"FORMATION AND EVALUTION OF BAMBOO PULP FOR MEDICAL APPLICATIONS"

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CERTIFICATE

This is to certify that the dissertation entitled "**FORMATION AND EVALUTION OF BAMBOO PULP FOR MEDICAL APPLICATIONS**" submitted by Mr. Balveer Singh to Delhi College of engineering in polymer technology is a record of bonafide work carried out by him. Mr. Balveer Singh has work under the guidance and supervision, has fulfilled the requirement for the submission of this dissertation, which to our knowledge has reached the required standard.

The results contained in this dissertation are original and have not been submitted to any University or institute for the any degree or diploma.

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ABSTRACT

This thesis deals with the preparation of bamboo pulp composite and its evaluation for it's suitability for medical application like wound dressing and absorbent material for hygiene application. Bamboo fibers have natural antibacterial property and have high absorbing capacity.

Bamboo fiber has a unique function of anti bacteria, which is suitable to make wound dressing article like bandage. . In the medical scope, it can be processed into the products of bamboo fiber gauze, operating coat and nurse dresses etc. Because of the natural antibiosis function of the bamboo fiber the finished products need no adding of any artificial synthesized antimicrobial agent. Therefore bamboo fiber products will not cause skin allergies.

Bamboo sanitary materials include bandages, masks, surgical clothes, nurse's wears and so on. The bamboo fiber has a natural effect of sterilization and bacteriostasis and therefore it has incomparably wide foreground on application in sanitary material such as sanitary towels, gauze mask, absorbent pads, and food packing and so on

It was observed in this study that bamboo pulp can be used for medical applications. In this study I prepare bandage using bamboo pulp and compare its property with the market available bandage.

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INTRODUCTION

CHAPTER-1 INTRODUCTION

Bamboo is the members of a particular taxonomic group of large woody grasses. Bamboo is lignocelluloses based fiber, and has 60.8% of cellulose and 32.2% of lignin. Bamboo is a natural composite material, unidirectional reinforced with fibers. Bamboo fibers have following properties.

- Natural anti-bacteria
- Green & biodegradable
- Breathable & cool

Bamboo produces natural and eco-friendly fiber without any chemical additives. More important, bamboo fiber is a unique biodegradable material. As a natural cellulose fiber it can be 100% biodegraded in soil by microorganisms and sunshine. The decomposition process does not cause any pollution in the environment. Bamboo fiber comes from nature and completely returns to nature in the end. Bamboo fiber is praised as “the natural, green and eco-friendly new-type material of 21st century”.

Bamboo fiber has a unique function of anti bacteria, which is suitable to make wound dressing article like bandage. . In the medical scope, it can be processed into the products of bamboo fiber gauze, operating coat and nurse dresses etc. Because of the natural antibiosis function of the bamboo fiber the finished products need no adding of any artificial synthesized antimicrobial agent. Therefore bamboo fiber products will not cause skin allergies.

Bamboo sanitary materials include bandages, masks, surgical clothes, nurse’s wears and so on. The bamboo fiber has a natural effect of sterilization and bacteriostasis and therefore it has incomparably wide foreground on application in sanitary material such as sanitary towels, gauze mask, absorbent pads, and food packing and so on. In the medical scope, it can be processed into the products of bamboo fiber gauze, operating coat and nurse dresses etc. Because of the natural antibiosis function of the bamboo fiber the finished products need no adding of any artificial synthesized antimicrobial agent. Therefore bamboo fiber products will not cause skin allergies and at the same time it has a competitive advantage in the market. Bamboo bathroom series enjoy good moisture absorption, soft feel and splendid colors as well as anti bacteria property which are very popular in home textiles. Bamboo towels and bath robes have a soft and comfortable hand feeling and excellent moisture absorption function. Its natural antibiosis function keeps bacterium away so that it will not produce bad odor.

This dissertation deal with the preparation of pulp composite from bamboo pulp and this composite is used as the absorbent pad in bandages. In this study I evaluate pulp properties and bandage properties and find that bamboo pulp composite is suitable for medical applications.

CHAPTER-2

LITERATURE REVIEW

CHAPTER -2 LITERATURE REVIEW

2.1 BAMBOO

Bamboo is the vernacular or common term for members of a particular taxonomic group of large woody grasses (subfamily Bambusoideae, family Andropogoneae/Poaceae). Bamboos encompass 1250 species within 75 genera, most of which are relatively fast-growing, attaining stand maturity within five years, but flowering infrequently. Dwarf bamboos may be as little as 10 cm in height, but stands of tall species may attain 15-20 m and the largest known grows up to 40 m in height and 30 cm in culms (stem) diameter. Bamboos are distributed mostly in the tropics, but occur naturally in subtropical and temperate zones of all continents except Europe, at latitudes from 46° N to 47° S and from sea level to 4000 m elevation. Asia accounts for about 1000 species, covering an area of over 180,000 km^2 size of Missouri, half the size of Germany, or about 2% of U.S. total land Most of this comprises natural stands of native species rather than plantations or introductions. China alone has about 300 species in 44 genera, occupying 33,000 km2 or 3% of the country's total forest area. Another major bamboo-producing country is India, with 130 species covering 96,000 km^2 or about 13% of the total forested area. Other nations with significant bamboo production and utilization include Bangladesh, Indonesia and Thailand.

The taxonomy of bamboos is still poorly understood, at least in part because of the infrequent flowering of many species. Major economic species include the following.

Dendrocalamus strictus: – native to India. Solid culms, of greatest economic importance in India, where only about 10 out of more than 100 bamboo species are commercially exploited. Used mostly for papermaking and construction.

Dendrocalamus asper: – thought to be native to Thailand. Thailand intends to propagate plantlets of this species since much of the present edible bamboo shoot production is from natural forests and not sustainable.

Thyrsostachys siamensis: – native to Thailand. Used for construction in both rural and urban areas of Thailand; also cultivated for edible shoots.

Phyllostachys pubescens: – sometimes described as Phyllostachys edulis. Originally from China, where it occurs extensively (20,000 km2 or 60% of total bamboo cover); introduced to Japan about 1750. The largest of the Phyllostachys genus, this species is harvested for both poles and edible shoots throughout South-East Asia. This species requires a climate with precipitation of 1200-1800 mm, mean annual temperature of 13-20° C and monthly mean minimum temperatures no lower than freezing

Phyllostachys bambusoides: – native to China, but extensively cultivated in Japan since 1866. The largest and most commercially valuable of this genus after Phyllostachys pubescens, producing good-quality wood. Hardier and more cold-tolerant than the latter.

Bamboo has been neglected or ignored in the past by tropical foresters, who tend to concentrate on timber trees at the expense of traditional multi-purpose woody species such as bamboo and rattan. Literature on the dynamics and productivity of natural bamboo stands is meager, and reports from plantation stands are almost non-existent. Bamboo has been used for handicrafts and building material in India and China for thousands of years, yet its potential contribution to sustainable natural resource management has only recently been recognized. Unfortunately, most bamboo is harvested from forest stands at a rate which exceeds natural growth, so current utilization is anything but sustainable.

2.2 BAMBOO AS NATURAL COMPOSITE

The bamboo composition has been studied by Jain et al. (1992). It was established that vascular bundles and xylem where the two major components in the bamboo column. Vascular bundles, surrounded by xylem, are composed of four groups of fibers, two vessels and sieve tubes. Average fiber diameter is 10-20 m. Bamboo is a lignocelluloses based fiber, and has 60.8% of cellulose and 32.2% of lignin. Bamboo is a natural composite material, unidirectional reinforced with fibers. The location, the density and the orientation of the fibers have been in the centre of studies over the last years in order to predict the mechanical properties of bamboo fibers.

Properties of a composite material are in strong correlation with the bonding between the different materials involved, i.e. the adhesion between fibers and matrix. Bamboo has often been studied as an alternative for wood, since it is renewable much more rapidly than wood. In order to be competitive, the matrix used in the bamboo fibers composites has to have a low price and good mechanical properties. Polypropylene fits well in that approach. The interface between fibers and matrix, and its influence in the composite properties have been studied. First, differential scanning calorimetry, wide angle X-ray diffraction and optical microscopy have been used to look at the crystallization and the interfacial morphology of both bamboo fibers reinforced PP-composite and bamboo fibers reinforced MAPP-composite (maleic anhydride polypropylene). The previous reactive agent was used to increase the bonding in the interface region between bamboo fibers and the polypropylene, and observations confirmed better bonding. The influence of MAH regarding mechanical properties has then been studied. The role of MAH, which acts as a compatibilizer between the hydrophilic bamboo surface and the hydrophobic properties of PP, has been considered as rather important since both tensile strength and tensile modulus reached values much higher than the ones obtained without MAH. Other studies established that dividing the fibers bundles into single fibers was of importance to increase the mechanical properties. Okubo et al. (2004) investigated the use of the steam explosion technique to extract the bamboo single fibers. The study showed an increase for both tensile strength and Young's modulus of about 15% and 30% respectively if compare with bamboo fiber reinforced MAPP-composite. This can be explained by a better impregnation of the matrix between the single bamboo fibers.

2.3 COMPOSITION OF BAMBOO

The chemical composition of Bamboo is as follows.

Major components	
Cellulose (alpha)	61-71 %
Lignin	20-30 %
Minor components	
Pentosans	16-21 %
Silica	0.5-4.0 %
Ash	1.0-9.0 %

2.3.1 CELLULOSE

It is a long-chain polymeric polysaccharide carbohydrate, of beta-glucose. It forms the primary structural component of green plants. The primary cell wall of green plants is made primarily of cellulose; the secondary wall contains cellulose with variable amounts of lignin. Lignin and cellulose, considered together, are termed lignocellulose, which (as wood) is the most common biopolymer on Earth.

Cellulose is a common material in plant cell walls and was first noted as such in 1838. It occurs naturally in almost pure form in cotton fiber. In combination with lignin and hemicellulose, it is found in all plant material. Cellulose is the most abundant form of living terrestrial biomass.

Some animals, particularly ruminants and termites, can digest cellulose with the help of symbiotic micro-organisms - see methanogen. Cellulose is not digestible by humans, and is often referred to as 'dietary fiber' or 'roughage', acting as a hydrophilic bulking agent for faeces. Cellulose is a versatile polymer which is found in pent in nature in the form of cotton, hemp, jute, flax, etc. also , a good percentage of wood consists of cellulose. Cellulose has an extremely high degree of crystallinity and this is due to the formation of several hydrogen bonds originating from its hydroxyl group. Its high stereo-regularity is also a contributory factor for its high crystalline cellulose has a very high melting point in fact it is decompose before beginning to melt. It is generally resistant to dissolution in several solvents, though it can swell in some, such as water, owing to the presence of hydrogen bonds. A closer analysis of the swelling process shows, that it takes place only in the amorphous regions, whereas, the crystalline regions as practically unaffected. Mostly cellulose is dissolved through chemical reactions. In industry, cellulose is usually dissolved and subsequently reprecipitated in pure form. This form of cellulose is known as the “regenerated cellulose”. Cotton contains the highest amount of cellulose with only small amounts of other substances such as protein and pectin.

