To my Supervisor, Dr Balu Ranganathan

ACKNOWLEDGEMENT

I would like to thanks the following people and organisations:

- My supervisor Dr. Balu Ranganathan for his continuous guidance and supports through an effective well-arranged weekly meeting. He gives me a lot of help and tips to conduct experiments. Specially thanks Dr Balu Ranganathan for being my source of inspiration all the time when I doing my Undergraduate Research Project.

- Friendly Staffs for guidance during visit to Forest Research Institute Malaysia (FRIM), Kuala Lumpur

- In-charge-person of National Tobacco and Kenaf Board, Kuantan for supplying raw material for the experiment and letting us visit the kenaf plantation and decorticator for process raw material.

- Parents for great encourage me to keep strong and smart during doing my project

- Friend, Khor Ken Hwan for helping drive car to National Tobacco and Kenaf Board, Kuantan

ABSTRACT

Kenaf has been discovered for its potential in different kinds of industrials such as paper making, manufacturing materials, sanitary products and tissues. Kenaf is known as the most economical crop. The present exist of feminine hygiene product are produced by high cost chemicals. This may cause to increase the price. Lots of women in the developing countries still do not have enough supply of cheap feminine hygiene product and this force them use unhygienic materials such as rags, barks and even mud. So there is a need in invention and manufacturing of low cost sanitary product. This research is to analyse the best method for the production of low cost feminine hygiene from kenaf by using suitable mechanical and chemical method. Application of acidic, alkaline and hypochlorite treatment in the pulping process will increase the quality of fluff pulp without affect its basic fibre properties. The raw material of kenaf is supply by National Kenaf and Tobacco Board, Kuantan Branch. Mechanical separation was done to remove the outer bast fiber of kenaf manually. In this study, Sodium Sulphite, Glacial Acetic acid and sodium hypochlorite was used in the production of pulp as it is low cost and suitable for treating core fibres. All the samples were sent for FESEM and SEM scanning to investigate the morphological condition of the pores of the fibres for the sample. Absorbency test was carried out for each sample. The absorbency of each sample includes untreated and treated samples are higher than 1.00 g of ink/g of ink/g of sample as shown in table 1. Samples treated with 20% Glacier Acidic acid show lowest absorbency with 1.08 g of ink/g of sample. Samples treated with 1 g of sodium sulphite showed quite high absorbency at 1.836 g of ink/g of sample. The treated sodium sulphite kenaf core pores are porous and there is increasing in the absorbency characteristics. Furthermore, EDS FESEM analysis shown elementary composition contains inside samples without any sulphur remained in sodium sulphite treated sample.

TABLE OF CONTENTS

SUPERVISOR'S DECLARATION IV
STUDENT'S DECLARATION V
Dedication VI
ACKNOWLEDGEMENT VII
ABSTRACT VIII
TABLE OF CONTENTS IX
LIST OF FIGURES XI
LIST OF TABLES XIII
LIST OF ABBREVIATIONS XIV
LIST OF ABBREVIATIONS XIV
1 INTRODUCTION 1
1.1 Background of Study 1
1.2 History of Kenaf 2
1.3 Basic Growth Cycle of Kenaf 3
1.4 Current Applications of kenaf 3
1.5 Basic Economic of kenaf 3
1.6 Motivation 4
1.7 Problem Statement 4
1.8 Objective 5
1.9 Scope of this research 5
2 LITERATURE REVIEW 6
2.1 Overview 6
2.2 Introduction 6
2.3 Types of Kenaf 9
2.4 Commercialise of Kenaf 10
2.5 Chemical composition of kenaf 11
2.6 Chemical Pulping 12
2.7 Fluff Pulp 13
2.8 Feminine Hygiene 13
2.9 Absorbency 14
2.10 FESEM and SEM 14
2.11 PH considerations 15
2.12 Moisture Content 15
2.13 Previous Work on Natural Fibre on Fluff and Pulp Production 15
2.14 Summary 17
3 MATERIALS AND METHODS 18
3.1 Overview 18
3.2 Chemicals 18
3.3 Equipment 18
3.4 Preparation of raw material 18
3.5 Manually mechanical process of kenaf stalk 18
3.6 Cutting core stalk into chips 19
3.7 Process of transform chips into pulp 19
3.7.1 Treatment 1 19
3.7.2 Treatment 2 19
3.7.3 Treatment 3 20

3.7.4 Treatment 4 20
3.7.5 Treatment 5 21
3.8 FESEM and SEM scanning 22
3.9 Absorbency test 23
3.10 Moisture Analysis 24
3.11 Summary 25
4 RESULTS AND DISCUSSION 26
4.1 Overview 26
4.2 Results 26
4.3 Cutting the stalk of kenaf to chips and measurement is taken 27
4.4 Effect on Physical properties of Kenaf 28
4.5 Colour changes on kenaf samples after chemical treatment 29
4.6 SEM Scanning result for all treatment 29
4.6.1 Treatment 1 SEM Scanning result 29
4.6.2 Treatment 2 SEM Scanning result 30
4.6.3 Treatment 3 SEM Scanning result 32
4.6.4 Treatment 4 SEM Scanning result 34
4.6.5 Treatment 5 SEM Scanning result 34
4.7 PH measurement for chemical treated samples 35
4.8 FESEM Scanning result for chemical treated samples 36
4.9 Moisture Analysis 37
4.10 Different Chemical Treated Samples Absorbency result 37
4.11 Discussion 38
4.11.1 Effect of chemical treatment time on kenaf chips 39
4.11.2 Effect of different chemical treatment on kenaf chips pores 39
4.11.3 Effect of different particles size use for chemical treatment 40
4.11.4 Effect of chemical treatment on the absorbency 41
4.11.5 Element Composition in chemical treated Kenaf sample 42
4.11.6 Effect of Moisture content in chemical treated Kenaf sample on Absorbency 42
5 CONCLUSION 44
5.1 Conclusion 44
5.2 Recommendation 44
5.3 Future work 44
REFERENCES 46
APPENDICES 51

LIST OF FIGURES

Figure 2-1: Kenaf crop which was harvested and tied in bunches at Cherating Plantation Farm....8
Figure 2-2: Different fractions of kenaf core and kenaf pith (Steef et al.2008). 8
Figure 2-3: Australia type of Kenaf with cordate leaves....9
Figure 2-4: China type of Kenaf with linear leaves. 10
Figure 3-1: Grinder used for grind kenaf chips into small particles 21
Figure 3-2: SEM used to investigate morphology of samples....22
Figure 3-3: FESEM JEOL JSM-7800F used for morphology scanning and EDS 23
Figure 3-4: Moisture Balance that used for moisture content analysis of each sample ..24
Figure 4-1: Different diameter and length of kenaf chips being produced 27
Figure 4-2: Two different length of kenaf chips being produced (3 cm and 2 cm) 27
Figure 4-3: Fungus growth on kenaf chips after 3 days in room temperature....28
Figure 4-4: (SEM Scanning) Fungus growth on another kenaf chip after 3 days in room temperature 28
Figure 4-5: Colour Changes on kenaf samples during chemical treatment....29
Figure 4-6: 10% Glacier Acetic Acid treatment at 90°C for 2 days 29
Figure 4-7: Deionised water treatment at 90°C for 2 days 30
Figure 4-8: 1g Sodium Sulphite treatment at 90°C for 1 hour (1.3-1.4cm) 30
Figure 4-9: 1g Sodium Sulphite treatment at 90°C for 1 hour (D=0.8-0.9cm) 30
Figure 4-10: 10% Glacier Acetic acid treatment at 90°C for 1 hour (D=1.3-1.4cm) 31
Figure 4-11: 10% Glacier Acetic acid treatment at 90°C for 1 hour (D=0.8-0.9cm) 31
Figure 4-12: Deionised water treatment at 90°C for 1 hour (1.3-1.4cm) 31
Figure 4-13: Pith treated with deionised water 32
Figure 4-14: Core treated with deionised water....32
Figure 4-15: Pith treated with 1 g Sodium Sulphite....32
Figure 4-16: Core treated with 1 g Sodium Sulphite 33
Figure 4-17: Pith treated with 10% of Glacier Acetic Acid....33
Figure 4-18: Core treated with 10% of Glacier Acetic Acid 33
Figure 4-19: Kenaf small particles treated with 1 g of Sodium Sulphite 34
Figure 4-20: Kenaf small particles treated with 0.5 g of Sodium Sulphite 34
Figure 4-21: Kenaf small particles treated with 20% of Glacier Acetic Acid....34
Figure 4-22: Kenaf small particles treated with 20% of Sodium hypochlorite 35
Figure 4-23: Kenaf small particles treated with 10% of Sodium hypochlorite 35

Figure 4-24: Graph composition of Kenaf small particles treated with Sodium sulphite 36
Figure 4-25: Graph composition of Kenaf small particles treated with Sodium hypochlorite 36
Figure 4-26: Kenaf small particles produce by using 6mm scale of plate for grinder....41

LIST OF TABLES

Table 2-1: Chemical Composition of Kenaf Bast fibre (MitulZaveri, May 2004) 12

Table 2-2: Chemical Composition of Kenaf Core fibre (MitulZaveri, May 2004) 12

Table 4-1:Kenaf measurement based on samples.. 26

Table 4-2:Kenafcore fibre chips measurement based on samples 27

Table 4-3: pH measurement after treatment for Kenafsamples................................. 35

Table 4-4: Moisture analysis result for each test sample.. 37

Table 4-5: Absorbency measurement for each Kenaf samples.................................. 38

LIST OF ABBREVIATIONS

°C	Degree of Celcius
cm	Centimentres
μL	Microliters
%	Percentages

LIST OF ABBREVIATIONS

CTMP	Chemothermomechanically pulp
EDS	Energy Dispersive X-Ray Spectroscopy
FESEM	Field Emission Scanning Electron Microscopy
SAP	Superabsorbent polymer
SEM	Scanning Electron Microscopy
TMP	Thermomechanical pulp

1 INTRODUCTION

1.1 Background of Study

Kenafwith scientific name *Hibiscus cannabinus L.is belong to* Malvaceae family. *Hibiscus cannabinus* based from genus *Hibiscus.* The kenaf is mainly grown in Asia country for example Thailand, India and China. Southern parts of the United States and Mexico also have the production of kenaf, too. Kenaf fibres show similar characteristic with jute fibres, so it can be jute-like fibres (Steef et al.2008). Fibres of kenaf are one of those which have been widely researched since late 1950s. Based on FAO (2011), world production of kenaf and allied fibres cover about 290.1 kilo tonnes (FAO,2011). Kenaf in Malaysia has the potential to be famous in the production of different kinds of fibre products such as newspiece, diapers, absorption pads and more. Kenaf contain of two kind of fibre that is inner fibre and outer fibre. Usually Kenaf grow in straight, without branch, and need about 5 to 6 months to achieve maximum height. Kenaf height is about four to five meters and its diameter is around 25 to 35mm.

Nowadays in the field of non-fibre wood production, Kenaf can be referring as the most economical crop. Different researches are done for kenaf based on it fibre characteristic and absorption characteristic of kenaf core. For example, kenaf core and bast has been proved that absorption can achieve about 35 times its weight of oil. This show effectiveness of kenaf core removes oil from water surfaces (Anthony, W.S. , May 1994). Pakistan Paper Corporation (PPC) Mill, Charsada research has successfully produce newsprint from kenaf pulp. The newsprint from the kenaf chemi-thermomechanical pulp showed well in printability tests and achieves the quality of standard newsprint (Gopang,A.D.,2000). Based on the studies, the past invention of production of cellulose products from pulp to form fluff by using dry disintegration and treatment composition having good liquid absorption and it is suitable use as acquisition layer for absorbent articles (Laursen,1981;Othman A.H. 2007). Usually absorbent articles of feminine hygiene product consist of four parts that are an absorbent core, acquisition layer, top sheet and a back sheet. Top and back sheet mostly is made from textile fibre such that one side is porous while the other side is impermeable. This kind of design is to enable fluid can flow contact with absorbent core at the porous whereas prevent fluid flow out at the impermeable side. For better distribution of liquid and higher rate of liquid absorption, the acquisition layer is inserted in the absorbent article. Besides, this kind of feminine care product structure can have better surface dryness and decreased the probability of gel blocking. Usually an acquisition layer may consist of synthetic fibres and composite of cellulosic fibres. Hygiene product which made from synthetic agents can achieve high absorption rate. However some invention may use cross-linked cellulosic fibre as easy to manufacture (Othman A.H. 2007).

For production of good sanitary product, the main things are to ensure that the product can absorb liquid and retain for a range of time when a compressive load is apply. The product should not leak when absorbing and distributing the liquid. High absorption capacity is the main properties that an absorbent should have. Besides, the hygiene product which is produce need to be comfortable to wear without any harmful and irritating components (Leif, N., 1996).

