UNIVERSITI MALAYSIA KELANTAN

APPLICATION WASTE BANANA PEEL WITH WASTE CARTON'S BOX IMPROVE BY FISH BONE FILLER FOR PAPER PRODUCT.

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A proposal submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Faculty of Bioengineering and Technology) with Honours

FACULTY OF BIOENGINEERING AND TECHNOLOGY
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DECLARATION

I declare that this thesis entitled “application waste banana peel with waste carton’s box improve by fish bone filler for paper product” is the results of my own research except as cited in the references.

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Date : 20 FEBUARY 2024

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Date : ______________________________

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APLIKASI KULIT PISANG BUANGAN DENGAN KOTAK KERTAS BUANGAN DITINGKATKAN OLEH BAHAN ISI TULANG IKAN UNTUK PENGELUARAN KERTAS.

ABSTRAK

Untuk meningkatkan produksi kertas, penelitian ini menganalisis penggunaan sisa kulit pisang (WBP) dan sisa kotak karton (WCB) bersama dengan tulang ikan (FB). Untuk memberikan pemahaman yang lengkap, penyelidikan ini menyiasat berbagai aspek optik, mekanikal, dan dari fizikal komposisi-komposisi tersebut. Pembacaan warna digunakan untuk menentukan kombinasi yang tepat yang menghasilkan nada yang lebih cerah dan netral. Penekanan utama alat ini adalah untuk memastikan konsistensi warna dikekalkan. Dengan melakukan berbagai uji mekanik yang berbeda, seperti mengukur kekuatan tarikan, Modulus Young, dan ketahanan terhadap retak, kita dapat menentukan komposisi yang memberikan keseimbangan yang tepat antara kekakuan dan kelenturan. Campuran ini sesuai untuk banyak aplikasi, termasuk pengeluaran filem dan pembungkusan barangan. Kajian ini mengusulkan penggunaan bahan buangan ini dalam produksi kertas secara bertanggung jawab terhadap lingkungan dan efisien.

Kata Kunci: Kulit pisang buangan, Tulang ikan, Kotak kertas buangan, Ujian fizikal, Ujian mekanikal.

APPLICATION WASTE BANANA SKIN WITH WASTE CARTON'S BOX IMPROVE BY FISH BONE FILLER FOR PAPER PRODUCTION.

ABSTRACT

This research investigates the improvement of paper manufacturing by integrating waste banana peel (WBP) and waste carton box (WCB) with fish bone (FB) filler. The inquiry uses a hand sheet machine and pneumatic pressure to obtain information on morphology, mechanical properties, and tactile characteristics. The Color Reader identifies options for achieving a lighter shade with a uniform tint. Mechanical tests, such as tensile strength, Young's Modulus, and tear resistance, are used to determine the optimal compositions that provide a balance between stiffness and flexibility. These compositions are particularly suitable for applications in film manufacturing and packaging. The research provides specific suggestions for the ecologically conscious use of these byproducts in the production of paper. To summarize, the results of the experiment indicate that the combination of "5 WCB + 3 FB + 5 WBP" is the most ideal for achieving a lighter and neutral hue, which is essential for maintaining color constancy. The combination of 5 water carton box (WCB), 3 fish bone (FB), and 3 waste banana peel (WBP) creates a well-suited balance for film production. On the other hand, the combination of 5 WCB and 3 FB excels in tear resistance, making it perfect for packaging and durable paper products. Combining WCB, FB, and WBP enhances the quality and versatility of paper, indicating possible uses for each mix and promoting sustainable waste usage in paper production.