Cellulose is the major constituent of paper; further processing can be performed to make cellophane and rayon, and more recently modal, a textile derived from beech wood cellulose. Cellulose is used within the laboratory as a solid-state substrate for thin layer chromatography, and cotton linters, is used in the manufacture of nitrocellulose, historically used in smokeless gunpowder.

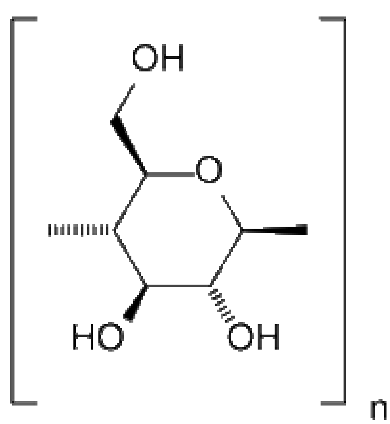

FIGURE 2.1 Cellulose as polymer of glucose

Cellulose monomers (β-glucose) are linked together through 1→4 glycosidic bonds by condensation. Cellulose is a straight chain polymer: unlike starch, no coiling occurs, and the molecule adopts an extended rod-like conformation. In micro fibrils, the multiple hydroxyl groups on the glucose residues hydrogen bond with each other, holding the chains firmly together and contributing to their high tensile strength. This strength is important in cell walls, where they are meshed into a carbohydrate matrix, helping keep plant cells rigid.

Given a cellulose material, the portion that does not dissolve in a 17.5% solution of sodium hydroxide at 20 °C is cellulose, which is true cellulose; the portion that dissolves and then precipitates upon acidification is β cellulose; and the proportion that dissolves but does not precipitate is γ cellulose. Cellulose can be assayed using a method described by Updegraff in 1969, where the fiber is dissolved in acetic and nitric acid, and allowed to react with anthrone in sulfuric acid. The resulting colored compound is assayed spectrophotometrically at a wavelength of approximately 635 nm.

2.3.2 LIGNIN

Lignin (sometimes "**lignin**") is a chemical compound that is most commonly derived from wood and is an integral part of the cell walls of plants, especially in tracheids, xylem fibers and sclereids. It is the second most abundant organic compound on earth after cellulose. Lignin makes up about one-quarter to one-third of the dry mass of wood.

In wood non cellulosic compound are much more plentiful and also more difficult to separate. The chief of these is lignin, and the processes of cooking and bleaching are designed to remove this component. Lignin is a complex material generally characterized by the method used in isolating it from wood and by a series of color reactions. Lignin is isolated from wood by the conventional methods differs from native lignin in that it is insoluble both in organic solvents and in sulfite cooking liquor. Chemically bamboo is similar to hard wood. For it contain about 20% of pentosan is xylan and the balance is araban. The lignin content is higher than in hard wood, so bleachability of bamboo pulp is similar to softwood, which is richer in lignin than hardwood. Native cellulose of bamboo has a distribution curve of the degree of polymerization which shows a peak at 200 of D.P. much lower than in case of softwood and hardwood. Alpha cellulose is also high compared to wood cellulose. The most distinguished feature of bamboo from the chemical point of view is its high ash content which is five to ten times as much as in wood. About 50% of the minerals contained in the woody portion are silica.

Lignin fills the spaces in the cell wall between cellulose, hemicellulose and pectin components. It confers mechanical strength to the cell wall and therefore the entire plant. It is particularly abundant in compression wood, but curiously scarce in wood. Lignin plays a crucial part in conducting water in plant stems. The polysaccharide components of plant cell walls are highly hydrophilic and thus permeable to water. Lignin makes it possible to form vessels which conduct water efficiently. Lignin is difficult to degrade and is therefore an efficient physical barrier against pathogens which would invade plant tissues. For example an infection by a fungus causes the plant to deposit more lignin near the infection site.

Highly lignified wood is durable and therefore a good raw material for many applications. It is also an excellent fuel, since lignin yields more energy when burned than cellulose. However, lignin is detrimental to paper manufacture and must be removed from pulp before paper can be manufactured. This is costly both in terms of energy and environment.

In the sulfite and sulfate (also called Kraft) chemical pulping processes, lignin is removed from wood pulp as sulphates. These materials have several uses

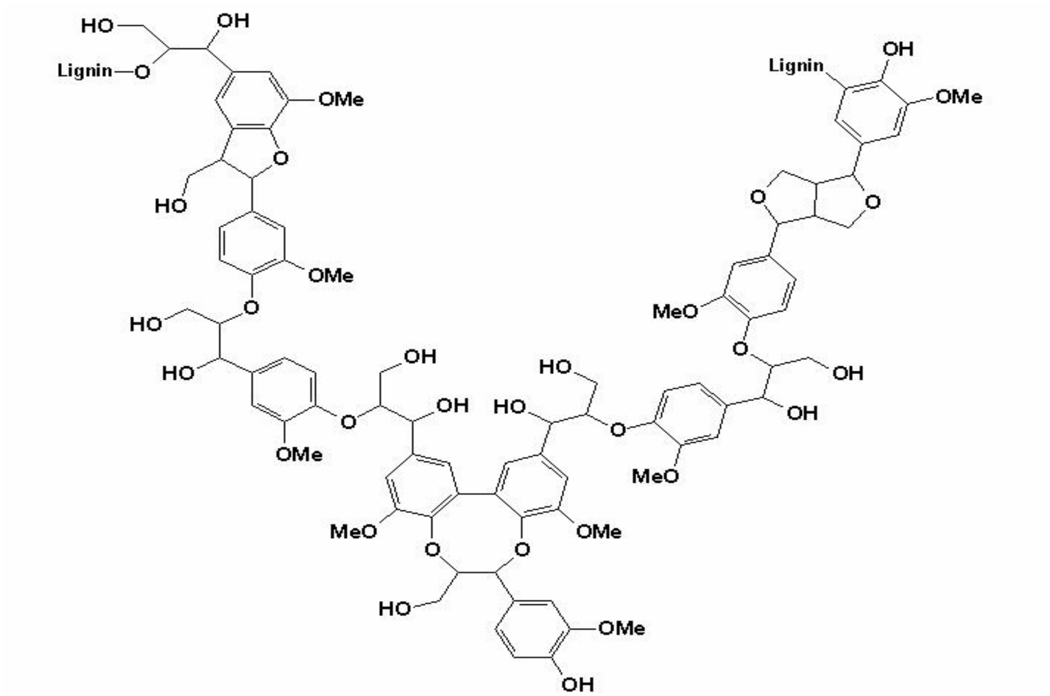

Figure 2.2 Structure of lignin

2.3.3 MINOR COMPONENT

In addition to cellulose, lignin, and hemicelluloses, wood contains also smaller amounts of resins, terpenes, fats, nitrogenous matter, tannin, coloring matter, and mineral ash.

2.4 PROPERTIES OF BAMBOO FIBERS

2.4.1 NATURAL ANTI-BACTERIA

It's a common fact that bamboo can thrive naturally without using any pesticide. It is seldom eaten by pests or infected by pathogen. Why? Scientists found that bamboo owns a unique anti-bacteria and bacteriostasis bio-agent named "bamboo Kun". This substance combined with bamboo cellulose molecular tightly all along during the process of being produced into bamboo fiber. Bamboo fiber has particular and natural functions of anti-bacteria, bacteriostasis and deodorization It is validated by Japan

Textile Inspection Association that, even after fifty times of washing, bamboo fiber fabric still possesses excellent function of anti-bacteria, bacteriostasis. Its test result shows over 70% death rate after bacteria being incubated on bamboo fiber fabric. Bamboo fiber's natural anti-bacteria function differs greatly from that of chemical antimicrobial .The later often tend to cause skin allergy when added to apparel.

2.4.2 GREEN AND BIODEGRADABLE

As a regenerated cellulose fiber, bamboo fiber was 100% made from bamboo through high-tech process. The raw material bamboo is well-selected from non-polluted region in Yunnan and Sicuan Province, China. They are all 3-4 year old new bamboo, of good character and ideal temper. The whole distilling and producing process in our plant is green process without any pollution. Our company manufactures bamboo fiber strictly according to ISO9000 and ISO 14000. It produces natural and eco-friendly fiber without any chemical additive. What's more, bamboo fiber is biodegradable textile material. As a natural cellulose fiber, it can be 100% biodegraded in soil by microorganism and sunshine. The decomposition process doesn't cause any pollution environment. "Bamboo fiber comes from nature, and completely returns to nature in the end" Bamboo fiber is praised as "the natural, green, and eco-friendly new-type textile material of 21st century

2.4.3 BREATHABLE AND COOL

What's notable of bamboo fiber is its unusual breath ability and coolness. Because the cross-section of the bamboo fiber is filled with various micro-gaps and micro-holes, it has much better moisture absorption and ventilation. With this unparalleled micro-structure, bamboo fiber apparel can absorb and evaporate humans sweat in a split second. Just like breathing, such garments make people feel extremely cool and comfortable in the hot summer. It is never sticking to skin even in hot summer. According to authoritative testing figures, apparels made from bamboo fibers are 1-2 degrees lower than normal apparels in hot summer. Apparel made from bamboo fiber is crowned as Air Conditioning Dress.

2.5 COMMERCIAL APPLICATIONS OF VARIOUS BAMBOO SPECIES

Many Asian species of bamboo have strong, light and flexible woody stems, which lend themselves to applications as a construction material - one of the most notable modern uses being temporary scaffolding poles which are often seen surrounding the most modern of high-rise buildings in Asian countries. Bamboo utilization in South America is modest by comparison, except in certain local areas where indigenous species have been used for centuries, and where some Asian bamboos have been introduced. African use of bamboo is more limited and recent, since there are few native species except in Madagascar, although indigenous and introduced bamboo has been used in Kenya for soil stabilization, construction and fuel and in Tanzania for water pipes. Worldwide commercial bamboo utilization is reported to be 20 million tones per annum. It is unclear whether this figure represents dry weight or (more likely) harvested weight at about 15% moisture content – but this number is considered unreliable since about 80% of bamboo is used locally and statistics are hard to obtain. More than half of this amount is harvested and utilized by poor people in rural areas. Total revenues from bamboo and its products were estimated in the 1980s at $4.5 billion.