1.2 History of Kenaf

This project focuses on both the CFD and experimental study of gas-liquid bioreactors, i.e. bubble column and stirred tank. Scaling-up method of stirred tank bioreactor depending on the knowledge of mass transfer, mixing and gas-liquid hydrodynamics which was Africa was the first country which started plant and used kenaf as domestic crop. In the past 200 years, India also began to involve in production and used kenaf producing twine and rope. Kenaf was produced in Russia at year 1902 and brought to India in year 1935. During World War 2, United States had done lots in kenaf research and production to supply material for war use. The war cause increasing in the use of fibre by United States and supply of fibres from countries like Philippines to be disturbed. Scientists managed to invent high-yielding antharacnose-resistant cultivars, cultural practices and cutting machinery successfully as the research was done continuously. Kenaf was being recognised as excellent fibre crop for a wide range of products including papers in the 1950s and early 1960s. In 1990s, most researches in mainly focussed on suitability of kenaf crop for production of new products such as adsorbents, textiles, building materials and so on (Charles.L.,Webber.III,Harbans L.,et al, 2002).

1.3 Basic Growth Cycle of Kenaf

Kenaf has become main fibre crops for production of different types of product as it is low cost and fast growth plant. As kenaf can achieve maximum height within 4 to 5 months, so kenaf can be harvested 3 times annually. There are more than 20 countries involve in kenaf cultivation. For example Vietnam, Iran, Russia, Taiwan and so on. China, India and Thailand possess around 95% of total production of kenaf (Yaghoob.T. et al, 2011). According to Julian C. Crane and Julian B. Acuna (1945), kenaf crop which at different growth stages has different percentage of fibre. About 1.66 to 2% of fibre is present in the kenaf which is 97 days after planting. On the other hand, there is 6.44% of fibre content in the plant collected during time of seed maturity. This shows that as the plant is actively grown the fibre yield is increasing (Julian C.C. & Julian B.A., 1945).

1.4 Current Applications of kenaf

Kenaf is a popular short day herbaceous crop which most countries harvest for its bast and core fibres. There is a big potential for kenaf to become commercial crop in Malaysia as some product has been produce and more research are done on kenaf currently. Kenaf was mainly applied in production of paper, thermoplastic, composites fabrics and absorbent. Fishing nets, sacks, ropes and doormats which made from kenaf stem fibre are good for use as high mechanical strength of fibre is being produce by specific polymer treatment. Besides that, woven produces from soft fibre can be use to produce clothes. In addition, there is cooking oil and margarine produce from kenaf. Kenaf is also important in manufacture of soap, linoleum, paints and more. Physical and chemical properties of kenaf bring lots of advantages to commercial product as well as alternatives for wood products (Department of Agriculture, Forestry and Fisheries, 2012).

1.5 Basic Economic of kenaf

Kenaf is a low cost, biodegradable and environment friendly plant which produce in large amount. Nowadays, kenaf has gain high market values as more and more commercial products is being produce based on kenaf. Less chemicals are needed for kenaf pulping as low lignin content compare to other wood. Besides, bleaching is less use for fibres and thus help in reducing of wastewater contamination. Only storage for raw material and fibre preparation need a larger investment (Ovidiu Inlius Chiparus, May 2004). Based on journal by Techno Forest Co. Ltd (May 2004), the market price for pulp had increase from US$600/Mt to US$700/Mt during year 2000. For softwood pulp, the price is raised slowly about 5 % while hardwood paper pulp price improved at 10% for last 7 to 8 years. Increasing trend of pulp market price shows there is demand for kenaf which function as an alternatives crop for production of pulp. Japan which is a high-tech country also starts import in kenaf pulp for their country paper production (Techno Forest Co., Ltd, May 2004).

1.6 Motivation

Few chemical and mechanical methods have been tested to get better production of fluff pulp since early 1970s. However most of the fluff pulp is produce by using expensive chemicals or mix with superabsorbent materials to increase the absorbency. There is a need for production of low cost fluff pulp from kenaf by using common and cheaper mild chemicals. It will be nice if the cost of fluff pulp production can more economically and low cost feminine hygiene product can be produced for millions of women it is unaffordable to buy feminine hygiene products.

1.7 Problem Statement

Based on the previous invention, most of the research is being done by using chemicals for the production. Specific chemicals use may increase or decrease the performance of the fibre and it is non-biodegradable. This kind of product may cause environmental concerns and it is expensive. Suitable chemicals must be chosen for the production of high quality feminine hygiene product and also must be low cost. The continuously increasing cost of fluff pulp bring concerns and rising the need of production of better feminine hygiene product which is cheaper, natural and environmental friendly absorbent core. This research will help production of more economical feminine hygiene product and improve the lifestyle of women in developing countries even other countries.

1.8 Objective

The objective of this research is to analyse the best method for production of low cost feminine hygiene by using suitable mechanical and chemical method.

1.9 Scope of this research

The following are the scope of this research:

i) Using grinder and blander as the machine for the mechanical method

ii) Application use of low cost chemicals in pulping process

iii) Examine the structural morphology and elementary composition by using FESEM and SEM

iv) Obtain absorbency and moisture content of fibres through analysis.

2 LITERATURE REVIEW

2.1 Overview

Kenaf usually produce in large amount as it is has high adaptation and easily grow. Kenaf has 2 layers component that is an outer periphery and another one is inner woody component. The whole stalk of kenaf is bound by lignin. The pith that is present in the kenaf core is highly absorbent material. Based on the chemical composition of the fibres, alkaline and acidic treatment is being used during the pulping process. This will help to improve the quality and performance of pulp produce.

2.2 Introduction

In Ancient Africa, kenaf has been grown for almost 4000 years. United States got a lot of kenaf plantation too. Kenaf is a type of fast growing plant and it can grow to a height about 3.5 to 4.5 metres within 5 months. According to U.S. Department of Agriculture, yield of kenaf is about 6 to 10 tons of dry fiber / acre annually. Kenaf grow best in sandy well drained soil although it got high adaptation ability (Mitul Zaveri, May 2004).

In Malaysia, kenaf fibres are produce in large amount mainly at east coast including Kelantan and Pahang. National Kenaf and Tobacco Board is one of the organisations that were established in the year 1973. The culvation of kenaf was started since 2005. Around 2010, more lands are allocated for the plantation of kenaf and some of the research and development are carry out to studies the fibres production from kenaf. National Kenaf and Tobacco Board Malaysia is also working hard on getting good quality seed and fibre production. Kenaf as natural fibres has become more popular in various industries. As there is a large possibilities commercial product from kenaf, kenaf has been identify as new industrial plant for Malaysia by National Kenaf Research and Development Program. During 9th Malaysia Plan (2006-2010), about RM 12 million of budgets are allocated to encourage the research and development of kenaf-based industry. Based on the data provide by National Kenaf And Tobacco Board about 2911 tonnes kenaf fibre was produced from 343 hectares of land at Kelantan and Terengganu in Year 2009. 50 farmers were involved in the plantation of kenaf fibre (National Kenaf and T.B, 2009). Plantation of kenaf yields approximately 6 to 10 tons of dry fibre per acre per year based on information given by the research officer from Malaysian Agricultural Research and Development Institute (MARDI). Yield of kenaf is roughly 3 to 5 times more than the yield of pine trees which require 7 to 40 years to achieve same amount as kenaf's yield. Kenaf generally gives height of 3.66m to 4.27m (12-14 feet) within 4 to 5 months because kenaf is a fast grow fibre crop (Muhammad Ridzwan.b.I, 2007).

Previously, crops such as jute, abaca, pineapple and jute are mainly applied for production of ropes, twine and burlap. Physical and chemical properties of natural fibre such as low weight, low cost, low density, biodegradable and high specific properties bring advantages to automotive and construction industries. This proves that kenaf has the potential in replacement of wood for both industrial and apparel applications. As time passed, kenaf has gradually become commercial and enlarging the field from main role as cordage crop to different new applications. New invention products make from kenaf including absorbents, paper products, livestock feed, building materials and so on. As more products are being produce from kenaf, there is an increase demand for kenaf crop. Kenaf has grown from basic agricultural production to commercial product in the market. According to previous researches, kenaf has been recognised as excellent cellulose fibre source for paper products. Besides, less energy and chemical is need for kenaf pulping process than other standard wood source. Harvesting of kenaf is being done by hand manually. A curved blade or machete is use to cut kenaf stalk near the ground level during hand-harvested. Most of the time of harvest is the time when plants were still actively growing (Charles.L. 2002).

Figure 2-1: Kenaf crop which was harvested and tied in bunches at Cherating Plantation Farm

There are two components that kenaf has is an outer periphery and another one is inner woody component. The outer periphery component with name Bast Fibre takes around 30 to 40% of the plant by weight whereas the inner woody core weighs about 60 to 70% of the plant. The whole stalk of kenaf is bound by lignin. The lignocellulosic fibre cell wall of kenaf is formed by strong semicrystalline cellulose microfibrils (Mehdi et al. 2010). These two components of kenaf can be separate by a process called retting. There are three types of retting will be done that is bacterial retting, chemical retting and mechanical retting (Mitul Zaveri, May 2004). Decorticator is used for mechanical operation for the very first process of production. However, decorticators were only design for getting bask fibre as main material and throw the unused core material. There is a number of new and advanced ribboner or decorticators are created especially for in-field harvest-separator. By this kind of new inventions, core materials can be harvest for other uses besides bark material.

Figure 2-2: Different fractions of kenaf core and kenaf pith (Steef et al.2008).

The bast fibre of the kenaf which is obtained can be cut into specific length and its density is about 1.293 + 0.006 gm/cm^3. The bast fibre can be used for production of carpet backing, canvas, sacking, door and instrument panels or high quality paper. For the core, it is hard wood material which commonly used in production of absorbent for example packing materials, animal beading, insulative and acoustic Pads and more. The refined fibres can achieve length about 0.6 mm. Density of the core is range from 0.09 to 0.11gm/cm^3. Besides, the pith that is present in the kenaf core is highly absorbent material which has absorption ability of fluid up to 20 times its own weight. The pulps that produce from kenaf is usually treat with white pigment, to get a brighter colour to pulp fibre. Colorant or fluorescent whitening agent can also be used as those chemicals are help to whiten the pulp (Amar N. N., Hugh W., David L.L., 2005).

2.3 Types of Kenaf

Kenaf can be obtained easily at tropical and subtropical areas. For example China, India, Northern Africa, Russia and even United States are joining in cultivation of kenaf. Lots of research is being done to maximise and enlarge the uses of kenaf for commercial market. It is popular as biodegradable crop which has many commercial values in market. There are different types of kenaf being cultivated for better resistant to insect pests and disease, faster growing rate and increase in quality of fibre. Even though kenaf have high growth ability at different soil types, choosing suitable location for plantation of kenaf is important as kenaf is sensitive to frost. Refers to Nasional Tobacco and Kenaf Board of Kuantan information, there are two kind of species that are plant by the farmers at kenaf plantation of Pancing and Cherating areas plantations. One is Kenaf origin from China and another one is species from Australia.

Figure 2-3: Australia type of Kenaf with cordate leaves.

Figure 2-4: China type of Kenaf with linear leaves.

2.4 Commercialise of Kenaf

A lot of research have been carried out to wider the use of kenaf as an absorbent as kenaf core comprise of high absorbency material. Kenaf core can be use in many others field for example as a poultry litter and animal bedding , as a bulking agent for sewage sludge composting, and as a potting soil amendment . There is a creation of animal bedding for livestock like horses, cattle and rodents from kenaf core material. The main reason for this creation is that the animals do not consume it. Based on the previous research, the core will absorb about 4 times its own weight of water. The most coarse fraction absorbing the largest amount of water. Manually separated kenaf pith showed 20 times its weight of water absorption. However, kenaf core must free from fibre and dust because animal bedding materials require low dust content.

Other than above core products which can be seem in the market place, few amount kenaf core products have given a big contribution in toxic waste clean-up. This toxic waste cleanup including oil spills on water, and the remediation of chemically contaminated soils. (Webber, et al, 2002) Kenaf fines are excellent sorbent materials comparable to commercial sorbent materials. Kenaf has the same absorption capacities and a higher retention capacity as polypropylene. Kenaf core performs as well as a polypropylene web does in absorption of high viscosity oil from seawater. (Monti,

2013) Natural Fibres uses kenaf core fibres as the absorbent filler in the manufacture of patented oil and chemical spill products, e.g. booms, pillows, and mats. (Kugler, 1995)

Furthermore, the entire kenaf plant, including the stalk (core and bark), and leaves, can be used as a livestock feed. Research proved that there is high protein content in kenaf. Kenaf stalk content crude protein about 2% to 12% while about 6% to 23% is whole-plant crude protein .Sheep usually feed on kenaf as a supplement in rice ration.