Keywords: Waste banana skin, Fish bone, Waste carton box, Physical test, Mechanical test.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Background of Study

Past decades, significant focus has been paid to industrial sectors that pollute the ecosystem. Large amounts of solid garbage generally end up in rivers and lakes and exhaustion. They were many types of waste which were Municipal solid waste, hazardous waste, industrial non-hazardous waste, agricultural and animal waste, medical waste, radioactive waste, construction and demolition debris, extraction and mining waste, oil and gas production waste, fossil fuel combustion waste, and sewage sludge are all examples of waste. According to Vaishnavi. J & Samuel. J (2023) in their journal Relationship Between Microbes and the Environment for Sustainable Ecosystem Services said that waste can be in different forms including solid, semisolid, liquid, and slurry. Total solid concentration is the important criterion in the manure, which indicates the handling of materials. Banana *Musa sp.* is an appetizing fruit that is grown in tropical and subtropical countries around the globe. The discarded outer skin or peel of a banana after it has been eaten or removed is referred to as an unneeded banana peel. It is classified as non-toxic trash since it decomposes spontaneously over time and is biodegradable. People frequently discard banana peels after eating the fruit inside, however they may be recycled or used in a variety of ways rather than being discarded. Banana peel trash is often dumped in municipal garbage dumps, contributing to current pollution issues. Yet, the issue may be solved by using its high-value constituents, such as bio-products (Nik Alnur Auli. N. Y; Ernie. S. R; Mazlan. M & Mohamad Bashree. A. B. 2016). A filler is an inert component or material uploaded to a product to enhance its bulk, weight, volume, or overall size in the scope of product manufacture or formation. Fillers are added to paper manufacture to improve specific qualities of the paper. Inorganic fillers, such as calcium carbonate, calcium, kaolin clay, or titanium dioxide, are common. They serve several functions, including increasing opacity, brightness, and printability. Fillers cover the gaps between the fibers of paper, resulting in a smoother surface and higher ink receptivity.

They also add to the volume, weight, and stiffness of the paper. Paper makers can minimize the number of expensive pulp fibers required by introducing fillers, making the process more cost-effective. Furthermore, fillers can improve the optical characteristics and overall appearance of the paper. Paper fillers are color powders derived mostly from natural minerals. Minerals are made up of various elements, such as carbon and calcium (Wahab, 2018). Filler recognized globally for its exceptional brightness and light scattering properties, as well as its usage as an economical filler in the production of brilliant opaque paper. It also aids in the production of paper with excellent brightness and gloss, as well as good printing qualities.

1.2 Problem Statement.

Concerns have been raised about the possible ecological impact of the chemical process used in pulp and paper manufacture. the past bleaching procedures employ chlorine compounds, such as chlorine dioxide, as by-products, which can produce chlorinated organic molecules. These molecules, known as chlorinated dioxins and furans, are long-lasting and can harm biodiversity and human health. According to M L Parker; R G Mauldon; D R Chapman (1990) in their journal Pulp and Paper Bleaching and The Environment said that Anything is produced during the pulp making.

A large portion of the garbage is in fluid form. This discharge is produced by washing pulp between separation on lignin and fibrous from raw material that used chemical steps. Regardless of the chemical process used, the effluent may contain contaminants that are harmful to the environment, such as suspended particles and the ability to deplete oxygen from receiving waterways. Banana skin papers is a novel and environmentally friendly method of producing paper. Banana skins, which are plentiful leftovers, are converted into pulp and converted into paper sheets by using thrown banana skins. This aids in preserving forests and aids to minimise a major deforestation. This eco-friendly option saves waste and encourages a circular economy.

The produced paper has distinct properties and may be utilised for a variety of purposes, demonstrating the creative potential of recycling natural materials. Furthermore, banana skins consist of natural fibres like cellulose that add to the strength and texture of the finished paper while banana skin fibres are not as long or as strong as those found in traditional papermaking materials, they may nevertheless be treated and combined with other fibres to make usable and varied paper products. Because of the parchments in banana skin paper, it has greater fiber. It also has higher cellulose, less lignin, and is 300 times stronger than regular wood paper. Banana skins are also readily available, and banana plants develop quickly.

As a result, a million tons of banana skins may produce 100,000 tons of paper, providing us with a more convenient supply of paper. It is also water and fire resistant, making it more robust and suitable for handling stuff like packing usage cases (Ahmad. U. Z; Muhammad. A. R; Muhammad. A. M. & Nor. A. T. 2021) natural colorants like lignin, which may make paper seem yellow or brown. This produces a stronger paper with higher tensile and tear strength.