Approximately 1500 commercial applications of bamboo have been identified – mostly in Asia, except where noted below. They may be divided up into the following broad categories

Construction and reinforcing fibers – these include agricultural and fishing tools, handicrafts, musical instruments, furniture, civil engineering (bridges, scaffolding poles), and domestic building (house frames, walls window frames, roofs, interior dividers).

Paper, textiles and board - (including rayon, plywood, oriented strand board, laminated flooring). Bamboo fibers are relatively long (1.5-3.2 mm) and thus ideal for paper production. Paper production in China dates back 2000 years, whilst in India, 2.2 million tones of bamboo per year are processed into pulp, making up about two-thirds of total pulp production .At least eight North American suppliers are importing and marketing tongue-and groove flooring made from laminated bamboo, which is said to be as hard, durable and dimensionally stable as oak or other hardwood flooring. Bamboo culms are sliced into strips, which are boiled to remove starch, dried, and laminated into solid boards using urea-formaldehyde adhesives. The boards may be treated with preservatives such as boric acid, before or after laminating, or both, and a darker amber color may be produced by pressure-steaming the bamboo to carbonize it. Although the adhesive tends to emit formaldehyde for a long time after production, the amount of reaformaldehyde resin in a laminated product is much less than in a panel board product.

Food – bamboo shoots of a number of species are a well-known feature of Chinese and other Asian cuisine, generally imported into the USA in canned form (one estimate suggests 30,000 t/year in the early 1990s). Exports from Taiwan are worth $50 million annually, and those from Thailand $30 million, with much of this going to meet Japanese demand.

2.6 PULPING PROCESS

Plant fibers are made up of cellulose (long un-branched chains of glucose), hemicelluloses (short chains of branched and un-branched polysaccharides, including galactose, mannose, and xylose), and lignin (a complex aromatic structure, which gives the inherent strength properties to plants). The ratio of these constituents and the chemical nature of the lignin and hemicelluloses varies according to plant species.

The main purpose of wood pulping is to liberate the fibers, which can be accomplished chemically, or mechanically, or by combining these two types of treatments. The common commercial pulps can be grouped into chemical, semi-chemical, chemi-mechanical, and mechanical types. These differ principally by the nature of the process used and the yield of pulp obtained. Typically, chemical processes produce pulp yields in the range 35-65%, semi-chemical 70-85%, chemi-mechanical 85-95%, and mechanical processes 93-97%. This yield difference highlights the fact that the chemical process effectively separates the cellulose from the lignin present, whereas the mechanical process converts all the constituents present. The choice of process will depend primarily on the nature of the material to be pulped and the grade of paper or board product desired.

Chemical processes are often used to produce fibers for strength and high quality printing products such as Kraft paper or fine paper. Mechanical and chemi-mechanical processes produce pulp for lower grade products such as newsprint and board.

2.6.1 MECHANICAL PULPING

These are characterized by high yields, which result from the whole material or a major part of the material being converted into pulp by mechanical action. This pulp contains lignin, hemicelluloses, and cellulose. Mechanical processes use a lot of energy and create fiber damage. Development of the basic processes has sought to reduce energy consumption and improve fiber properties.

Stone ground wood (SGW) is the earliest mechanical process and, as the name suggests, grinds debarked logs by pressing them against a rotating stone. The grinding stone is showered with water to control the temperature and to remove the ground wood. Pressurised ground wood (PGW) has been developed from the SGW process to produce pulps with better strength properties and at lower energy consumption by producing the pulp at a steam generated overpressure.

Refiner mechanical pulp (RMP) is manufactured by feeding the raw material, in the form of chips into the centre of a rotating disc refiner. Using wood chips has made it possible to broaden the raw material base as also saw mill chips can be used. Another advantage of this method is that the chips can be treated chemically before pulping. Thermal mechanical pulp (TMP) is a development of the RMP process where heat in the form of steam is applied to the raw material before the refining stage. This softens the chips and reduces fiber damage caused by the mechanical action.

2.6.2 CHEMICAL PULPING

These are characterized by the use of chemicals to separate the lignin fraction of lignocelluloses materials from the cellulose. Chemical separation results in little or no effect on the fiber length. Kappa number is used to describe the extent of lignin removal in the cooking process. The kappa number is the quantity of potassium permanganate consumed by one gram of pulp under specific conditions. A low kappa number indicates low lignin content of the pulp sample.

The processes developed rely on the action of one or more radicals acting on the lignin compounds. Various improvements have been made to established processes to improve the selectivity (avoiding degradation of hemicelluloses and cellulose) of the separation process. Chemical recovery of the active chemicals is an important economic and environmental consideration in any assessment of a pulping process.

The Kraft process is the dominant chemical pulping process. The process has been refined over the years to improve yield and chemical recovery. The Kraft process has better selectivity and gives a higher pulp quality compared to the soda process. It has also almost completely replaced the sulphite process because of better chemical recovery system and the ability to use a broader range of raw materials. In the Kraft cooking process, two chemicals, namely sodium hydroxide and sodium sulfide, are used to delignify the wood chips. During the course of the reaction, the lignin part which represents some 20-25 % of the wood is solubilised and removed. However, cellulose and hemicelluloses, which are desirable materials, are also attacked. Theoretically, it should be possible to fully retain cellulose and hemicelluloses. The weight contribution of these components varies with each wood species but is usually around 70 %. However, in an industrial Kraft cooking process, the amount retained is more in the order of 45-50 %. Typically, 85 % of the lignin, 50 % of the hemicelluloses and 10 % of the cellulose are removed. The hemicelluloses are easily attacked since they are low molecular weight sugars that are more accessible than crystalline cellulose. Hence, one of the goals sought by the industry during cooking and bleaching is to protect this fraction in order to achieve a better yield.

The soda process is based on sodium hydroxide and is widely used in the processing of non-wood fibers. Unlike the Kraft process, the soda process does not produce malodorous emissions. The process, however, does produce a pulp of lower quality compared to the Kraft process because of lower selectivity. Major developments have centred on improving the yield from the process using additives such as anthraquinone (AQ). AQ accelerates the delignification while at the same time stabilizing the polysaccarides from alkaline degradation. Sulphide in the Kraft process is often replaced by AQ in alkaline sulphur-free processes.

The sulphite process is one of the earliest chemical processes and has developed into an array of variations used on wood and non-wood materials. This process has, however, become less favored for economical reasons, and is almost totally replaced by the Kraft process.

2.6.3 ENZYME PULPING

Enzymes used in pulping can increase the yield of fiber, lessen further refining energy requirements, or provide specific modifications to the fiber. Celluloses have been used in many processes in the paper industry. Enzyme pretreatments using cellulose, hemicelluloses, and pectinase have been shown to enhance the Kraft pulping of sycamore chips and other pulp sources. This enzyme mixture allowed for better delignification of the pulp and savings. In bleaching chemicals without altering the strength of the paper. The cost of the enzymes and questions about the effectiveness of a large enzyme aiding the low molecular weight pulping chemicals has led to skepticism about the implementation of celluloses to enhance the Kraft process.

Celluloses have been tested on mechanical pulps as well. In this case, there are conflicting results shown by a benefit in brightness and an increase in energy required for refining using crude cellulose on radiate pine compared with reduced energy required after a cellobiohydrolase treatment on spruce mechanical pulps. Other enzymes such as laccase and protease have been reported to reduce energy requirements in mechanical pulping. Laccase treatment has the additional benefit of increasing fiber bonding, which enhances the strength of the paper.

The use of enzymes in the refining of virgin fibers has been ongoing for decades. Kraft pulp has been treated with celluloses and xylanases, and both enzymes have reduced the energy required for further refining. The celluloses must be used carefully so they do not reduce the strength of the fibers. Xylanase treatments are more effective on unbleached pulps than they are on bleached Kraft pulps.

The yield of thermo mechanical pulp can also be increased by the use of enzymes. De-esterifying the soluble O-acetyl-galactoglucomannans of Norway spruce using an acetyl esterase was shown to precipitate the galactoglucomannans onto the fiber and increase the yield of fiber from the process.

2.7 BLEACHING PROCESS

Bleaching is defined as any process that chemically alters pulp to increase its brightness. Bleached pulps create pulp that is whiter, brighter, softer, and more absorbent than unbleached pulps. Bleached pulps are used for products where high purity is required and yellowing is not desired. Unbleached pulp is typically used to produce boxboard, linerboard, and grocery bags.

Any type of pulp may be bleached, but the type of fiber furnish and pulping processes used, as well as the desired qualities and end use of the final product, greatly affect the type and degree of pulp bleaching possible. Printing and writing papers comprise approximately 60 percent of bleached paper production. The lignin content of a pulp is the major determinant of its bleaching potential. Pulps with high lignin content are difficult to bleach fully and require heavy chemical inputs. Excessive bleaching of mechanical and semi chemical pulps results in loss of pulp yield due to fiber destruction. Chemical pulps can be bleached to a greater extent due to their low lignin content.

Much pulp is used in its unbleached form, particularly for packaging and industrial papers, for some tissues and for newsprint. Bleaching is often undertaken, primarily for two purposes: first, to increase brightness; second, to remove residual lignin .Lignin can be thought of as the 'glue' holding the cellulose fibers of wood together; it accounts for up to 50 per cent of the weight of pulpwood, the basic feedstock for pulp manufacture. Mechanical pulping processes retain the lignin to obtain a higher yield. To the extent that these pulps are bleached, hydrogen peroxide or some other non-chlorine process is generally used. The lignin content causes the paper to yellow relatively quickly when exposed to light, and so papers from mechanical pulps are generally used in products such as tissues and newsprint, which have short lives. Chemical pulping with chlorine bleaching is used when a durable, high-brightness product with a more permanent application, such as printing and writing, is required. This process removes virtually all the lignin.

The most common chemicals used in the bleaching process are sodium hydroxide, elemental chlorine, and chlorine dioxide. The use of chlorine dioxide in the bleach process has steadily increased relative to molecular chlorine usage due to its reduction in the formation of chlorinated organics in bleach plant effluent and lower bleach plant chemical consumption. Common bleaching chemicals are presented below along with the approximate percentage of mills using them, their chemical formulae, and bleach chemical code letter.

2.7.1 BLEACHING TECHNOLOGIES

Bleaching is a sequence of chemical treatments and washes of the pulp. The particular sequence used mainly depends on the nature of the fiber. While the main purpose of bleaching is to improve the optical characteristics of the pulp, characteristics such as absorbency, strength, durability, and cleanliness can also be improved.