Besides, Kenaf is also suitable for production of paper and cardboard products. Scientists at the ARS have tested several kenaf pulping techniques, with the pulps being used to make several grades of paper including newsprint, bond, coating raw stock and surfaced sized. Results have been positive, particularly in terms of paper quality, durability, print quality and ink absorption.

Newspapers made from kenaf pulp have been shown to be brighter and better looking, with better ink lay down, reduced rub off, richer color photo reproduction and good print contrast. Quality analyses showed kenaf newsprint to have superior tear, tensile and burst ratings. Additionally, kenaf newsprint manufacturing requires less energy and chemicals for processing, an important advantage, both economically and environmentally (Webber, et al, 2002).

2.5 Chemical composition of kenaf

Cellulose, hemicelluloses, and lignin are the main component for kenaf soft wood crop. Besides there are some extractive and a bit inorganic matter content in the plants. Knowledge on the chemical properties is will lead to better understanding of the strength of plant and help in deciding pulping method for absorbent production. Lignin is a type of mechanical support of plant which exists in three-dimensionally branched network polymer. Lignin holds the fibres tightly as it act as binder for lignocellulosic plants. Different parts of plant body have different lignin concentration. There is a high concentration of lignin in the middle lamella of secondary cell wall. Lignin is the main component that needs to be removed from bundle fibres during chemical pulping lignin to separate the fibres. Cellulose refers to the homo-polysaccharide long linear chains which is main cell component in plant. Effective chemicals must be used when dealing with cellulose as the cellulose fibres arrangement is in high strength crystalline form. For hemicellulose, it helps occupies the fibre which is in white solid substances.

Hemicellulose can be easily hydrolysed to simpler form of sugars due to its low degree of polymerisation of 100 to 200. On the other hand, Organic solvent and water can be used to isolate the extractives which present in plant for example terpenes, fatty acids esters, volatile oils and others. Inorganic content of plant like ash is generally deposit in cell wall and parenchyma cells (Ahmad.A.M, et,al. 2010). The specific chemical composition for kenaf bast and core fibre is shown in Table 2-1 and 2-2.

Table 2-1: Chemical Composition of Kenaf Bast fibre (Mitul Zaveri, May 2004).

Constituents (%)	Natural	BR	CR
Cellulose	59.8	73	82.8
Hemi Cellulose	11.6	12.6	8.2
Lignin	17	5	3.6
Cell Wall Contents	10.4	7.9	4.6
Ether Soluble Extract	1.2	1.5	0.8

Table 2-2: Chemical Composition of Kenaf Core fibre (MitulZaveri, May 2004).

Constituents (%)	Natural	BR	CR
Cellulose	59.8	73	82.8
Hemi Cellulose	11.6	12.6	8.2
Lignin	17	5	3.6
Cell Wall Contents	10.4	7.9	4.6
Ether Soluble Extract	1.2	1.5	0.8

2.6 Chemical Pulping

The process of converting lignocellulosic raw materials into mass of fibre (pulp) is call as pulping. Pulping process is done before proceed to fluffing process. Acid and alkaline are used to treat the fibres at optimum temperature. The acidic and alkaline treatments are effective for degrading the lignin and other non-cellulose component in the plants (Ahmad.A.M, et,al. 2010). Furthermore, undesired substances which contain in the natural fibres can be removed through alkali treatment. Besides, the properties of the fibre-matrix interlocking and fibres will be altered by the chemical treatment using alkaline. Fine structure of fibres cellulose is affected by the alkali treatment which gives the fibres a rougher surface as compare to untreated fibre. This is because few amount of lignin and cellulose component are being removes through alkalization (Y.A.El-Shekeil, 2012). According to Mohd.S.S.et al (2011), acidic treatment that is applied on kenaf core fibres are proven increase the adsorption capacity of adsorbent effectively. Less chemical is need for kenaf process as the lignin content is low.

2.7 Fluff Pulp

There is about 2.5 million tons of fluff pulp produce from all country in the world. Only long fibres which are inside the softwood can be used for the production of fluff pulps (Olli, J. et al, 1991). Mostly the material for production of absorbent is chemical pulp, for example bleached chemical pulp and CTMP (chemothermomechanically pulp). (Leif, N., 2002). Lignin fraction in the softwoods and hardwoods will be removing by using chemical treatment to manufacture a cellulosic pulp. (Martin, G.H., 2000)Based on previous record, the production of complete bleached chemical pulps make up about 90% of the pulps produce. This kind of bleached chemical pulps usually make up of sulphate pulps. The remaining portion is for production of CTMP (chemicalthermomechanical pulps). Peroxide is use for bleaching of fluff pulp to degree in the range 70 to 80% of the brightness. Besides, fluff pulps that can be used for hygiene product include TMP (thermomechanical pulp) and groundwood, too. Fluff pulp production is different from paper pulp production in terms of drying, web formation and wet pressing process. However, all these process steps are important to ensure production of high quality product. Fluff pulp is commonly sold in rolls form which still contains moisture about 5 to 10%. Fluff pulps are the main source of absorbent layers in the hygiene product for example napkins, diapers, pads and more. There is large demand of fluff pulp for the production of air laid products. The pulp production process will determine the ratio between the knot content and energy needed (Olli, J. et al, 1991). Other than that, process of air laying of dry fibre can also be done for the wood pulp as it will help to create bulkier structure for the absorbent. This kind of bulkier structure has high absorbent capacity for liquid and cushioning properties (Robert, T.E, Dennis, C. H., 1980).

2.8 Feminine Hygiene

Feminine hygiene product is design fully for all the women in the world. Synthetic materials always become choice of producer to produce the sanitary pads as it give high absorbency and easy to produce. However, this may cause discomfort and health problems to female as time pass because the product contains lots of chemicals. Natural fibre is the best material for producing absorbent for feminine hygiene product since it does not contain any synthetic materials. Feminine hygiene product should possess the basic criteria of natural pH balances for good absorbent which would not bring irritation and yeast infection (Cannabis Cosmetics, 2012).

2.9 Absorbency

Nowadays, mostly natural absorbents that are selling in the market are originally from cellulosic fibres. Absorbency refers to the phenomena of aqueous fluids absorption by porous or fibrous materials or polymeric systems. It is relate to the swelling and partial dissolution of absorbent core. The most important quality of feminine hygiene product is absorbency. A feminine hygiene product must have high absorbency to keep sensitive area dry without leaking or cause any discomfort. Absorption is a process that one fluid diffuse through an absorbent material. Absorption generally occurs due to the capillary pressure which is applicable in fluff pulp which it fibres is scattered in random style to make a Nonwoven. Porosity of the fibres is very important in affecting the absorption capacity of product. Level of amorphous and crystalline of the materials will determine the rate of absorption of the absorbent core (Mitul Zaveri, May 2004). Larger specific surface area and higher absorption ability of a fibre are most suitable for the production of fluff pulp in absorption articles (Inger,V.E., Goran E. A, Lars, E.R.W, Feb 20, 1996).

2.10 FESEM and SEM

Field Emission Scanning Electron Microscopy (FESEM) isa scanning electron microscope which consists of field emission cathode in the electrode gun that can provide thinner probing beams. This high technology electron microscope able to give high quality of spatial resolution and reduced the risk of sample charging and destroy. Besides that, FESEM also provide high magnification for different types of sample and produces clearer image than SEM. For observation of sample surface structures, it is usually can be obtained through JEOL JSM-7800F Field Emission Scanning Electron Microscope. JEOL JSM-7800F possess of in-lens objective design which allows high resolution observation of nanostructures. In addition, JSM-7800F is design with JEOL r-filter of 2nd generation. The specimen morphology and composition can be clearly observe by adjust the filter of the secondary and backscatter electrons. Features that are being observed in the FESEM image generate can be immediately transfer for elemental composition analyse using EDS (PhotoMetrics FESEM, Retrieved on Dec 2013). For Scanning Electron Microscopy (SEM), it more focuses on scanning the surface of specimen and generates signals which will be collected by detectors to form image. The image of the scanning result is displayed on a cathode ray tube screen. The signals that are generated can be grouped into 3 types, that is secondary electrons, backscattered electrons and characteristic X-rays (PhotoMetrics SEM, Retrieved on Dec 2013).

2.11 PH considerations

The pH of a substance for liquid is refer to the measurement for the molar concentration of hydrogen ions for example test whether a solution is acidic or base type. pH of fluff pulp is an important criteria which need to be consider in the production of absorbent for feminine hygiene products. Inappropriate pH level of chemical treatment absorbent produce may cause yeast infection or mycosis as the natural of bacteria flora is affected. It is necessary to maintain the pH level of 5.5 to ensure proper intimate hygiene for women. Therefore, in order reduces the risk of bacteria overgrowth, intimate hygiene should be take care all the time (Women Web, 2004-2010).

2.12 Moisture Content

Moisture refers to the water content in a sample. Moisture content can be defined into two basics that are wet and dry. The amount of water per unit mass of dry sample is the dry basic of moisture content. On the other hand, the wet basis moisture content can be defined as amount of water present per unit mass of wet sample. Moisture content of the kenaf plant at harvest is usually at 75%. Moisture content of the growing plant may affect the harvesting and processing system of kenaf. Kenaf plant which has higher moisture brings ease to cutting process.

2.13 Previous Work on Natural Fibre on Fluff and Pulp Production

From previous invention, it is known that non-ionic fatty acid esters can mix with cationic retention agents to produce cellulose pulp with better disintegration. After dry-defibration, the fluff showed quick liquid absorption property. Even though cationic surface-active agents for example quaternary ammonium compounds are use to weaken the bonds between the cellulose fibres, it may cause increase in water absorption time as it consist of longer fatty acid chains. However this kind of application may cause bad effect on the hydrophilic properties of product manufacture. (Oscar, W. M., Philip M.H., 1984) Besides, that compounds may cause corrosion damage on equipment and decrease the brightness of the fluff as the present of chloride ion as anion (Laursen, 1981).

An innovation for production of fluff pulp for absorption products by using mineral type of micro particle like bentonite and additional inorganic particle compound of synthetic silicate compound has been reported. The fluff pulp which produces has low knot content after defibering process is carried out. Bentonite is usually used in the retention agent system with particles size range from 2.5 to 100nm. Addition of bentonite is done to wet pulp stock at a fixed and optimum pH (Annica S., Stefan, Helena, 2005).

According to United States Patent US 7,312,297 B2, treatment composition can be one of the method use for fluff pulp production in sheet form. For treatment composition, it involves mixture of cross-linking chemical and anti-hydrogen-bonding agent. Fibres produce by cross-linking is aimed for better physical and chemical properties of fibres as it improving shrinkage resistance, reducing wrinkling and increase fluid absorbency. Although cross-linking agent can help to improve some fibres properties, there is some difficulties relating to defiberize fibres cross-linked in sheet form. The method of using cross-linked is not very suitable for production fluff pulp in sheet form as it the process cause decrease in fibres performance and involve higher cost (Othman A.H., Dec 2007).

The advance of superabsorbent agents also being introduce into production of absorbent material as it can reduce the use of fluff pulp. Superabsorbent materials or polymers (SAP) have greatly improved the fluid retention characteristic of absorbent core. The absorbent core which is produce by using SAP can absorb up to 100 times their weight. However the superabsorbent polymers are relatively higher cost compare to other natural materials (Mitul Zaveri, May 2004).

Besides that, application of enzyme treatment in the production of fluff pulp is also being invented based on US Patent 5,068,009 (1991). The invention won't cause any main properties of fluff pulp being affected. It may increase the quality of fluff pulp as the knot content is decrease and reduce the usage of energy when shredding process is done. The experiment is carried out by using xylanase on the mixture of spruce and pine (Olli, J. et al, 1991).

2.14 Summary

This paper presents a study of production of low cost feminine hygiene from kenaf by using chemical treatment approach in pulping process. Kenaf is a kind of natural fibre that can be easily get and good for absorbent production in feminine hygiene product. Previous study on fluff and pulp production is being referred for getting better method for the production of fluff and pulp.

3 MATERIALS AND METHODS

3.1 Overview

The raw material of kenaf was supplied by National Kenaf and Tobacco Board, Kuantan Branch. There is a kenaf plantation at Merchong Village, Kuantan, Pahang. Mechanical separation will be done to remove the outer bast of kenaf by using decorticator. The final core material that is obtain after the mechanical process will be about 90% purity containing some pith and bast fibers. At the central part of the stalk there is sponge like material which called pith component. It is highly absorbent. After the mechanical process manually, the chips will be chopped into specific length. Next, the chips produced are used for further processing of pulp manufacturing. In this study, Sodium Sulphite, Glacier Acetic acid and Sodium Hypochlorite will be used in the production of pulp as it is low cost and suitable in treating fibres.