This contributes to the longevity of paper goods and assures their long-term preservation.

To obtain specified brightness levels and fulfil the needs of diverse end applications, several bleaching procedures and chemicals can be used. This adaptability enables the paper sector to meet the needs of many industries, such as printing and writing papers, tissue goods, packaging materials, and others.

1.3 Expected Output

The goal of this study project is to create a paper from two substance which is discarded banana peels and a filler of fish bone powder and see if the tensile strength, and opacity of the paper are the same as conventional paper in industries. However, it's important to note that proportion of the substance being used.

1.4 Objectives

1. To investigate the physical and morphology of the physical on paper production with different percentage of waste banana peel and fish bone fillers.

2. To determine mechanical effect, tensile strength, brightness on paper production with different ratio of waste banana peel and fish bone fillers.

1.5 Scope of Study

This research project is to get paper that used waste banana peel (WBP) and filling a filler are fish bone powder whether the tensile strength, brightness, opacity of the paper is same as the resistance pressure than common paper in industries.

1.6 Significant of Study

The significance of this study is to determine the success of production paper by being used with different materials. The use of fishbone filler is derived from natural or synthetic organic materials. Unlike inorganic fillers these fillers are derived from minerals or other inorganic sources. This can include pollution into the ecology and human health’s. Other than that, used municipal solid waste can improve and reduce the municipal waste and improve quality of the environment.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Benefit of using dry banana peel powder and fishbone as a filler in the paper industries.

Dry banana peel powder includes cellulose fibres, according to (Shewta. M, Bala. P & Prashant. S. K ,2023) in their article banana Skin Garbage a Growing Cellulosic Material to Extract Nanocrystalline to Cellulose, BP contains 60-70% (w/w) carbohydrate, protein (2-3%), fiber (4-5%), fat (4-5%), and moisture (20%). Nevertheless, on a dry basis, BP comprises 7.6-9.6% cellulose, 10-21% pectin, 6.4-9.4% hemicellulose, 6-12% lignin, and other low molecular components. These fibres boost paper's strength and durability, leading to higher grade and functionality. Waste decrease using dried banana peel flour in the paper-making production makes use of a by-product that would otherwise be wasted. The industry minimises the quantity of organic waste created and supports sustainable waste handling practises by recycling banana peels. Cost-effectiveness.

When as opposed to conventional wood pulp used in paper manufacture, banana peels are a comparatively cheap and abundant raw resource. Using dry banana peel flour might possibly lower manufacturing costs, making it a cost-effective choice for the paper sector also helped to reduce tree logging. Enhanced paper attributes the use of dry banana peel powder can enhance paper qualities such as smoothness, ink absorption, and surface tenacity.

These enhancements can lead in higher print quality and overall paper effectiveness. The application of dry banana peel flour in the paper sector has various benefits. The use of fish bones as a filler in the paper industry had numerous benefits, such as a filler is an inert component or material used in a product to enhance its bulk, weight, volume, or overall size in the context of product manufacture or the creation.

Fillers are commonly employed to reduce production costs by substituting higher-priced active components while maintaining the product's appearance or outcome. According to statistics from the Institute for Research and Development of Cellulose Sectors, banana skin trash has greater finer fibres than wood debris with high cellulose (60-65%), hemicellulose (6-8%), and lignin (5-10%). Furthermore, the main often utilised softwood for conventional paper raw source comprises just cellulose (41%), hemicellulose (24%), and lignin (27.8%). It shows that the cellulose content of banana skin is much higher than that of softwood.