2.7.2 BLEACHING OF CHEMICAL PULP

Chemical pulping breaks down the wood by dissolving most of the lignin. In this Process, the woodchips are mixed with strong acids or alkalis, with or without pressure and heat. Various chemicals and processes can be used to produce different types of chemical pulp, for example, sulphite, Kraft and soda Anthraquinone pulp. Bleaching of chemical wood pulps involves the removal of residual lignin. Bleaching sequences involving the application of elemental chlorine and/or chlorine-based compounds are commonly used. The chlorine bleaching sequences usually commence with the treatment of the unbleached pulp with a lignin degrading chemical, such as elemental chlorine. Chlorine dioxide may be partially substituted for elemental chlorine in this stage. An alkali treatment stage follows, in which the pulp is treated with chemicals that extract the degraded lignin. After extraction, the pulp is brightened with chemicals such as sodium or calcium hypochlorite, or chlorine dioxide. Further stages include repeated alkali extraction and brightening. Between stages the pulp is usually washed.

2.7.3 BLEACHING OF MECHANICAL PULP

Mechanical pulping involves separating the fibers by abrasive mechanical action, usually by passing woodchips between rotating metal discs (refiner ground wood). Modifications to these processes include:

- Thermo-mechanical pulping where the lignin in the woodchips is softened by heat prior to mechanical processing;
- Chemi-mechanical pulping where the lignin is softened by chemicals; and

- Chemi-thermo-mechanical pulping where the lignin is softened by both chemicals and heat. Chemi-thermo-mechanical pulping is not currently used.

Mechanical pulps are not bleached with lignin degrading chemicals such as elemental chlorine, since this would cause a substantial loss of yield. Instead the bleaching is undertaken with lignin preserving chemicals, such as peroxide and hypochlorite. Sodium dithionite can be used in some cases.

2.7.4 BLEACHING SEMI-CHEMICAL PULP

Semi-chemical pulping combines both chemical and mechanical methods of pulping. It consists of chemically treating the wood prior to mechanical processing. Chemicals such as caustic soda or alkaline sulphite liquor act to partially delignify and break down the lignin bonding in the wood chips. Semi-chemical pulping processes include neutral sulphite semi-chemical and cold soda pulping. Semi-chemical pulps are usually bleached with lignin preserving chemicals such as hypochlorite. Bleaching semi-chemical pulps with similar sequences used for the bleaching of chemical pulps is possible, but substantial amounts of elemental chlorine and caustic are needed to degrade and extract the residual lignin and this would substantially reduce yields.

TABLE-2.1 COMMON CHEMICALS USED IN BLEACHING PROCESS

Bleaching Chemical	Approximate % of mills	Chemical Formula
Sodium Hydroxide	100%	NaOH
Elemental Chlorine	99%	Cl2
Chlorine Dioxide	89%	ClO2
Hypochlorite	69%	HClO, NaOCl, HCa(OCl)2
Oxygen	64%	O2
Hydrogen Peroxide	43%	H2O2
Sulfur Dioxide	10%	SO2
Sulfuric Acid	9%	H2SO4

CHAPTER-3

EXPERIMENTAL WORK

CHAPTER 3.0 EXPERIMENTAL WORK

OBJECTIVE:

The main object of this project is evaluation of bamboo pulp composite for medical application. Bamboo fibers have natural antibacterial property that's why bamboo can be used in medical application such as absorbent material for hygiene application and wound dressing (bandage).

WORK PLAN

Work on this project is done in steps. These steps are as following.

- Analysis medicated dressing
  - Extensibility
  - Water vapor permeability
  - Physical analysis
- Preparation of pulp
  - Mechanical processing
  - Chemical processing
    - Chemical pulping
    - Bleaching
- Analysis of pulp
  - Cellulose content
  - Brightness
  - Absorbency
  - Water retention
- Preparation of medicated dressing from bamboo pulp
  - Preparation of bamboo pulp composite
  - Analysis of bamboo pulp composite
    - Tensile test (cut strip test)
    - Absorbency

Water retention capacity

- Preparation of bandage
- Analysis of bandage

  Extensibility

  Water vapor permeability

  Toxicology test

3.1 ANALYSIS MEDICATED DRESSING

The wound dressings were analyzed as per British Pharmocopoia Vol. II, 1993.

3.1.1 Extensibility

Carry out the test on a suitable tensilometer with a constant rate traverse using six sample of material being examined, each at least 100mm long and as representative as possible of the material and calculate the average result. Determine the load required to produce a 20% extension at a rate of extension 270 to 230mm per minute. The load is not more than 14 N/cm width. Maintain the 20% extension of the material for the 55-65 seconds; allow recovering for 4.75 to 5.25 minutes and redetermining the length. The permanent set of elongated material is not more than 5% of the original un-stretched length. The result is given in following table.

TABLE-3.1 EXTENSIBILITY OF BANDAGES

S.No.	**BRAND NAME**	**Extensibility % (<5)**
1.	DRESS-AID	3.3
2.	DRESS-AID(wash proof)	Break before 20% elongation
3.	NICE-AID	6.64
4.	NICE-AID(wash Proof)	Break before 20% elongation
5.	FAST-AID	3.90
6.	LASTHEALS	3.30
7.	STICKOBAND	5.20
8.	SHELLPLAST	Break before 20% elongation
9.	BANG-YU	3.3

3.1.2 WATER VAPOR PERMEABILITY

Apparatus

A box constructed of suitable non-corrodible material, having external dimensions of about 95mm X 25 mm X 25mm, weighing not more than 60g when empty, and completely closed except for a rectangular opening, 80 mm X 10mm X, in the top. The box is completely impermeable to water and to water vapor, other then the opening.

Method:

Place a tray containing approximately 1kg of anhydrous calcium chloride on the floor of an electrically heated humidity cabinet fitted with an efficient means of circulating air and maintain 36-38 c. Place about 2 gram of absorbent cotton in each five of boxes complying with the above specification. Pour about 20 ml of water into each box and cover the opening in the top with a strip of the material being examined, press down without stretching the material, so that the opening is completely sealed. Ensure that the wet absorbent cotton is not in contact with the under surface of the material being examined. The width of the material must be at least five mm greater than the corresponding dimensions of the aperture.

TABLE-3.2 WATER VAPOR PERMEABILITY OF BANDAGES

S.No.	**BRAND NAME**	**Permeability** gm/m2 per 24 hrs (minimum 500)
1.	DRESS-AID	1505
2.	DRESS-AID (wash proof)	2762
3.	NICE-AID	210
4.	NICE-AID (wash Proof)	518
5.	FAST-AID	43
6.	LASTHEALS	819
7.	STICKOBAND	606
8.	SHELLPLAST	780
9.	BANG-YU	630

TABLE No 3.3 PHYSICAL ANALYSIS

S.No.	TRADE NAME	WEIGHT OF ADHESIVE PER UNIT AREA	WEIGHT OF FILM(gm/m2)	ABSORBENT PAD	
				DIMENSION (mm)	WEIGHT PER UNIT AREA(gm/m2)
1	DRESS-AID	115.4	132.80	19X20	61.0
2	DRESS-AID (WASH PROFF)	42.7	90.90	19X14	61.7
3	NICE+AID	120	123.30	18X18	61.0
4	NICE+AID (WASH PROFF)	42.5	89.20	19X16	54.0
5	FAST-AID	56.4	90.45	20X19	75.0
6	PLASTHEALS	98.5	120.00	15X24	160.8
7	STICKOBAND	96.8	115.6	12x26	178
8	SHELLPLAST	94.3	110.4	12x26	106
9	BANG-YU	127	122.7	18x22	68.9

3.2 PREPARATION OF PULP

Bamboo pulp is prepared by Kraft process. In the Kraft cooking process, two chemicals, namely sodium hydroxide and sodium sulfide, are used to delignify the wood chips.

3.2.1 MECHANICAL PROCESSING

First bamboo is cut in pieces of size 2 inches. Knot portion are removed because it contain less fiber and difficult to bleach. Now bamboo crushed in compressor molding machine or in crusher. After that these bamboo chips are boiled in water for one hour after boiling start at pressure of two atmospheres. Boiled bamboo chips now dry and again crushed in crusher.

3.2.2. CHEMICAL PROCESSING

3.2.2.1 CHEMICAL PULPING

Now bamboo treated with a solution containing 13% sodium hydroxide and 13% of sodium sulfide. This step is cooking step of bamboo. Bamboo consistency is 10%. Solution containing sodium hydroxide, sodium sulfide and bamboo is boiled at 1200 C for 5-6 hours. In cooking process lignin dissolve in solution and natural bamboo fiber are separate. Fiber are separate from cooking solution and wash several time untie all lignin wash out. Now pulp is dry in oven at 80oC temperature. After drying fibers are open. Summery of this process is as fallow.

TABLE-3.4 CHEMICAL PULPING

Cooking Solution	13% sodium hydroxide, 13% sodium sulfide
Bamboo Consistency	10%
Temperature	1200C
Pressure	1 Atmosphere
Cooking Time	5 Hours

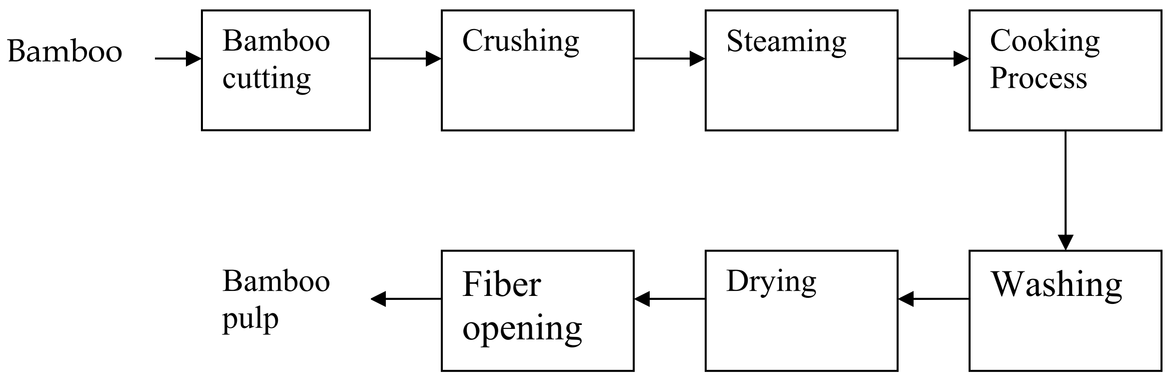

FIGURE-3.1 FLOW CHART FOR BAMBOO PULPING

3.2.2.2 BLEACHING

Bleaching of bamboo pulp is done by hydrogen per oxide in alkaline medium. Bleaching solution contain sodium hydroxide, sodium silicate, magnesium sulphate, hydrogen peroxide. Bleaching of bamboo pulp is done by taking different -different concentration of hydrogen per oxide to optimize bleaching process for bamboo pulp. Bleaching was done at 40^0C temperature and at one atmospheric pressure. After bleaching is complete pulp was washed with water and treated with 5% sulphuric acid to neutralize alkali solution of caustic. I did eight experiments with increasing concentration of hydrogen peroxide. Bleached pulp was analyzed for brightness and cellulose content. Brightness increases with the increasing concentration of hydrogen peroxide. Cellulose content also increased with the concentration of hydrogen peroxide. Pulp sample No P7 is best. This pulp is used for bamboo composite for preparation of bandage.