3.2 Chemicals

Glacier Acetic acid, Sodium Hydroxide, Sodium Hypochlorite

3.3 Equipment

Oven, water bath, vacuum pump, chipper, Grinder, FESEM, SEM, Grinder

3.4 Preparation of raw material

Raw material of the kenaf was supplied by National Kenaf and Tobacco Board, Kuantan branch. Kenaf plant is freshly cut from the plantation field situated in Panching and Cherating. Fresh kenaf is stored at room of approximately 25ºC to keep the moistures of the plant. Next, the excess branches with leaves and flowers of kenaf are peel off and the remaining kenaf stalk are used as the raw materials. Measurement is taken for kenaf stalk diamete. Height of each plant is measured. All the measurement taken is recorded in a table.

3.5 Manually mechanical process of kenaf stalk

After all the measurement has been carrying out, suitable kenaf plant are chosen and bast fibre are peeled off. The bast fibre is needed to be separated from the core fibre as only core fibre and pith will be used in this experiment. Extra bast fibre is weight and disposes away. The diameter of the core fibre is measure and record in a table.

3.6 Cutting core stalk into chips

Then, the kenaf core fibre is cut into small chips manually by using small saw. The kenaf stalk is cut in 2 different lengths, one is 2cm and another one is 3cm.After it is cut, the chips is leave in room temperature (27°C) for 3 days in a sealed bag. Any the changes happen to the kenaf chips within the 3 days is observe and record.

3.7 Process of transform chips into pulp

For the pulping process, kenaf stem fibres chips which is manually mechanically produces is treated by using sodium hypochlorite, glacier acetic acid and sodium sulphite. The pulping process will cause swelling of fibres, increasing the hydrogen bonding between the fibres and weaken the bond of lignin.

3.7.1 Treatment 1

5 grams of kenaf chips is weighted by using weight balance. 10% of Glacier acetic acid is prepared in a 250ml beaker by mixing 10ml of glacier acidic acid with 90ml of deionised water. Next, the chips are put into the beaker. The beaker is placed in water bath at 90°C for 2 days. The water bath water level is maintained by adding water consistently to prevent from dry out. After 2 days, the samples are washed with deionised water 4 times with the help of vacuum pump to clear the chemical inside. The chips is dried in the oven at 80°C for 1 day after it is washed. The chips are sealed in a plastic bag after it is completely dry. The experiment process is repeated by using 100ml of deionised water for kenaf chips treatment. All the samples are sent for SEM scanning to investigate the condition of pores of the fibres for the chips. The chips are randomly chose and cut into half. Small pieces of samples are obtained by cutting used small knife. The small pieces sample are used for SEM analysed.

3.7.2 Treatment 2

The kenaf chips are weighted by using weight balance. There are two types diameter of the chips is being used. One is 1.3cm to 1.4cm, while another type is 0.8cm to 0.9cm. 6 packs of 5 grams kenaf chips samples with two different diameters is prepared. Six

250ml beakers are provided for this experiment. Two beakers contained 10ml of Glacier acetic acid mixed with 90ml deionised water, two beakers contain 1 gram sodium sulphite mixed with 100ml of deionised water and another two beakers only contained 100ml of deionised water each. The beakers are labelled. All the 5 grams chips are separately put into 6 beakers. The beakers are placed in water bath at 90°C for 1 hour. The water bath water level is making sure enough for the experiment. After 1 hour, all the samples are washed with deionised water 4 times to clear the chemical inside. The chips inside the beakers are dried in the oven at 37°C for 1 day after it is washed. The chips are sealed in plastic bags and labelled after it is completely dry. The experiment process is repeated by using 100ml of deionised water for kenaf chips treatment.

3.7.3 Treatment 3

Weight balance is used to weight 5 grams of kenaf. 3 packs of 5 grams kenaf chips samples is prepared. The chips are cut into half. The pith is separate from the core. The core of kenaf is put into a blander and blander for around 20s into uniform small pieces size. Six 250ml beakers are provided for this experiment. Same as trial 2, two beakers contained 10ml of Glacier acetic acid mixed with 90ml deionised water, two beakers contain 1 gram sodium sulphite mixed with 100ml of deionised water and another two beakers only contained 100ml of deionised water each. The beakers are labelled. All the pith and core are separately put into 6 beakers. 3 beakers contain pith and another 3 beakers contained core fibre. The beakers are placed in water bath at 90°C for 1 hour. The water bath water level is making sure enough for the experiment. After 1 hour, all the samples are washed with deionised water 4 times to clear the chemical inside. The chips inside the beakers are dried in the oven at 37°C for 1 day after it is washed. The chips are sealed in plastic bags and labelled after it is completely dry.

3.7.4 Treatment 4

Weight balance is used to weight kenaf chips. The kenaf chips are put into grinder using 6mm sizes plate to produced small particles of samples. One 250ml beakers contained 1 gram sodium sulphite mixed with 100ml of deionised water is prepared. The beakers are labelled. The pH of the solution is tested by using pH paper. The beaker is placed in water bath at 90°C for 1 hour. The water bath water level is making sure enough for the experiment. After 1 hour, all the samples are washed with deionised water 5 times to clear the chemical inside. Each time washed, the solution is tested with pH paper. All the result is recorded in the table. The samples are pressed hard by using tissue paper to absorb the excess water. The sample is transferred to beaker and dried in the oven at 37°C for 1 day. The sample are sealed in plastic bag and labelled after it is completely dry.

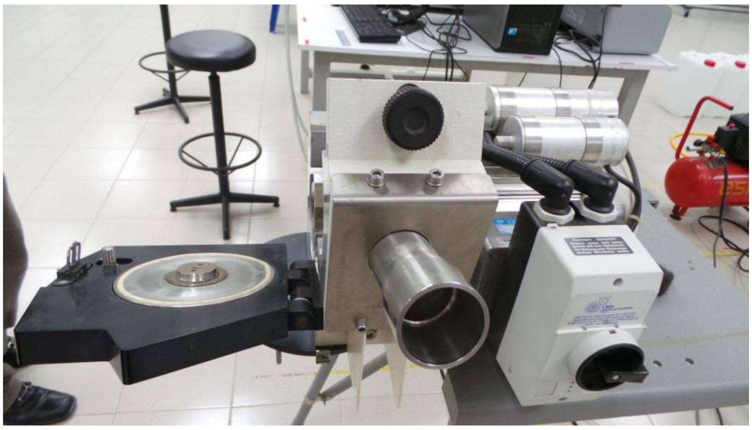


Figure 3-1: Grinder used for grind kenaf chips into small particles

3.7.5 Treatment 5

The fresh kenaf stalk obtained freshly from the plantation is stored at the air conditioned place. The total weight of the kenaf supply is weighted and recorded. 4 kenaf stalks is randomly chosen for further experiment needed. The diameter of kenaf stalk with bast fibre is measured. The weight of 4 kenaf stalk sample chosen is also weighted. Next, the kenaf outermost bast fibre is peeled off manually and dried under the sun for 7 hours. This is to ensure the kenaf samples is dry before it is cut into chips and put in grinder to get small particles of samples. The kenafchips are put into grinder using 6mm sizes plate to produced small particles of samples. 4 packs of 5 grams kenaf samples are weighted by using weight balance. Four 250ml beakers is prepared which contain different chemicals used. 1st beaker contained 0.5 gram sodium sulphite mixed with 100ml of deionised water, whereas 2ndbeaker contains 20ml glacier acetic acid mixed with 80ml of deionised water. The 3rd beaker contain 10ml of sodium hypochlorite mixed with 90ml of deionised water while the 4th beaker is filled with 20ml sodium hypochlorite mixed with 80ml of deionised water. All the beakers are labelled. The pH of the solutions is tested by using pH paper. The beakers are placed in water bath at

90°C for 1 hour. The water bath water level is making sure enough for the experiment. After 1 hour, all the samples are washed with deionised water 5 times to clear the chemical inside. Upon each washing, pH is measured in the wash solution. All the result is recorded in the table. The samples are pressed hard by using tissue paper to absorb the excess water. The sample is transferred to beaker and dried in the oven at 37°C for 1 day. The sample are sealed in plastic bag and labelled after it is completely dry.

3.8 FESEM and SEM scanning

All the samples are sent for SEM and FESEM scanning to investigate the structural morphology of pores of the fibres for the chips. The chips are randomly chose and cut into half. Small pieces of samples are obtained by cutting used small knife. The small pieces sample is used for SEM analysed. EDS analysis is being carry out for determination of elementary composition of treated samples.

Figure 3-2: SEM used to investigate morphology of samples

Figure 3-3: FESEM JEOL JSM-7800F used for morphology scanning and EDS
(Source of link: http://www.jeolusa.com)

3.9 Absorbency test

The absorbency test is applied to test how much liquid the treated kenaf particles can hold up. 1g of treated sample of 1g sodium sulphite is weighted by using weight balance. Three sample holders are prepared for absorbency test. 1 g of the treated sample is put into the sample holder and press hard until it fully compact by using glass rod. This process is repeated for another 2 sample holders. Next, the height of the compact kenaf sample in sample holder is measured and the average value is recorded. 400µL, 600µL and 1000µL of ink are poured slowly into the sample holder by using pipette. The kenaf pulp is waited for 2 hours to absorb the liquid. The distance that is travelled by the liquid is measured and recorded. More liquid is added to the kenaf pulp to absorb maximum amount of liquid to be held by the samples. The amount of liquid used and distance travel by the liquid is recorded. The experiment steps is repeated by using another 5 different samples, 4 samples that are treated by using 0.5g sodium sulphite, 10% sodium hypochlorite, 20% sodium hypochlorite, 20% Glacier Acetic Acid and one untreated sample. All the results are recorded and absorbency value is calculated in the tables.

3.10 Moisture Analysis

Moisture Analysis on the different types of treated and untreated samples is being done by using Moisture Balance EQPCL 093, MX 50. The amount of water remained in the samples after the drying process can be determined by moisture analyzer. This is to ensure whether the samples is completely dry or not as this may influence the absorbency value of the samples. For the general process of moisture analysis, initial weights of samples are taken at standard temperature and relative humidity. The instrument is adjusted to about 160°C for heating process of the samples. By this, all the moisture and water contain in the sample will be removed. The final weights of the samples are recorded. The percentage of moisture content in the pores of initial samples can be calculated by using the following equation: (Mitul Zaveri, May 2004)

$$\text{\% of moisture present within the sample} = \frac{\text{Weight of (initial sample- final sample)* 100}}{\text{Weight of initial sample}}$$

Figure 3-4: Moisture Balance that used for moisture content analysis of each sample

3.11 Summary

This paper presents a study of production of low cost feminine from kenaf by applying suitable mechanical and chemical treatment on pulping process. Three types of chemical treatment are being applied in this research are acidic, alkali and hypochlorite treatment. Main focus of this research is to study the effect of chemical treatment on the absorbency and condition of pores of kenaf.

4 RESULTS AND DISCUSSION

4.1 Overview

Experiment is carried out followed the methodology stated. The main objective of this research is to analyze the best method for production of low cost feminine hygiene by using suitable mechanical and chemical method. All the result are recorded properly for each measurements.

4.2 Results

This paper presents a study on the morphology condition and absorbency of kenaf fibre based on different chemicals used.

Table 4-1: Kenaf measurement based on samples

Samples		**1**	**2**	**3**
Length of whole sample (cm)		281	293.5	298.5
Length of Upper part of samples (cm)		153.5	168	174
Length of Bottom part of samples (cm)		127.5	125.5	124.5
Circumference of Each Part of Kenaf Samples (cm)				
Upper part	(1st part)	3.4	3.2	3.4
	(2nd part)	4.8	4.5	4.3
Bottom part	(1st part)	5.1	4.7	4.6
	(2nd part)	5.6	5	5.1
	(3rd part)	6.2	5.5	5.6
	(4th part)	7.2	6.2	5.9
Diameter of Each Part of Kenaf Samples (cm)				
Upper part	(1st part)	1.08	1.01	1.08
	(2nd part)	1.52	1.43	1.36
Bottom part	(1st part)	1.62	1.49	1.46
	(2nd part)	1.78	1.59	1.62
	(3rd part)	1.97	1.75	1.78
	(4th part)	1.98	1.86	1.87
Inner circumference of Upper Part (cm)		4.3	3.9	3.8
Inner circumference of Bottom Part (cm)		6	5.5	5.4
Inner diameter of Upper Part (cm)		1	0.9	1
Inner diameter of Bottom Part (cm)		1.5	1.4	1.4

4.3 Cutting the stalk of kenaf to chips and measurement is taken

Length and diameter measurement

Figure 4-1: Different diameter and length of kenaf chips being produced

Figure 4-2: Two different length of kenaf chips being produced (3 cm and 2 cm)

Table 4-2: Kenaf core fibre chips measurement based on samples

Samples	Part of stalk where chips produce	Length	Diameter Measurement for Chips (cm)					Average
			1st reading	2nd reading	3rd reading	4th reading	5th reading	
1st	Lower part	3cm	1.5	1.5	1.5	1.4	1.4	1.46
2nd	Upper part	3cm	1.3	1.3	1.2	1.1	1.2	1.22
3rd	Upper part	2cm	1	1	1	0.9	0.9	0.96
4th	Upper part	2cm	0.8	0.7	0.8	0.8	0.7	0.76

4.4 Effect on Physical properties of Kenaf

The physical properties of kenaf samples are being observed after 3 days. There is fungus growth on the chips which are left in room temperature (27°C) for 3 days in a sealed bag. Lots of black spot can be seen through figure 4-3 as shown below.