Furthermore, banana skin has just a small amount of lignin (5-10%), making the cellulose extraction procedure simpler. Thus, the banana peel might be able to be utilised as a raw resource in papermaking, reducing reliance on wood as a raw resource in papermaking. (Widiastuti Agustina E.S. 1* and Elfi Susanti V.H2, 2018). Filler is commonly used in composites to improve mechanical and tribological qualities. Fillers supplemented with a little percentage of weight can enhance the characteristics. Fillers are being used extensively from the introduction of polymers to reduce costs. The use of fillers in PMCs improves their mechanical and tribological qualities. Fillers come in a variety of types, including molecules, nanofillers, articular, and fibrous fillers. Particulate fillers outperform all other fillers in enhancing the firmness and stiffness of PMCs. (Vijayakumar. P; Devarajaiah. R. M; Suresha. B. & Bharat. V. 2021)

Parameter%	Cuttlebone sample	Fish bone of tilapia (Oreochromis niloticus) [1]	Fish bone of tuna (Thunus sp.) [2]	Remark
Moisture	3.54±0.11	-	-	Wet basic
Protein	4.78±0.23	15.18	24.93	Dry basic
Ash	89.61±0.26	77.74	67.39	Dry basic
Lipid	0.32±0.19	5.97	0.54	Dry basic
Carbohydrate	5.29±0.02	1.11	7.14	Dry basic
*= by difference,1 =Hemung (2013);2= Hanura et al (2018)				

Figure 2.1.1: Chemical composition in fishbone.

(Source: Krisman Umbu et al., 2019)

2.2 General aspect on waste carton box and paper.

The pulp and paper business are made up of several main features that characterise its activity. It all starts with the use of raw resources predominantly wood fibres supplied from softwood and hardwood trees, as well as reused paper, agricultural leftovers, and non-wood fibres. These raw resources are mechanically or chemically broken down into unit fibres.

Wood is one of the majorities of plentiful resources in the bio-based sector, but it is also one of the most complicated stuffs, made of polymers of lignin and carbohydrates that are physically and chemically bonded jointly. Wood (hardwood and softwood), agricultural leftovers, and reused paper are the primary resources used in pulp and paper manufacture.

Most carton boxes are built to be recyclable and ecologically friendly, contributing to sustainable packaging practices (Smith et al., 2020). Carton box specifications might vary depending on the specifics of the packaging process and the expected usage of the boxes. Nevertheless, below are some typical carton box characteristics and features. Carton boxes, which are frequently used in packing, are often made of paperboard or corrugated fibreboard.

The latter, a popular substance, has a layered structure. It is made up of three layers: an inside corrugated or wavy layer called the corrugated medium that is sandwiched between two external flat layers. The flute size in corrugated fibreboard is frequently used to determine the strength of a carton box, with different flute sizes giving variable amounts of strength and cushioning.

Carton box specs vary according to aspects such as target usage, contents, and industry requirements. Carton boxes are often built of paperboard or corrugated fibreboard, with the material used influencing their strength and longevity. Dimensions such as length, breadth, and height are important criteria, while customisation choices like as printing, colour, and other features such as die-cut windows are available to fulfil individual needs. Furthermore, carton boxes may have unique coatings for increased protection, such as water-resistant coatings.

2.3 Composition waste carton box process.

A carton box, which is often referred to as a cardboard box, is constructed for the purpose of holding many layers of paperboard. To construct a carton box, the primary components that are used are cardboard, adhesives, inks, corrugated material, linerboard, and paperboard. One kind of paper that is both robust and compact is paperboard, which is manufactured from wood fibres. The thickness and quality of the box are regulated in accordance with the purpose it serves and the items that it is intended to contain. In many cases, corrugated paperboard or corrugated media is used in the production of multiple carton boxes. On the exterior, there are two layers that are flat, and on the inside, there is a layer that is wavy.

The corrugated media in this box provides both strength and stiffness, making it an excellent choice for transporting and packaging a wide range of things. Linerboard is used in the building of the box, which results in an improvement in both its durability and its strength. When it comes to printing labels and logos, a smooth surface, which is offered by the outer layers, is preferable. It is necessary to use adhesives throughout the production process to guarantee that the layers are bound together firmly and that a strong structure is generated.