TABLE-3.5 BLEACHING COMPOSITION

Sample No.	Caustic (%)	Sodium Silicate (%)	Magnesium Sulphate (%)	Hydrogen Peroxide (%)	Bamboo (%)
P1	3	5	0.05	3	10
P2	3	5	0.05	6	10
P3	3	5	0.05	9	10
P4	3	5	0.05	12	10
P5	3	5	0.05	15	10
P6	3	5	0.05	18	10
P7	3	5	0.05	21	10
P8	3	5	0.05	24	10

3.2.3 ANALYSIS OF PULP

3.2.3.1 CELLULOSE CONTENT

GENERAL: - Alpha-cellulose is taken as the fraction that can be filtered out of a mixture consisting of the fibrous material and sodium hydroxide solution of maximum dissolving power, after the fibers have previously been swelled with sodium hydroxide solution. After separation, the alpha- cellulose is determined either by drying and weighing, or volumetrically by oxidation with potassium dichromate. Both methods are capable of the same reproducibility and give practically the same value.

APPARATUS: - Consisting of the following.

- **Grinder**: - A koerner or equivalent type grinder that will completely disintegrate the pulp without heating or contaminating it.

- **Mixer: -** A device with which uniform mixture of the ground material can be secured.
- **Bath: -** A water-bath that can be maintained at $20.0^0 \pm 0.1^0$ C.
- **Electrometric Titration Apparatus: -** For the estimation of dichromate an indicator may be used, but for rapid, accurate analysis, an electrometric apparatus is recommended. Any ordinary potentiometer circuit with a platinum wire electrode and calomel half-cell is suitable. The potentiometer arrangement may consist of a galvanometer with a sensitivity of 0.5 to 1.0 microampere per millimeter scale division, a dry cell, and a sliding- contact rheostat having a total resistance of 400 ohms. The large deflection at the end point is unmistakable from possible slow creeping during the titration. The galvanometer is adjusted to zero by varying the resistance at the beginning of the titration.

REAGENTS:-Consisting of the following.

- Sodium Hydroxide Solution (17.5 % w/w or 5.24 N)
- Potassium Dichromate Solution: - Dissolve 90.0g of oven- dry potassium dichromate in hot water (70^0 to 90^0C), and dilute to one liter after allowing the solution to cool.
- Ferrous Ammonium Sulphate Solution: - Dissolve 195g of Ferrous Ammonium Sulphate crystals in water containing 10 ml of sulphuric acid and dilute to one liter.
- Acetic Acid Solution for gravimetric procedure.
- Dichromate as indicator.
- Barium Chloride (3 N)
- Sulphuric Acid (24 N)
- Sulphuric Acid (6 N)

TEST PIECE: - The test piece shall be cut from the specimen in such a way as to be representative of the lot.

VOLUMETRIC METHOD

- Weight 0.3 ± 0.01 g of the disintegrated test piece in a 100 ml beaker. Add 20.0 ml of sodium hydroxide (17.5 %), macerate until the fiber are uniformly wet and dispersed, and let it stand for 10 minutes from the time of addition of sodium hydroxide. Then add 33 ml of water, stir the mixture thoroughly, and let it stand for one hour more, stirring once during the interval. After stirring once more, pour about 5 ml of the unsettled mixture on a copper or brass wire screen of 0.177 ± 0.011 mm aperture fitted in to a crucible. The crucible and ring are supported by a funnel fitted into the neck of a 100-ml volumetric flask with a rubber stopper through which passes a glass tube for suction. Avoid excessive packing of the fibers, as this retards filtering. It may be necessary to refilter the first filter, but loss of small amounts of alpha- cellulose to the filtrate does not affect the result appreciably, pour the remainder of the mixture on the mat and, before the last of the liquid has run through, wash the beaker and the mat with 35 ml of water.
- Moisten the residue of alpha-cellulose with water and remove it from the crucible. Place the crucible upright in a 400-ml beaker, fill it with 25 ml of 24 N sulfuric acid at room temperature, and rinse it after a few minutes with 50 ml more of the acid. Disintegrate the alpha-cellulose pad in the acid, using a stirring rod. Add to the alpha-cellulose solution, with a pipette, 25 ml of the potassium dichromate solution, and heat at 1400 to 1500Cfor 10 minutes. Bubble air in a fine stream through the solution to prevent bumping, and keep the beaker covered with a watch glass notched to permit entrance of a thermometer and the bubbling tube. After the solution has cooled to 1300C, add 50 ml of water, rinse the thermometer, bubbling tube, etc, and cool the solution to 600C or lower. Titrate the remaining potassium dichromate with the ferrous ammonium sulphate solution.

- Pipette exactly half of the filtrate from the alpha-cellulose, after all fiber present have settled, into a 400 ml beaker containing 5.0 ml of potassium dichromate solution. If the paper contains oxidizable fillers, such as zinc sulphide pigment or calcium sulphite, filter the filtrate once through a thick pad of asbestos in crucible before taking the portion for analysis. Cautiously, while stirring constantly, pour 50 ml of sulfuric acid down the side of the beaker containing the portion of the filtrate for analysis, then heat and titrate as described above for the alpha-cellulose solution.

CALCULATION

The percentage of alpha-cellulose can be calculate as following.

$$A = 25 - (V_1 \times R)$$

$$B = 2 \times (5 - V_2 \times R)$$

$$\text{Alpha-cellulose, percent} = \frac{A \times 100}{A + B}$$

Where

A= volume of potassium dichromate solution in ml required to oxidize the alpha-cellulose.

B= volume of potassium dichromate solution in ml required to oxidize the filtrate.

V_1 &V_2 = volume of ferrous ammonium sulphate solution in ml required for titration of the potassium dichromate remaining after oxidation of the alpha-cellulose and filtrate, respectively;

R= volume of potassium dichromate equivalent to one milliliter of ferrous ammonium sulphate solution.

TABLE-3.6 CELLULOSE CONTENT IN PULP

Sample No.	Hydrogen Peroxide (%)	Cellulose content (%)
P1	3	70
P2	6	72
P3	9	71
P4	12	72
P5	15	73
P6	18	75
P7	21	77
P8	24	78

3.2.3.2 BRIGHTNESS

GENERAL: Brightness, as determined by this test is primarily a measure pf freedom from yellowness arising in pulp and paper from the presence of lignin and other so-called impurities left by incomplete bleaching. Blue light is used for the measurement of brightness.

APPARATUS: The apparatus shall consist of a reflectometer, either visual or photo-electric type, having such source, filter, and receptor characteristics that it will measure, for undyed pulp, 45^0- 0^0 directional reflectance for blue light. The apparatus shall have the following characteristics.

- **Spectral Characteristics:-** The product of spectral energy of source, spectral transmission of any filters through which light must pass, and spectral response of receptor shall be equivalent to the product of the z function of the standard observer and colorimetric co-ordinate system recommended by the International Commission on Illumination multiplied by the energy distribution of the commission's standard illuminant. Such a combination will have a maximum spectral response to energy at about 460 mill microns.

- **Geometric Characteristics:-** Rays incident on the test piece shall spread no more than 4^0 from the axis of the incident beam; rays accepted for measurement shall spread no more than 15^0 from the axis of the viewed beam. Rays in the incident and viewing beams shall be symmetrically arranged with respect to their respective axes.

STANDARDS:-The primary standard of 45^0-0^0 directional reflectance shall be a layer (at least 0.5mm in thickness) of magnesium oxide freshly prepared by collecting the smoke from burning magnesium.

TEST PIECE: - Test piece shall be handled carefully to avoid soiling, and care shall be taken not to touch the areas tested. A pad of test pieces shall be used for the measurement, so thick that doubling the number of sheets does not cause change in the measured reflectance.

PROCEDURE: - When available, a working standard of about the same reflectance for blue light as the test pieces shall be used. The reflectance of this working standard shall be read both before and after readings of reflectance of the test pieces are made. Reading shall be made on at least five separate test pieces in each pad. To average out any effects of rotation, equal number of readings shall be taken along and across the machine direction.

TABLE 3.7 BRIGHTNESS OF PULP

Sample No.	Hydrogen Peroxide (%)	Brightness (%)
P1	3	46
P2	6	50
P3	9	55
P4	12	57
P5	15	62
P6	18	68
P7	21	72
P8	24	76

3.2.3.3 ABSORBENCY

This test is done as per British Pharmocopoia Vol. II; 1993.Water absorbency is measured in term of time. It is the minimum time required to absorb water completely by unit mass of absorbent.

Apparatus: - A dry, cylindrical, copper wire basket, 80 mm high and 50 mm in diameter, fabricated from wire of diameter 0.4 mm and having a mesh aperture of 15 to 20 mm; the basket weight 2.4 to 3.0 g.

Method: - Weigh the basket to the nearest 10 mg. Take five samples, each of approximately 1 g, from different places in the material being examined, pack loosely in the basket and weigh the packed basket to the nearest 10 mg. hold the basket with its long axis in the horizontal position and drop it from a height of about 10 mm into water at 200 contained in a beaker at least 12 cm in diameter and filled to a depth of 10 cm. Measure with a stopwatch the time taken by the basket to sink below the surface of water.

TABLE-3.8 ABSORBENCY OF PULP

Sample No.	Absorbency (in sec)
P1	3
P2	3
P3	3
P4	2
P5	2
P6	Less then 2 sec
P7	Less then 2 sec
P8	Less then 2 sec

3.2.3.4 WATER RETENTION

This test is done as per British Pharmocopoia Vol. II; 1993.In this test we determine the capacity of absorbent to hold water without ripping. In this test we tack absorbent and weight. Now this absorbent is dip in distilled ware for 20 minutes. After 20 minutes absorbent press between filter paper to remove extra water. When ripping stop absorbent again weighted. Water retention calculated as following.

$$\text{Water retention} = \frac{(\text{Final weight-Initial weight}) \times 100}{\text{Initial weight}}$$

Absorbency and water retention capacity of all samples is shown in following table.

TABLE-3.9 WATER RETENTION CAPACITY

Sample No.	Water Retention (in %)
P1	130
P2	139
P3	145
P4	151
P5	163
P6	174
P7	198
P8	204

3.3 PREPARATION OF MEDICATED DRESSING FROM BAMBOO PULP

Medicated dressing from bamboo pulp can prepare by following process.