Figure 4-3: Fungus growth on kenaf chips after 3 days in room temperature

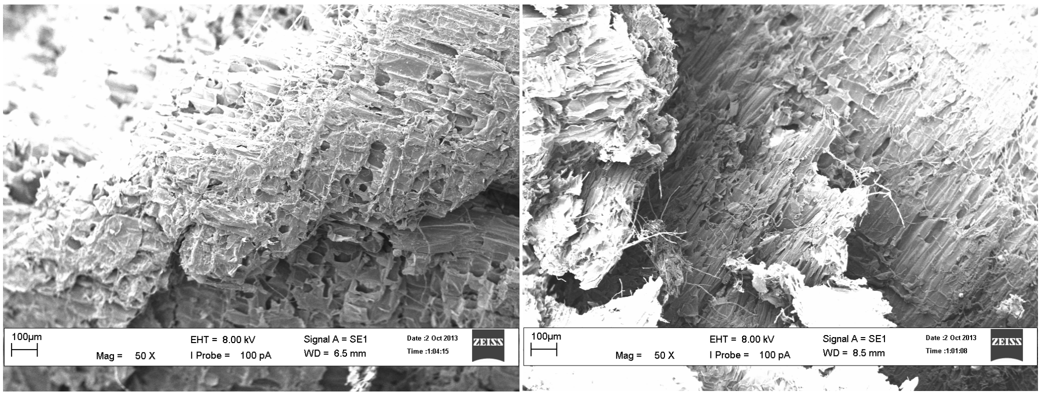


Figure 4-4: (SEM Scanning) Fungus growth on another kenaf chip after 3 days in room temperature

4.5 Colour changes on kenaf samples after chemical treatment

Figure 4-5: Colour Changes on kenaf samples during chemical treatment

4.6 SEM Scanning result for all treatment

4.6.1 Treatment 1 SEM Scanning result

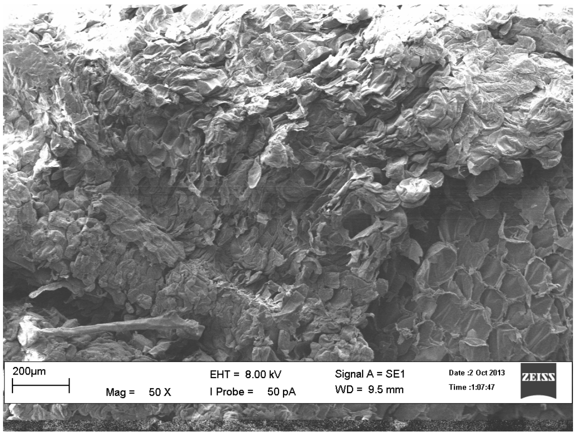


Figure 4-6: 10% Glacier Acetic Acid treatment at 90°C for 2 days

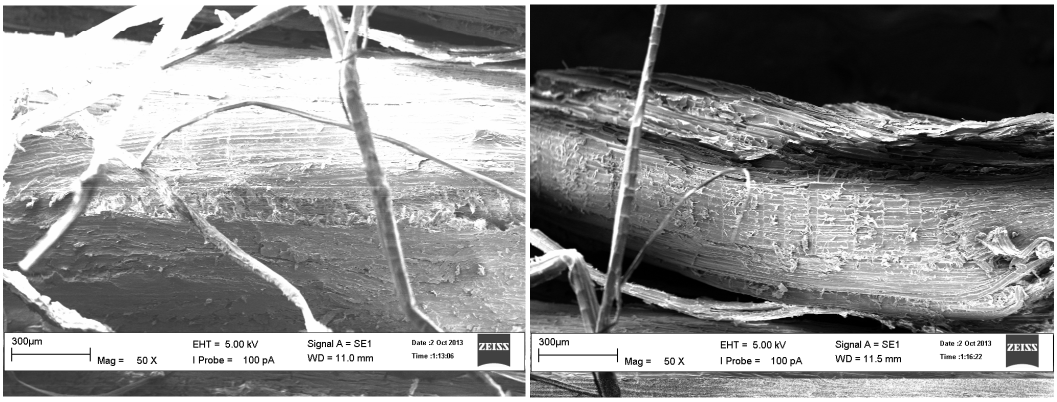


Figure 4-7: Deionised water treatment at 90°C for 2 days

4.6.2 Treatment 2 SEM Scanning result

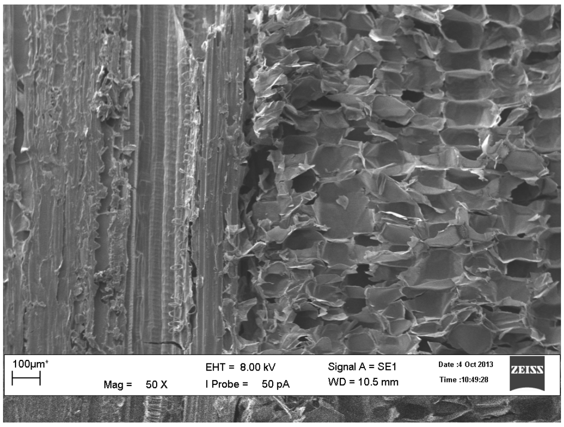


Figure 4-8: 1g Sodium Sulphite treatment at 90°C for 1 hour (1.3-1.4cm)

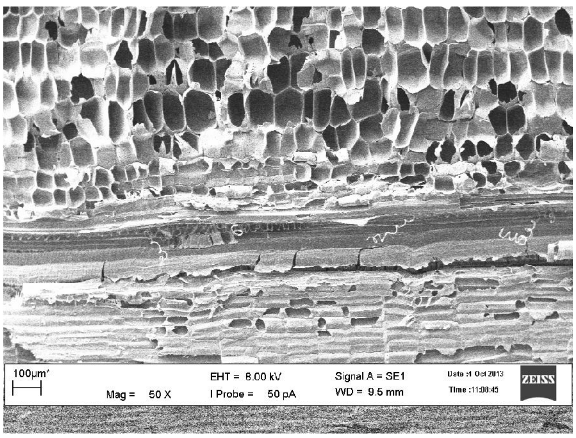


Figure 4-9: 1g Sodium Sulphite treatment at 90°C for 1 hour (D=0.8-0.9cm)

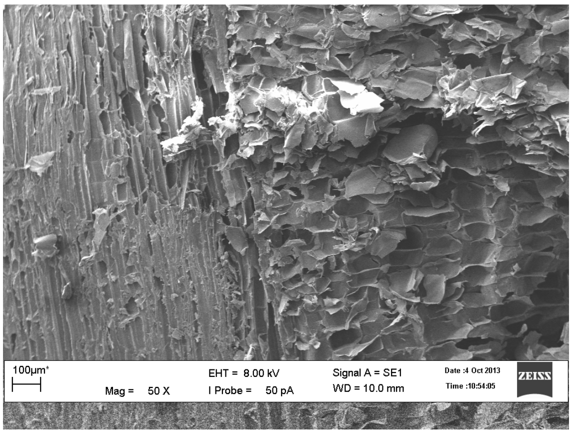


Figure 4-10: 10% Glacier Acetic acid treatment at 90°C for 1 hour (D=1.3-1.4cm)

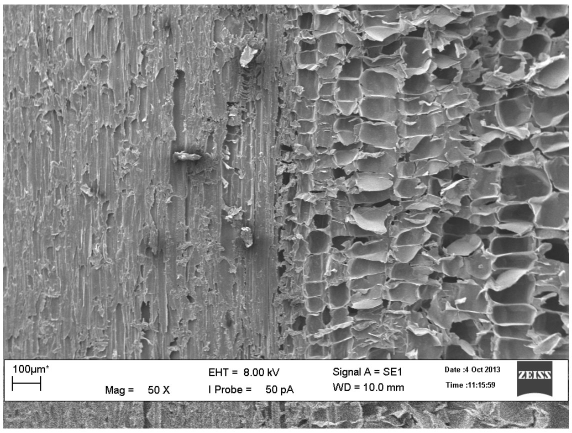


Figure 4-11: 10% Glacier Acetic acid treatment at 90°C for 1 hour (D=0.8-0.9cm)

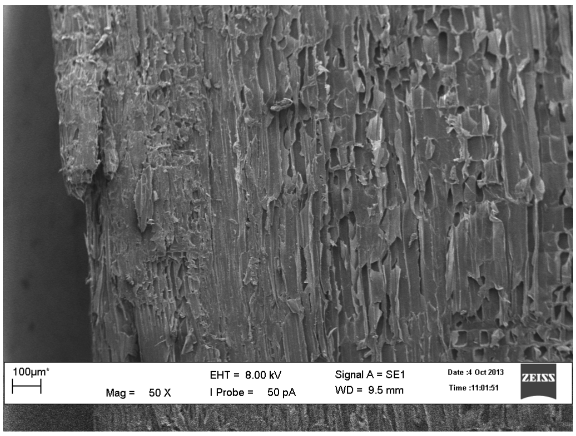


Figure 4-12: Deionised water treatment at 90°C for 1 hour (1.3-1.4cm)