3.3.1 PREPARATION OF BAMBOO PULP COMPOSITE

In this step bamboo pulp is converting in to pulp sheet (pulp composite). Sheet is prepared by wet laying process. Sheets are form with pulp and heat sensitive adhesive as a binder. Different –different concentration of adhesive is used to obtain best suitable composite for bandage. I use 2, 4, 6, 8, 10 and 12 % solution of adhesive for the sheet preparation. First bamboo pulp is open in fiber opening machine then 7 g of pulp disperse in to adhesive solution. After that mixture left for 15 minute so that fiber absorber adhesive solution. A screen is dip in to solution and pull up so that a uniform layer of pulp is form on the screen. This layer is dry in hot air. After pulp sheet is dried it is separated from the wire screen. The surface of the sheets is not smooth so sheets are compressed in compression molding machine. These sheets can be as patch in bandage for absorbing medicine.

3.3.2 ANALYSIS OF BAMBOO PULP COMPOSITE

Bamboo pulp composite sheets are analyzed for following properties.

- Tensile test (cut strip test)
- Absorbency
- Water retention capacity

3.3.2.1 TENSILE TEST

CUT STRIP TEST METHOD

This method is used in case of heavily sized, felted, laminated fabrics.

TESTING APPARATUS

A tensile testing machine provided with the following arrangements shall be used for testing

- Two clamps with the following provisions to grip the specimens. 1). Each clamp of the machine shall consist of two metallic jaws and each jaw face shall be in line both with respect to its mate in the same clamp and to the corresponding jaws of the other clamp.

  2) Each clamp shall be provided with a mechanical device so constructed that through its means a specimen can be secured firmly between the jaws of the clamps so that it does not slip during the test.
- Means for adjusting the distance between the clamps such that the specimens can be tested at 200 mm gauge length for strip test.
- Means for driving by power one of the pair of clamps at a specified constant-rate-of-traverse, loading or extension as the case may be, so that the test specimen breaks in 20±3 seconds.

SIZE OF TEST SPECIMENS

The size of test specimen for cut-strip test is 325 mm X 50 mm.

METHODS OF MOUNTING THE SPECIMEN

Mount the test specimen centrally in the clamp with the longitudinal, parallel to the direction of application of load, after pre-tensioning.

Tensile strength (breaking strength) is determined at constant speed of 300 mm per minute. Maximum breaking load is noted. The breaking strength of composite is shown in following table.

TABLE-3.10 BREAKING STRENGTH OF PULP COMPOSITE

SAMPLE No.	**ADHESIVE CONCENTRATION (%)**	**BREAKING STRENGTH (Kgf/50 mm)**
1	2	7.90
2	4	8.81
3	6	11.04
4	8	11.36
5	10	12.23
6	12	15.11

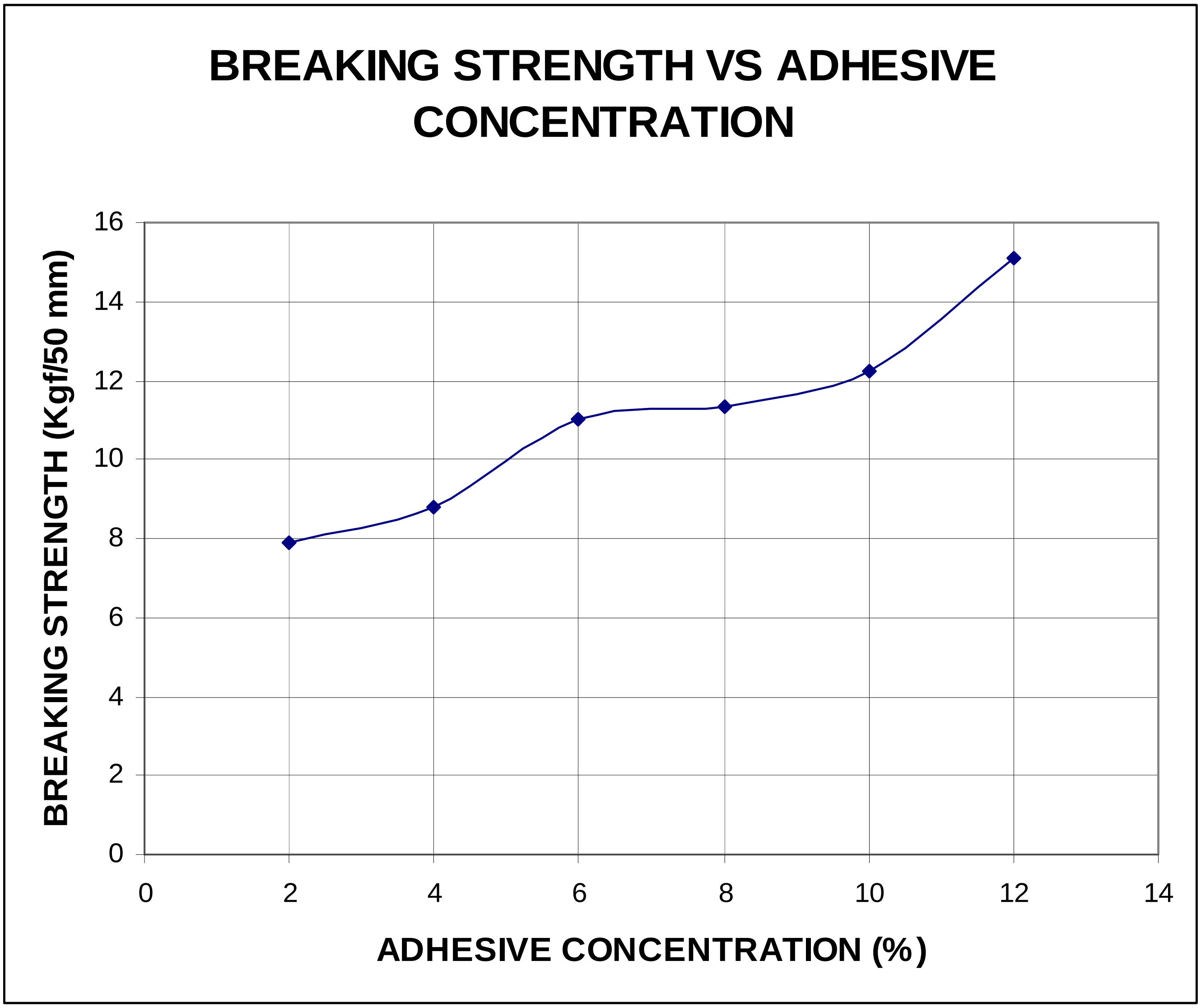

FIGURE-3.2 BREAKING STRENGTH Vs CONCENTRATION OF ADHESIVE

3.3.2.2 ABSORBENCY

Absorbency of composite sheets is determine by same procedure describe in Section 3.2.3.3. Absorbency of each composite sheet with adhesive concentration is given in following table.

TABLE-3.11 ABSORBENCY OF COMPOSITE SHEETS

S.NO.	CONCENTRATION OF ADHESIVE IN SHEET (In %)	ABSORBENCY (in seconds)
1	2	2
2	4	3
3	6	5
4	8	9
5	10	16
6	12	21

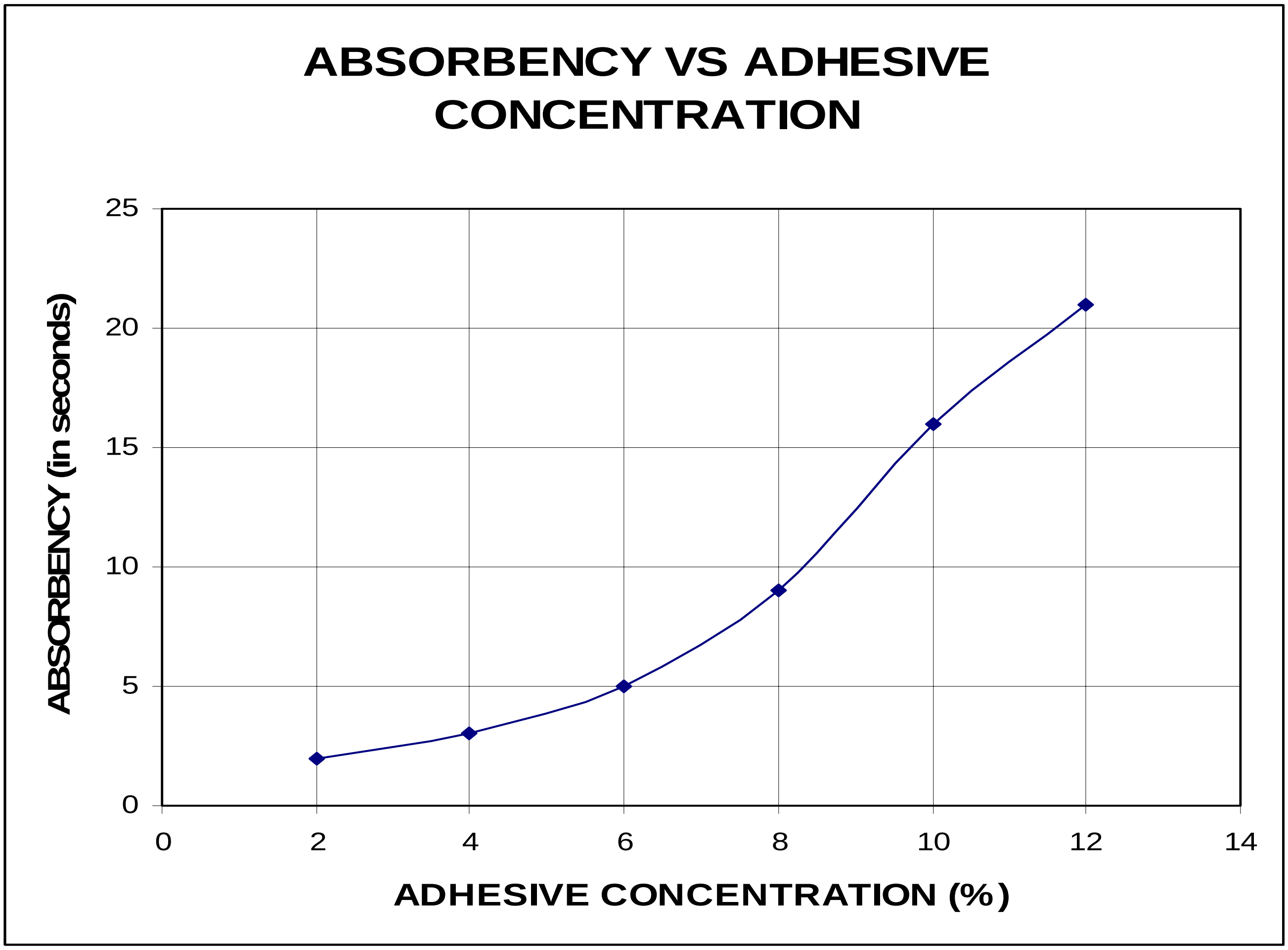

FIGURE-3.3 ABSOBENCY Vs ADHESIVE CONCENTRATION

3.3.2.3 WATER RETENTION CAPACITY

Water retention capacity of composite sheets is determine by same procedure describe in Section 3.2.3.4. Absorbency of each composite sheet with adhesive concentration is given in following table.