4.6.3 Treatment 3 SEM Scanning result

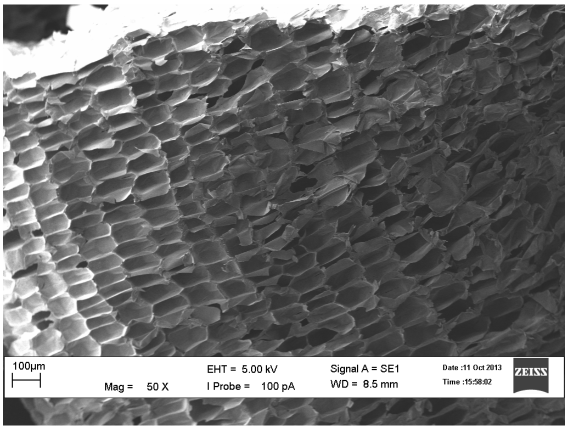


Figure 4-13: Pith treated with deionised water

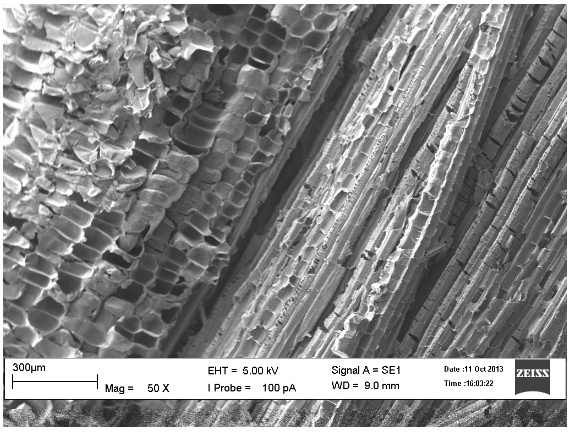


Figure 4-14: Core treated with deionised water

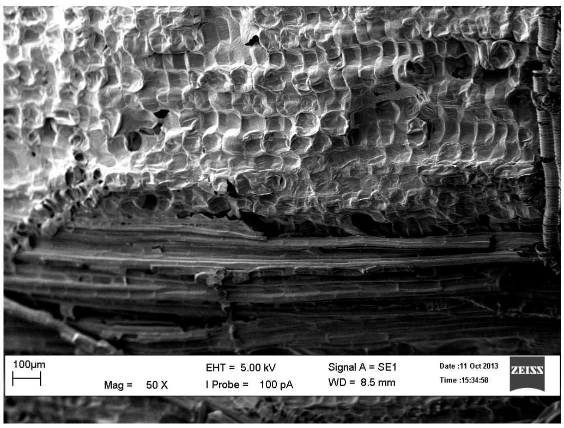


Figure 4-15: Pith treated with 1 g Sodium Sulphite

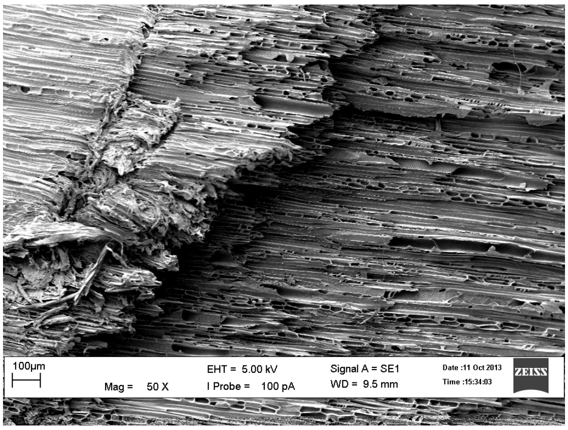


Figure 4-16: Core treated with 1 g Sodium Sulphite

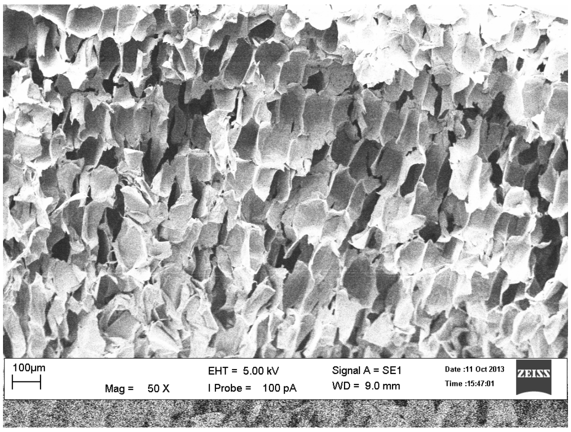


Figure 4-17: Pith treated with 10% ofGlacier Acetic Acid

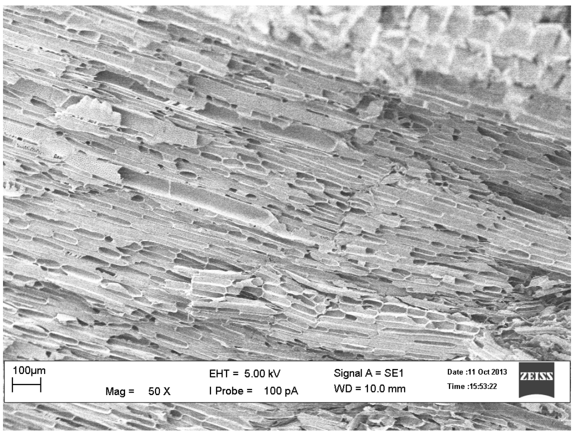


Figure 4-18: Core treated with 10% of Glacier Acetic Acid

4.6.4 Treatment 4 SEM Scanning result

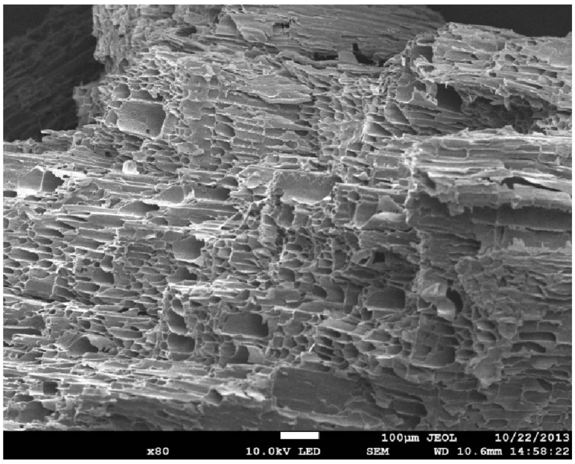


Figure 4-19: Kenaf small particles treated with 1 g of Sodium Sulphite

4.6.5 Treatment 5 SEM Scanning result

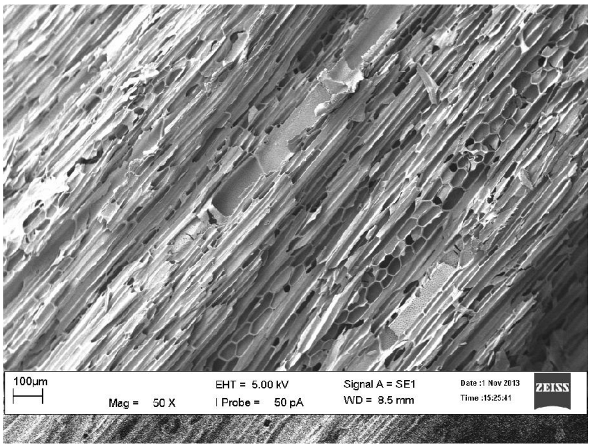


Figure 4-20: Kenaf small particles treated with 0.5 g of Sodium Sulphite

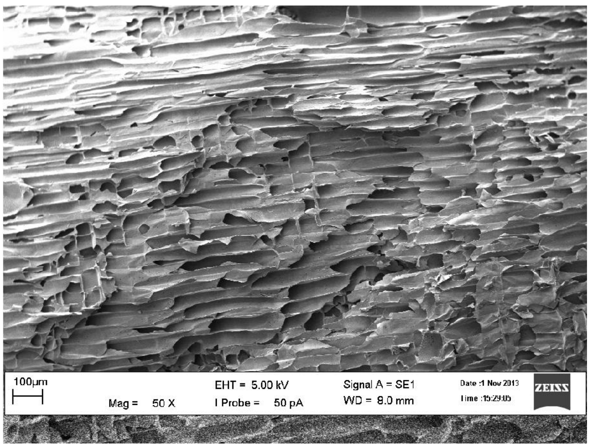


Figure 4-21: Kenaf small particles treated with 20% of Glacier Acetic Acid

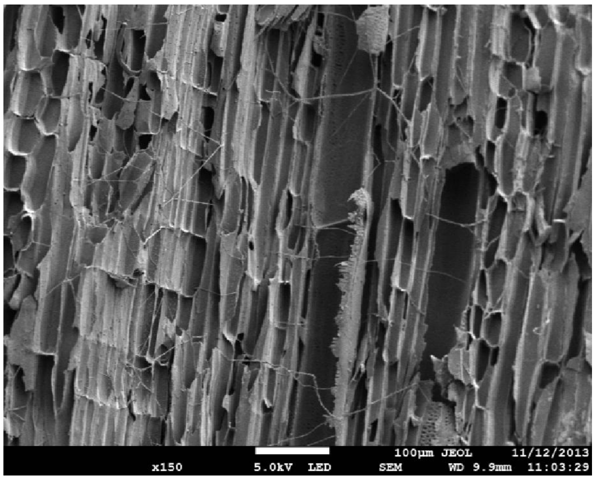


Figure 4-22: Kenaf small particles treated with 20% of Sodium hypochlorite

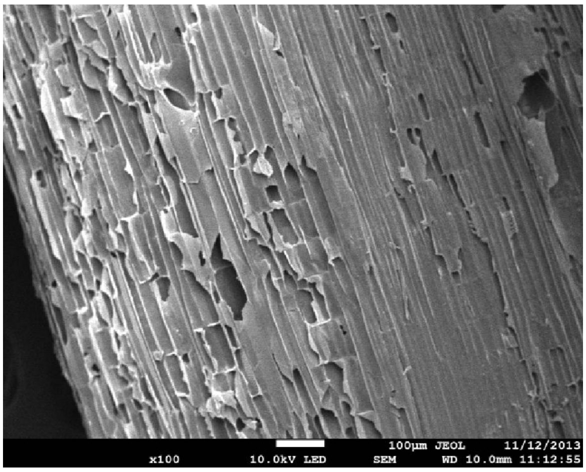


Figure 4-23: Kenaf small particles treated with 10% of Sodium hypochlorite

4.7 PH measurement for chemical treated samples

Table 4-3: pH measurement after treatment for Kenaf samples

Times wash	pH		
	Glacier Acetic Acid	Sodium Sulphite	Sodium hypochlorite
1st	2	8	6
2nd	2	7	6
3rd	2	7	6
4th	3	6	7
5th	3	6	7

4.8 FESEM Scanning result for chemical treated samples

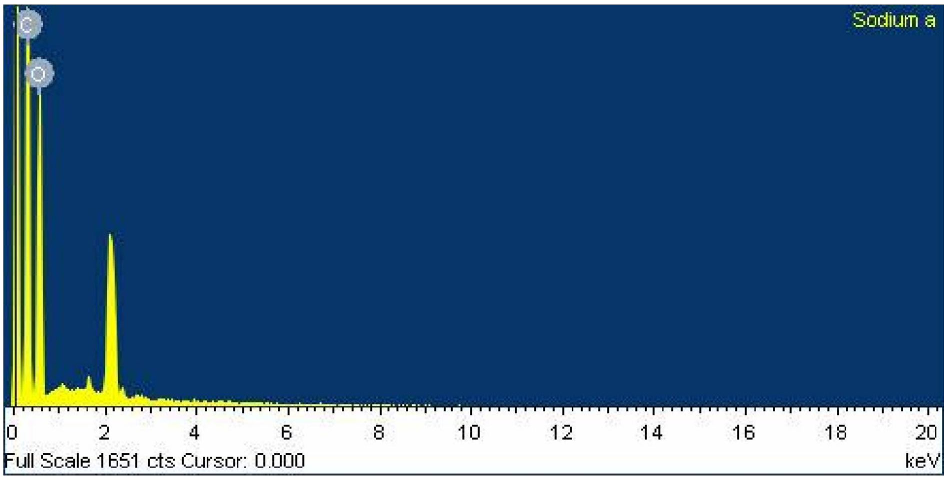


Figure 4-24: Graph composition of Kenaf small particles treated with Sodium sulphite

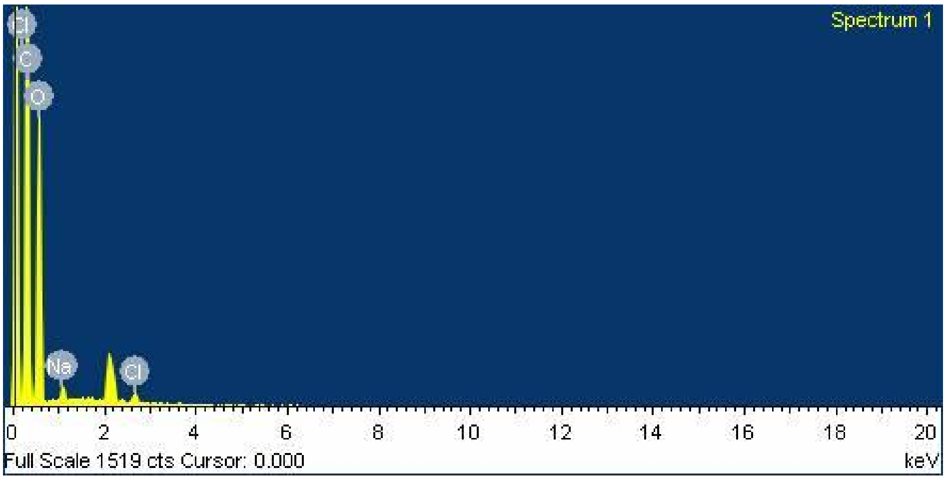


Figure 4-25: Graph composition of Kenaf small particles treated with Sodium hypochlorite

4.9 Moisture Analysis

Moisture analysis is being done by using moisture balance. The result shown is in unit of percentages (%).

Table 4-4: Moisture analysis result for each test sample

Type of samples	Moisture Content (%)
Fresh	48.77
Untreated (China)	12.54
Untreated (Australia)	11.51
Treated with 0.5g of Sodium Sulphite	42.70
Treated with 1g of Sodium Sulphite	37.19
Treated with 10% of Sodium Hypochlorite	13.35
Treated with 20% of Sodium Hypochlorite	26.67
Treated with 20% of Glacier Acetic Acid	44.10

4.10 Different Chemical Treated Samples Absorbency result

Experiment is carried out the absorbency test is carried out by using Epson ink of esyink as it has higher viscosity than water. Water is a low viscosity liquid that not suitable for absorbency test for feminine hygiene absorbent. As the blue ink had higher viscosity which is nearly similar as human liquid, it is been used for the absorbency test. In this experiment, 6 types of samples prepared earlier were test for the absorbency. This is to observe and investigate what is the maximum absorbency for each sample. 100µL of ink is equal to 0.1080g. The result for each sample is recorded in the tables 4-5.