TABLE-3-12 WATER RETENTION CAPACITY

S.No.	CONCENTRATION OF ADHESIVE IN SHEET (in %)	WATER RETENTION (in %)
1	2	200
2	4	176
3	6	148
4	8	128
5	10	104
6	12	85

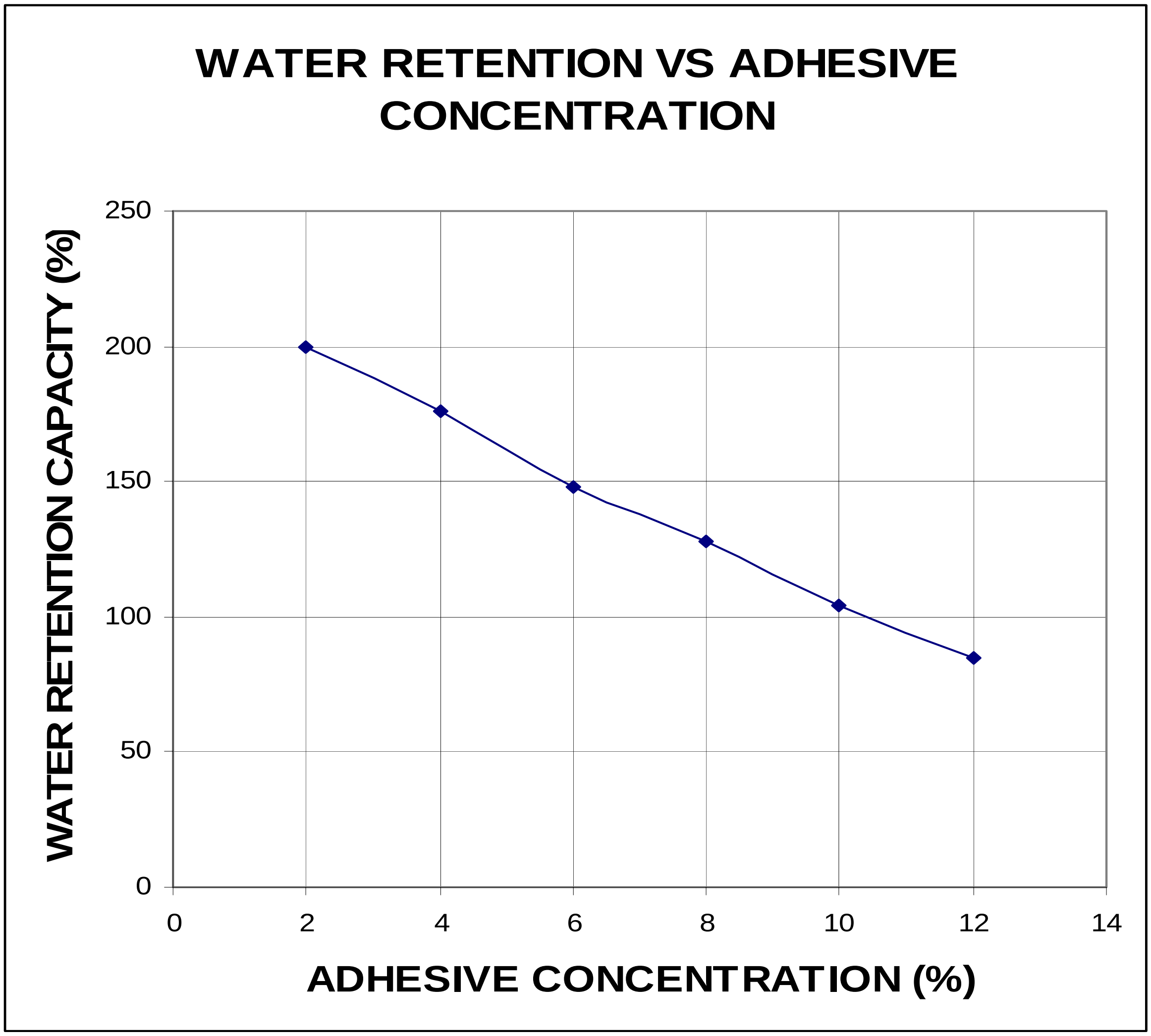

FIGURE-3.4 WATER RETENTION Vs ADHESIVE CONCENTRATION

3.3.3 PREPARATION OF BANDAGE

Bamboo pulp composite which is formed by using 2% adhesive suitable for formation of bandage patch because it have low absorbency and high water retention capacity. Pulp composite is cut in to patch size of 19 mm x 19 mm. Two type of bandage are formed one with fabric tape and second with plastic tape.

3.3.4 ANALYSIS OF BANDAGE

Bandages forms by bamboo pulp are under go following analysis

- Extensibility
- Water vapor permeability
- Toxicology test

3.3.4.1 EXTENSIBILITY

Extensibility test of bandage is done with the same way as in section 3.1.1. Results are given the following table.

TABLE-3.13 EXTENSIBILITY OF BANDAGE

SAMPLE	**EXTENSIBILITY** (%)
Requirements	< 5
Sample-1 (fabric backing)	4.5
Sample-2 (plastic backing)	3.4

3.3.4.2 WATER VAPOR PERMEABILITY

Water vapor permeability test of bandage is done with the same way as in section 3.1.2. Results are given in the above table.

TABLE-3.14 WATER PERMEABILITY OF BANDAGES

SAMPLE	**PERMEABILITY** (gm/m^2 per 24 hrs)
Requirements	Minimum 500
Sample-1 (fabric backing)	792
Sample-2 (plastic backing)	2129

3.3.4.3 TOXICOLOGY TEST

Bandage sample are tested for Toxicological properties. Toxicological test are skin irritation and skin sensitization. These tests are done at SRI RAM INSTITUTE FOR INDUSRIAL REASERCH. The result of toxicological test for bandages is ok.

CHAPTER-4

RESULT & DISCUSSION

4.1 EFFECT OF HYDROGEN PER OXIDE ON PULP

Brightness, cellulose content and water retention capacity of pulp is increases with the increasing concentration of hydrogen per oxide. This can be shown in the following table.

TABLE-4.1

Sample No.	Hydrogen Peroxide (%)	Brightness (%)	Water Retention Capacity (%)	Cellulose content (%)
P1	3	46	130	70
P2	6	50	139	72
P3	9	55	145	71
P4	12	57	151	72
P5	15	62	163	73
P6	18	68	174	75
P7	21	72	198	77
P8	24	76	204	78

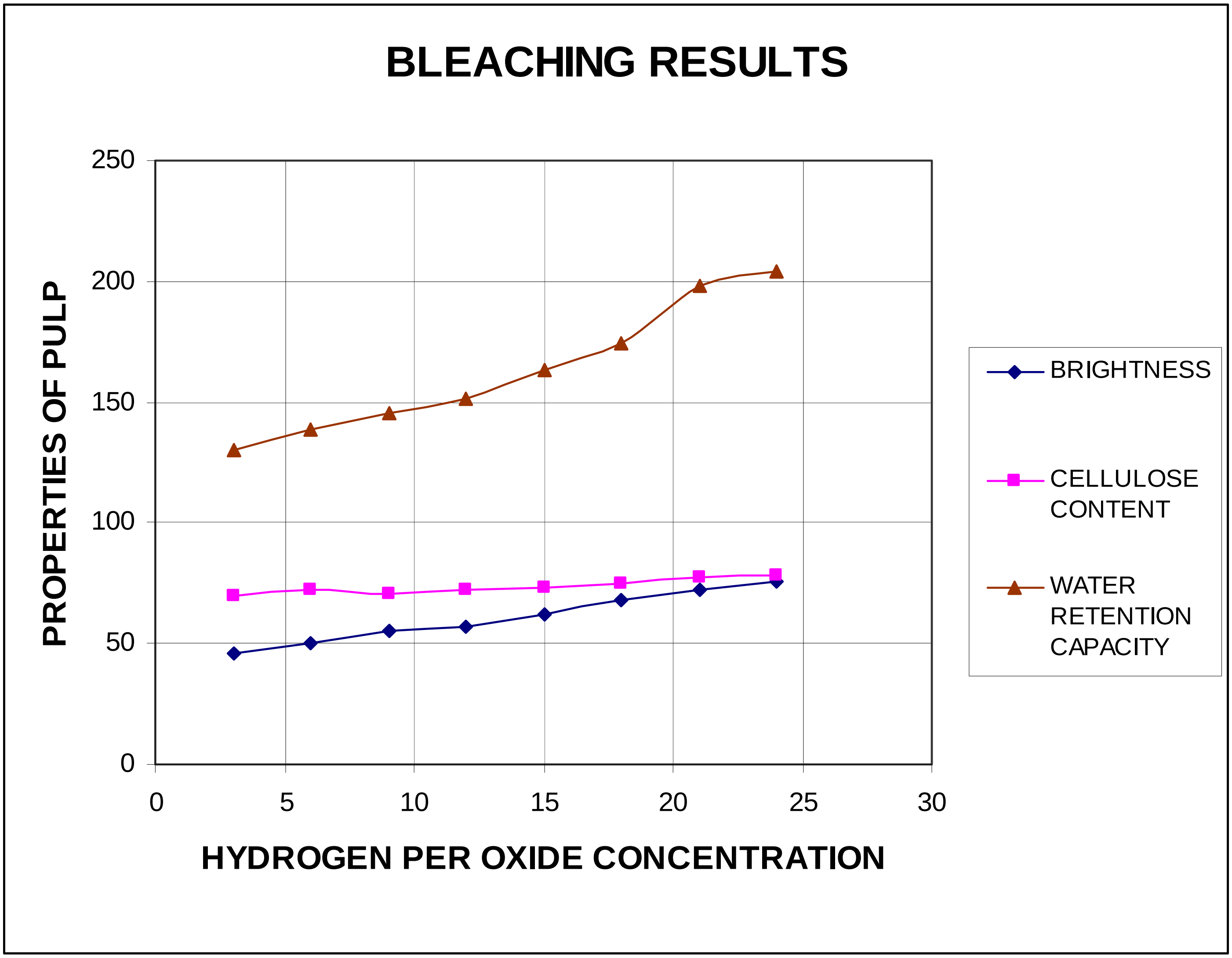

FIGURE-4.1 BLEACHING RESULT

RESULTS OF BLEACHING PROCESS

- Brightness of pulp increases with the increasing of hydrogen per oxide concentration.
- Cellulose content in pulp is also increases with the increasing concentration of hydrogen per oxide.
- Water retention capacity of pulp is also increases with the increasing concentration of hydrogen per oxide.