Table 4-5: Absorbency measurement for each Kenaf samples

Type of samples	Maximum absorbency (g fluid/g of sample)
Untreated	1.728
Treated with 1g of Sodium Sulphite	1.836
Treated with 0.5g of Sodium Sulphite	1.620
Treated with 10% Sodium Hypochlorite	2.376
Treated with 20% Sodium Hypochlorite	1.512
20% of Glacier Acetic Acid	1.080

4.11 Discussion

Based on the result show above, kenaf that is used in the experiment had height of 281 to 298.5 cm. This kenaf was about 3 months grown and not yet achieve it maximum height. The kenaf is obtained and stored at low room temperature about 25°C for about 2 months and 15 days after all the measurement is took. It is to observe whether there is any change to physical properties of kenaf fibres. Observation shows that the outer bast fibre of kenaf had turn colour from light green to brown. The core fibre of the kenaf had less moisture content compare to fresh kenaf. The core fibre is pale yellow colour as shown in the picture at the result. The diameter of the core fibres is about average of 1.46cm whereas the average diameter of sample 2 is 1.22cm. For the 3rd sample, it average diameter is 0.96cm and for 4th sample is 0.76cm. Sample 1 had highest core fibres diameter because it is the bottom part of the stalk of kenaf while sample 2, 3 and 4 are the sample from upper part of the kenaf stalk. From the observations obtained in changes of physical properties after 3 days in the room temperature, proved that fresh kenaf have high moisture content at the core and pith fibres. It was not practical to leave kenaf stalk without bast fibre in room temperature. These wet and warm conditions provide basic requirement for growth of fungus and microorganism. Based on the pH measurement table, samples which treated with glacier acetic acid increased from pH 2 to 3 after 5 times of washing. This show that there was acid content left inside the samples. Low acidic pH is not applicable for the production of feminine hygiene product as it will bring harm to sensitive area of human body. For sodium sulphite treated samples, the pH is dropped from 8 to 6. Mostly the sodium sulphite was being washed away by deionised water. On the other hand, the pH for the sodium hypochlorite treated samples increased from 6 to 7. The pH is neutral. Both pH for samples treated by using sodium hypochlorite and sodium sulphite were suitable for production of feminine hygiene as it is in the range of neutral pH.

4.11.1Effect of chemical treatment time on kenaf chips

According to the observation make after the experiment, all the chips turned very hard and completely dry externally and internally. The kenaf chips are exposed to too much heat as it is placed in water bath at 90°C for 2 days. There is no more acetic acid solution remained in the beaker because it is totally evaporated. The colour of kenaf chips are changed from pale light green to brown yellow. In addition, the kenaf chips are put in the oven for one day at 80°C. This adds more dryness to the kenaf chips. Based on the SEM scanning result obtained, the pores shape of kenaf sample is not uniform and damaged. The high temperature applied in this experiment cause the kenaf core fibre become burned and in very dry condition. So, this long time high temperature chemical treatment is not applicable for kenaf core chips. Compare to experiment being done in treatment 2, the time for the chemical treatment is more suitable for kenaf core chips. The kenaf core chips that is only treated with 10% acetic acid at 90°C for one hour remained same in pale light green colour and didn't burned as in treatment 1. The some of the pores of kenaf core are opened but not very uniform. The pores are remained in shape and didn't destroy. 1 hour chemical treatment for kenaf core is the best time to remain the core chips in same colour and did not damage the pores of core. Besides, it also leads to some pores opening which will contribute to higher absorption of liquid.

4.11.2 Effect of different chemical treatment on kenaf chips pores

The chemical that are used in treatment 1 and treatment 2 is glacier acetic acid and sodium sulphite as mentioned in the methodology. The controlled variable used is treated the chips by using deionised water. For deionised water and sodium sulphite treatment samples remained same colour after the chemical treatment. Samples which are mixed with acetic acid solutions changed to yellowish brown colour. There are some differences discovered through the SEM scanning for the changes of pores of each samples. Based on the image got from the SEM scanning, the condition and size of pores opening can be seem clearly. For the samples treated with 20% glacier acetic acid, the pith pores show some opening but not very uniform in shape. The pith pores looked like rectangular shape. The core pores shown were not much open. On the other hand, the chips treated with 1g of sodium sulphite showed pores with more opening and uniform shape. Most of the pith pores were opening wide and uniformly. The shape of the core pores also can be seemed clearly and well formed. This result obtained for sure would increase the absorption ability of the fluid. For the chips treated by using deionised water only, the core pores remained close and only a bit pith pores were opened. Samples which are treated with sodium hypochlorite show better pores opening compare to samples treated with glacier acetic acid. Pores opening are happened as few amount of lignin and cellulose component are being removes through alkalization (El-Shekeil, Y.A. Sapuan S.M., Khalina A. Et al, 2012).

4.11.3 Effect of different particles size use for chemical treatment

Different particle size of sample gives different surface area which is exposed to chemical. Smaller particles size gives larger surface area as compare to bigger particles size. In the experiment, the samples size can be dividing into 3 types that are chips, medium blended particles size and 6mm small particles size. Small particle size offer larger surface area for chemical contact and reaction. This may help to increase the effectiveness of chemical treatment on the pores of kenaf core. Based on the scanning result, the small particles which are treated with chemicals show better pores opening than the larger particles like chips used in 1st and 2nd treatment.

Figure 4-26: Kenaf small particles produce by using 6mm scale of plate for grinder

4.11.4 Effect of chemical treatment on the absorbency

Absorbency test is being carried out for each sample. The absorbency of each sample including untreated is higher than 1.00 g of fluid/g of sample as shown in table 4.5. Samples treated with 20% Glacier Acidic acid show lowest absorbency with 1.08 g of fluid/g of sample. Samples treated with 10% sodium hypochlorite achieved highest absorbency of 2.376 g of fluid/g of sample. Samples treated with 1 g of sodium sulphite showed quite high absorbency at 1.836 g of fluid/g of sample. While for the untreated kenaf sample, it showed absorbency of 1.728 g of fluid/g of sample. Both kenaf samples treated with 0.5g of sodium sulphite and 20% of sodium hypochlorite getting moderate absorbency values that are 1.62 g of fluid/g of sample and 1.512 g of fluid/g of sample. Kenaf sample which was treated with sodium hypochlorite show a significant increase in volume which leaded to higher absorbency value. Larger specific surface area and higher absorption ability of a fibre is most important for the production of fluff pulp in absorption articles (Inger V. E., Goran, E.A., Lars E.R.W., Feb.20, 1996).

4.11.5 Element Composition in chemical treated Kenaf sample

By using the EDS scanning of Field Emission Scanning Electron Microscopy (FESEM), the element composition in the chemical treated Kenaf samples can be determined directly. The number of iterations apply is 2. The common elements that consist in the Kenaf sample is Carbon (C) and Oxygen (O). For sample that is treated with Sodium Sulphite, the elements composition consists of carbon and oxygen only. 48.35% of Carbon and 51.65% of Oxygen by weight led to total sum of 100% weight of the sample. The result shows there is no any residual sulphite left in the sample which achieves the standard absorbent requirement of no harmful substances existing in product. On the other hand, the sample which is treated with sodium hypochlorite contained 30.85% of Carbon, 46.78% of Oxygen, 0.91% of Sodium and 1.46% of Chloride. As there is present of chloride, the treated pulp is not suitable for the production of absorbent as it may bring harm to health. There is requiring carrying out further processing to completely remove and eliminate the chloride.

4.11.6 Effect of Moisture content in chemical treated Kenaf sample on Absorbency

The moisture content of the kenaf sample is being done by using Moisture Balance EQPCL 093, MX 50. From the moisture result shown in Table 4.4, the fresh sample of kenaf achieved highest moisture content that is 48.77%. The moisture content of both untreated China and Australia type kenaf sample were low at 12.54% and 11.51%. The amount of moisture which existed in samples treated with 10% of sodium hypochlorite and 20% of sodium hypochlorite were 13.35% and 26.67%. For kenaf samples which are treated with 1.0g of sodium sulphite and 0.5g of sodium sulphite had higher moisture content of 42.7% and 37.19% compared to other treated samples. Besides that, sample treated with 20% Glacier acetic acid also had high moisture content at 44.1%. The moisture content in the treated samples will definitely affect the absorbency of the kenaf pulp as the higher the moisture content of a substance, the lower absorbency it had. The pores which are linearly arrangement were partially filled with water. This cause less liquid was being taken up by the pores in the samples. Kenaf sample which treated by 1.0g of sodium sulphite had high moisture content of 37.19% cause it absorbency value to be less at 1.836 g of ink/g of sample. Whereas untreated Australia Kenaf sample had moisture content of 11.51% achieved absorbency of 1.728 g of ink/g of sample. Treated kenaf sample by using sodium sulphite supposed to have much higher absorbency than untreated sample as the pores are open wide for liquid absorption. However, due to the high moisture content in the sample, it only makes a difference of 5.88% absorbency greater compare to untreated kenaf sample.

5 CONCLUSION

5.1 Conclusion

This research is mainly focuses on different parameters of kenafand experimental study on the effect of mechanical and chemical treatment on kenaf absorbency.Production of low cost feminine hygiene from kenaf is depending on the knowledge of mechanical and chemical treatments apply based on the properties of kenaf types. Alkali treatment by using sodium sulphite is proven to be suitable use in absorbent production as it increase in absorbency value than untreated kenaf sample. Moisture content is an important factor which will affect the absorbency value of pulp.

5.2 Recommendation

Smaller particles of samples can be used for experiment as increasing the surface area will increase the chemical contact reaction. This will greatly help in pores opening for better absorption of fluid. Plate of size 4mm or 2mm can be used in grinder for kenaf samples. Other than grinder, ball mill can be used for produce smaller particles of kenaf fibres, too. The residue of chloride which contain in the samples treated with sodium hypochlorite can be further eliminate by using hydrogen peroxide. More types of low cost chemicals can be used for production of higher absorbency fibre for example sodium hydroxide. Use of enzyme can be consider in this future pulping and fluffing process as it is non-chemical substances and more environmental friendly. Enzyme such as xylanase can be applied to treat the lignin in the kenaf core fibre. Biological production of fibre is better for health as feminine hygiene product should be free from harmful chemicals.

5.3 Future work

The research carried in this project will be carried on by Dr. Balu Ranganathan and next undergraduate student from UMP. More research will be done in improving the absorbency of kenaf pulp based on the chemical treatment choose and reduce the moisture content of pulp. There is cooperation between National Kenaf and Tobacco Board of Malaysia with Dr. Ranga in this research. Mitul Zaveri and few others researcher from Asia Country also show interest in development of this production of low cost feminine hygiene from kenaf. Any new information about research and development of kenaf project will be share among each other as we had regular contact with other country researchers. The main focus for this new work is to create a better quality of feminine hygiene and low cost in price.

REFERENCES

Ahmad.A.M,Jalaluddin. H, Seyed.R.F.S, Hossin.R,et.et.al.(2010).A Review of Literatures Related to Kenaf as a Alternative for Pulpwoods, Agricultural Journal, Vol 5, No.3, pp. 131-138.

Annica S., Gavle (SE), Stefan Hogman, Gavle(SE), Helena Tufvesson, Gavle (SE).2005.Fluff Pulp For Absorption Products, United States Patent No. 6,918,992 B1.Gavle.

Anthony, W.S. May 1994. Absorption of oil with cotton products and kenaf ,Applied engineering in agriculture ,v. 10(3) p. 357-361 Retrieved on March 29, 2013 from site:http://agris.fao.org/agrissearch/search/display.do?f=1995%2FUS%2F US95107.xml%3BUS9512059

Amar N. Neogi, Hugh West, David L.Lee. 2005, Whitened Fluff Pulp, Unites States Patent No. 6,893,473.

Bente L. Laursen, Ektorp , Sweden. Dec.1,1981. Method of Producing Fluffed Pulp, United States Patent No. 4303,471.

Cannabis Cosmetics.(2012),Feminine Hygiene Wash-Products. Retrieved on December 14, 2013 from site: http://www.cannabis-cosmetics.com/feminine-hygiene-wash-products/t-418/

Charles.L.,Webber.III,Harbans L.,et al, (2002), Kenaf Production: Fiber, Feed, and Seed, Trends in new Crops and New Uses.

Charles.L.,Webber.III,VenitaK.,et al, (2002), Kenaf harvesting and Processing, Trends in new Crops and New Uses.

Department of Agriculture, Foresty and Fisheries, (2012), Kenaf, Directorate Communication Services, Private Bag X144.

El-Shekeil.Y.A, Sapuan.S.M, Khalina.A. et al. (2012), Influence of Chemical Treatment on the Tensile Properties of Kenaf Fibre Reinforced Thermoplastic Polyurethane Composite, eXPRESS Polymer Letters, Vol 6, No.12, pp. 1032-1040.

FAO. 2010. FAOSTAT Agricultural Data. Retrieved on March 29, 2013 from site: http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Jute_Hard_Fibres/Documents/STAT_BULL_2010_01.pdf

Gopang, A.D.Oct-Dec 2000. Production of newsprint from 100% kenaf, Science Technology and Development**,** v. 19(4) p. 7-11 Retrieved on March 29, 2013 from site:http://agris.fao.org/agrissearch/search/display.do?f=2001%2FPK%2FPK01003.xml%3BPK2001000774

Harry J. Chmielewski, Othman A. Hamed, Micheal Haeussler. 2010. Plasticizing Formulation For Fluff Pulp And Plasticized Fluff Pulp Products Made Therefrom, United States Patent No. 7,854,822 B2.