4.2 EFFECT OF ADHESIVE ON BAMBOO PULP COMPOSITE

Properties of bamboo pulp composite like tensile strength, absorbency and water retention capacity effect by the adhesive concentration. Tensile strength and absorbency increase with adhesive concentration. Water retention capacity decrease with increasing concentration of adhesive. This is shown in the following table.

TABLE-4.2 PROPERTIES OF PULP COMPOSITE

SHEET No.	CONCENTRATION OF ADHESIVE IN SHEET (in %)	WATER RETENTION (in %)	ABSORBENCY (in seconds)	BREAKING STRENGTH (Kgf/50 mm)
1	2	200	2	7.90
2	4	176	3	8.81
3	6	148	5	11.04
4	8	128	9	11.36
5	10	104	16	12.23
6	12	85	21	15.11

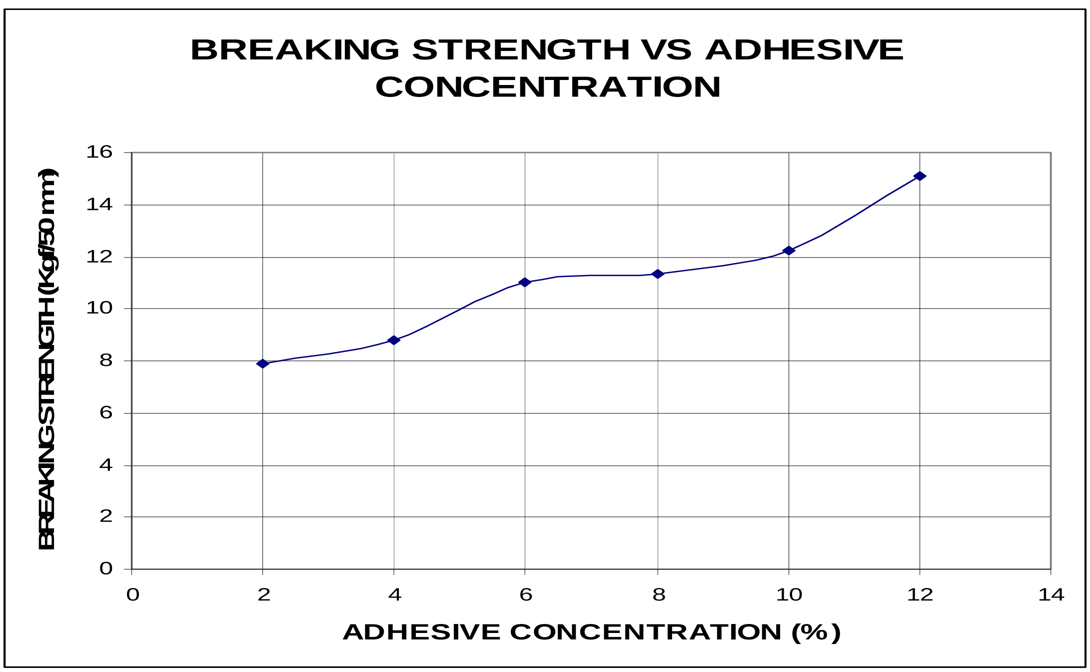

FIGURE-4.2 BREAKING STRENGTH Vs ADHESIVE CONCENTRATION

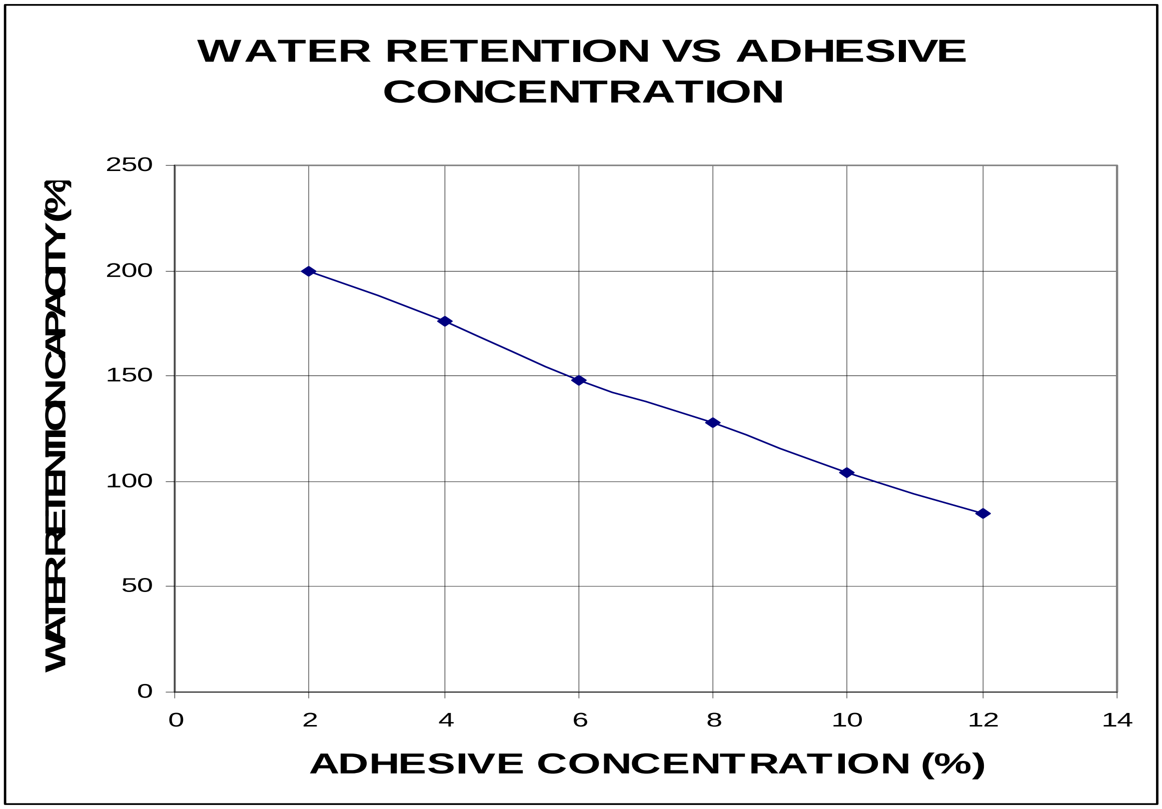

FIGURE-4.3 WATER RETENTION Vs ADHESIVE CONCENTRATION

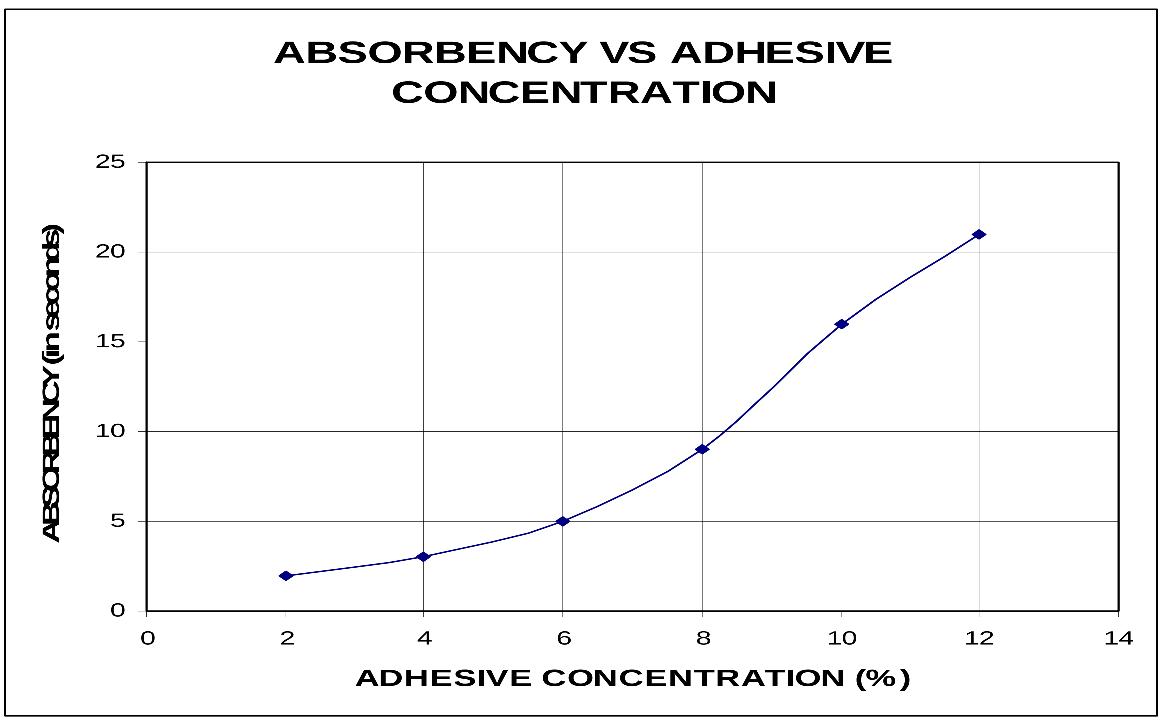

FIGURE-4.4 ABSORBENCY Vs ADHESIVE CONCENTRATION

PROPERTIES PULP COMPOSITE

- Breaking strength of pulp composite is increase with adhesive concentration.
- Water retention capacity of pulp composite decrease with increase adhesive concentration.
- Absorbency of pulp composite is increase with adhesive concentration.

4.3 PROPERTIES OF BANDAGES

1. Bandage prepared with bamboo pulp composite have following properties.

TABLE-4.3

SAMPLE	PERMEABILITY (gm/m^2 per 24 hrs)	EXTENSIBILITY (%)
Requirements	Minimum 500	< 5
Sample-1 (fabric backing)	792	4.5
Sample-2 (plastic backing)	2129	3.4

2. Bandage sample are tested for Toxicological properties. Toxicological test are skin irritation and skin sensitization. These tests are done at SRI RAM INSTITUTE FOR INDUSRIAL REASERCH. The toxicological test is ok prepared bandage.

CHAPTER-5

CONCLUSION

CHAPTER-5 CONCLUSION

It has been observed that the properties of bamboo fiber are better than other natural fiber. Some property is not so good. Bamboo pulp composite has better absorbency, water retention capacity and breaking strength. Bamboo pulp composite prepared by using 2 % adhesive have good absorbency and high water retention capacity. Bamboo fiber is best suitable for the medical applications. The bandages prepared in this project are best in quality.

CHAPTER-6

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