Inger V. E., Goran, E.A., Lars E.R.W.(Feb.20, 1996). Fibres of Increased Specific Surface Area, A Method for Their Manufacture, Fluff Pulp Consisting of Such Fibres and the Use of the Fibres as Absorption Material, United States Patent No. 5,492,759. Swedan.

James Jay Tanner, Harold Jay Koller, 2004, Method of Forming And Metering Fluff and Pulp, United States Patent No. 6,773,545 B2.

JEOL USA Inc, JEOL USA Electron Optics Instrument, Retrieved on 14 January 2014 from:http://www.jeolusa.com/PRODUCTS/ElectronOptics/tabid/184/Default.aspx

Julian C. Crane and Julian B. Acuna, (1945), Growth and Development of Kenaf, Hibiscus CannabinusL.With Special Reference to Fiber Content of the Stems, Journal of the American Society of Agronomy.

Kugler, D. E. (1995, March). Status of Commercial Development of Kenaf in the United States. Retrieved from: http://cool.conservation-us.org/byorg/abbey/ap/ap08/ap08-1/ap08-107.html

Leif, N.,(1996), Fluff Pulp and Method for the Preparation of Fluff Pulp, United States Patent No. 5,536,369.

Leif, N.,(2002). Method of Preparation of A Fluffed Pulp to be Used in Absorbent Products. United States Patent No. 6,340,408 B1.

Martin, G.H.(2000). Fluffed Pulp and Method of Production. United States Patent No. 6,059,924.Ga.

Mehdi J., Jalaludin H., Paridah Md. T., Alireza S., Syeed Sa. A. et al, (2010), Physicochemical Characterization of Pulp and Nanofibers from Kenaf Stem, Materials Letters 65 (2011) 1098-1100.

Michele M. S., A. Levent C., 2004, Preparation of Modified Fluff Pulp, Fluff Pulp Products and Use Thereof, United States Patent No. 6,821,383 B2.

Mitul Zaveri. May 2004, Absorbency Characteristics of Kenaf Core Particles. Department for the Textile Apparel Technology And Management.

Mohd.S.S, Chin.H.C, Sarani.Z. (2011), Citric Acid Modified kenaf Core Fibres for Removal of Methylene Blue from Aqueous Solution, Bioresource Technology, No. 102, pp. 7237-7243.

Monti, A. (2013). Kenaf: Multipurpose Crop for Several Industrial Applications. London, New York: Springer.

Muhammad Ridzwan B. I, (2007), A Comparison of Mechanical Properties between

Kenaf Core Fibre and Kenaf Bast Fibre Reinforced Polyester Composite, UniversititTeknikal Melaka Malaysia.

National Kenaf And Tobacco Board, 2009, Report on the Production of Kenaf . Retrieved on March 29, 2013 from site: http://www.lktn.gov.my/en/page.php102

Olli Jokinen, JukkaKettunen, JarkkoLepo, TapioNiemi, JaakkoE.Laine.(1991), Method Of Producing Fluff Pulp with Improved Defibration Properties, United States Patent No. 5,068,009

Oscar, W.M., Philip, M.H. (1984), Dimethylamide and Cationic Surfactant Debonding Composition and the Use Thereof in the Production of Fluff Pulp, United States Patent No. 4,425,186. Memphis, Tenn.

Othman A.Hamed. Dec 2007. Treatment Composition For Making Acquisition Fluff Pulp In Sheet Form, United States Patent No. 7,312297 B2.

Ovidiu Inlius Chiparus (May 2004), Baggase Fibre for Production of Nonwoven Materials, B.S. Technical University “Gh Asachi”, Iasi Romania.

Photometric, Field Emission Scanning Electron Microscopy (FESEM), Retrieved on December 16 from site: http://www.photometrics.net/fesem.html

Photometric, Scanning Electron Microscopy (SEM), Retrieved on December 16 from site:http://www.photometrics.net/sem.html

Robert, T.E., Dennis, C.H.(1980), Thin Skin Stabilization of Pads of Fluffed Pulp, United States Patent No. 4,233,345.New Brunswick, N.J.

She : Sustainable Health Enterprises. 2008. Retrieved on March 29, 2013 from site: http://www.sheinnovates.com/ourventures.html

Steef J.J. Lips, Goretti M. In˜ iguez de Heredia,Richard G.M. Op den Kamp, Jan E.G. vanDam. 2008. Water absorption characteristics of kenaf core to use as animal bedding material,Wageningen-UR, Agrotechnology and Food Sciences Group, Bornsesteeg 59, 6708 PD Wageningen, The Netherlands,73–79

Techno Forest Co.,Ltd, (May 2004), The Economic and Financial Analysis Study for the Jute/ Kenaf Pulp Manufacturing, Biotechnologocal Application of Enzymes, pp.28.

Webber, C.L., III, V.K. Bledsoe, R.E. Bledsoe. 2002, Kenaf Harvesting and Processing. 9. 340–347. In: J. Janick and A. Whipkey (eds.), Trends in new crops and new uses, ASHS Press, Alexandria, VA.

Women Web.(2004-2010). Reproductive Health. Retrieved on December 14, 2013 from site: http://www.womensweb.ca/health/repro/intimate.php

Yaghoon.T, Nor.A.A.S, Hazandy.A & Norlia.B,(2011), Growth Characteristic and Biomass Production of Kenaf, African Journal of Biotechnology, Vol. 10(63), pp. 13756-13761.

APPENDICES

Figure1: China kenaf sample

Figure 2: Australia kenaf sample

Figure 3: All the bast fibres were removed left the core fibre.

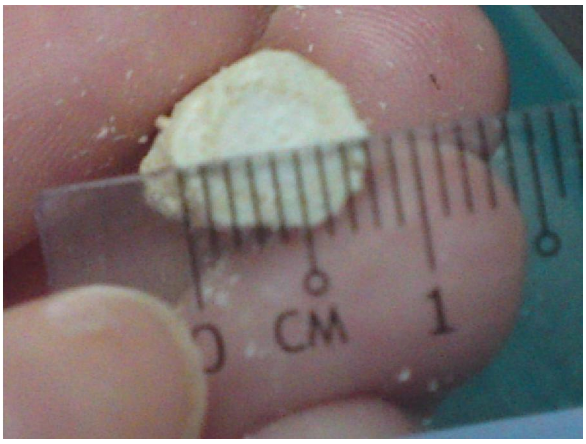
Figure 4: Australia kenaf dry stalk condition without bark fibre

Figure 5: All the bast fibres is thrown. Figure 6: Kenaf stalk was cut into chips.

Figure 7: Kenaf chips prepared for experiments.

Measurement of kenaf samples diameter

(a)



(b)

(c)

(d)

Figure 8: Kenaf chips diameter is measured as shown in figure (a),(b), and (c). Figure (d) show the pith inside the core fibre.

Samples use in Treatment 3

Figure 9: Kenaf samples treated with deionised water.

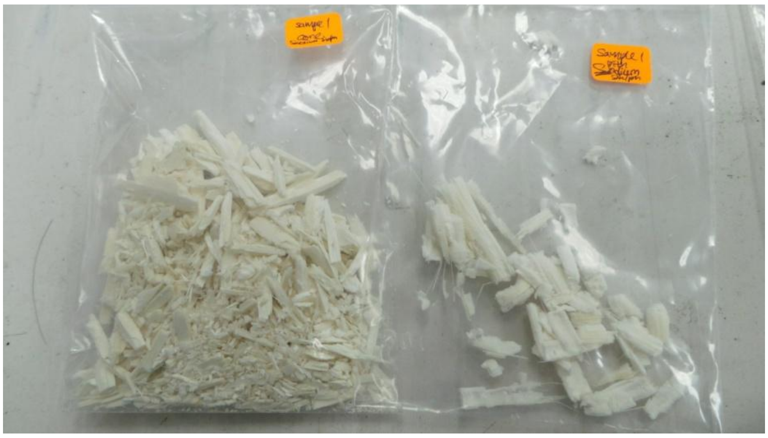


Figure 10: Kenaf samples treated with1g of sodium sulphite.

Figure 11: Kenaf samples treated with glacier acetic acid.

Figure 12: Kenaf small particles are produced by using grinder with plate size 6mm.

Figure 131: Kenaf samples which treated with Acetic acid solution showed colour change after the experiment when compared to samples treated with sodium sulphite.

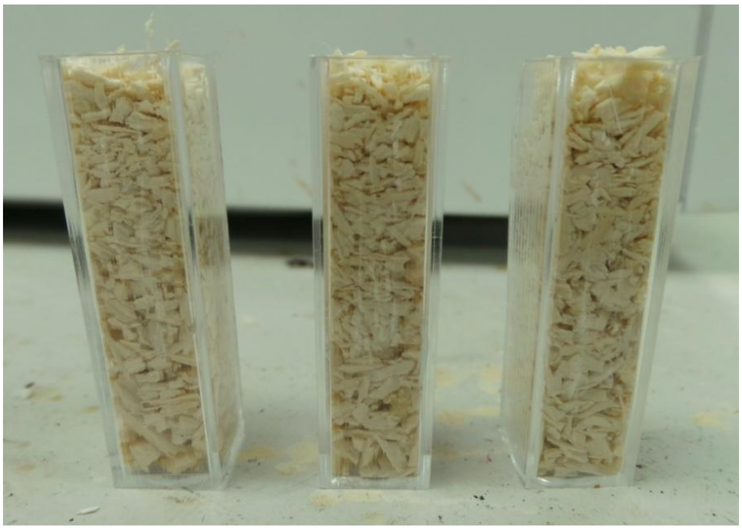


Figure 14: Kenaf samples is put into cuvette and press hard to make it compact prepared for absorbency test.

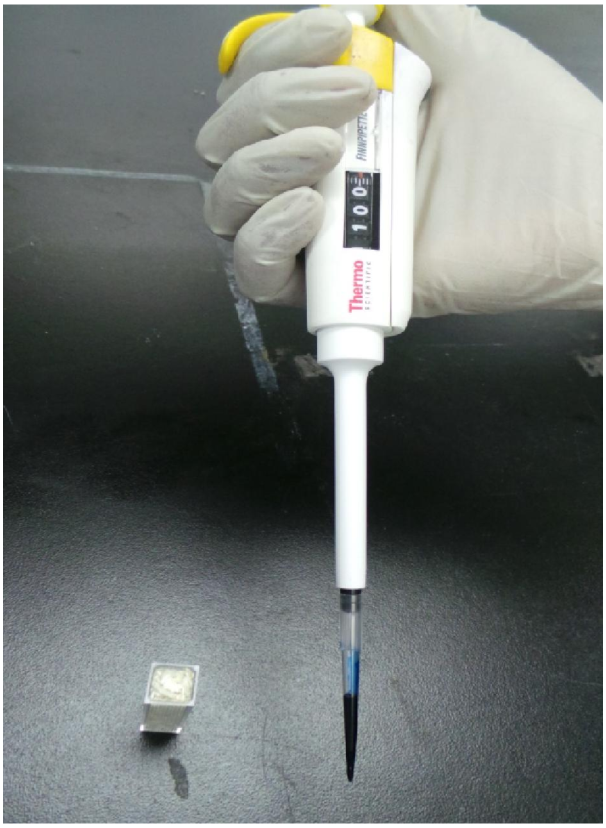


Figure 15: Pipette of 100µL is used to add the liquid to test the absorbency of chemical treated samples.

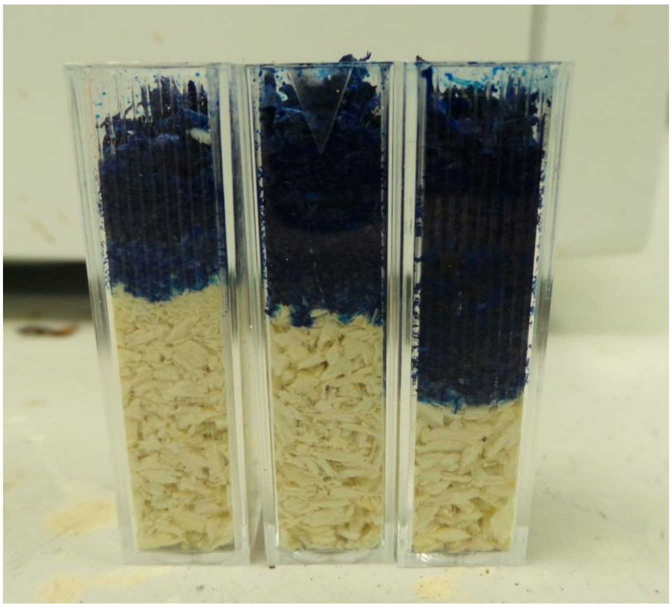


Figure 16: Kenaf chemical treated samples show different absorbency based on amount of liquid added.