The inks that are used to print on carton boxes may be used to display information such as labels, logos, or information about the contents of the box. To guarantee the material's continued viability over the long term, Jones et al. (2019) highlights the need of choosing inks that are compatible with processing techniques for recycling. Why I chose the carton box for raw materials for paper production is because according to Kumar, A., & Tiwari, A. (2020), Cardboard and corrugated cardboard boxes, among others, primarily employ wood fibre sourced from trees as their primary resource. Reusing and recycling these fibres might reduce demand for fresh fibre sources and increase their usefulness as papermaking raw materials. There are several ecological advantages to recycling trash cans for paper manufacturing. Reduced need for raw wood fibres, less energy usage, and fewer greenhouse gas emissions from paper production all contribute to better resource conservation. Less trash means less space in landfills.

2.4 Production of banana peel paper.

Paper created from banana peels is a green and creative disposal and paper manufacturing method. Banana peels, usually are generally thrown away as garbage, may be converted into a useful material for papermaking. Collecting and processing banana peels, eliminating contaminants, and turning the residual fibres. After that, the fibres are combined with various ingredients and produced into paper sheets. Furthermore, it has the potential to minimise the deforestation and the chemical consumption that has occurred in environmental. For paper manufacture, providing more protection to flora and fauna's ecosystems, which also served as a source of food and a secure environment to live. This will be proven by our study in the future.

Given that we do not use trees as our primary supply of paper in our endeavour. A further benefit of this technology is that we may utilise banana paper to replacing wood-based paper in applications such as industrial packaging. Banana paper is significantly stronger and has many more benefits than regular paper, such as more fibre and cellulose. This idea has the potential to have a significant good influence on the ecosystem and our lives. Even though we consider banana skins to be a waste, they have the potential to transform how we get papers for everyday use. (Ahmad. U. Z; Muhammad. A. R; Muhammad. A. M. & Nor. A. T. 2021).

According to Sharma, R. K., & Arora, P. (2017), The chemical make-up of ripe banana peels changes with age. The pectin and starch levels in young banana peels are greater, which might be problematic for making paper from them. The cellulose content of aged banana peels increases while the starch content decreases, making them more suitable for use in paper production. Banana peel fibres undergo a change in structure and characteristics as they age. Banana peels' moisture content changes as the fruit ripens. The skins of green, unripe bananas are more hydrated than those of ripe or overripe bananas. Paper production may be negatively impacted by pulping and paper manufacturing issues caused by excessive moisture content. Ripe banana peels that have lost most of their moisture are often used in the papermaking process.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 Location of the Study

A field of research will be chosen at the University Malaysia Kelantan Jeli Campus's laboratory and wood workshop. from September 2023 to February 2024. The equipment in the laboratory and wood workshop.

3.2 Materials

The substances required to make paper are as follows are Waste banana peels *Musa sp.*, fish bone, and carton box. The materials that I used to see the different of morphology paper produce. For the banana skin and fish bone were collected whereas small-medium enterprises (SME). Banana peels were dried in an oven to eliminate moisture content and powdered whilst fishbone was cleaned, dried, and powdered.

3.3 Methods

3.3.1 Preparation of waste carton box.

The waste carton box was collected near UMK from mini mart then the sample carton box's shred into tiny pieces using hand and being soak using distilled water for 24 hours before used.

Figure 3.3.1.1: Preparation of waste carton box.

3.3.2. Preparation powdered the waste banana skin and fish bone filler and waste carton box.

To desiccate banana peels in an oven, begin by gathering immaculate and newly harvested peels, ensuring they are devoid of any impurities. Divide the banana peels into smaller fragments to expedite and ensure a more consistent drying process. Set the oven to a low temperature of around 65°C to gently remove moisture from the food while maintaining its nutritious value. Place an aluminum sheet to avoid adhesion. Place the banana peels on the prepared sheet in a single layer, being sure to leave some space between them to allow for adequate air circulation. Position the aluminum sheet in the oven that has been warmed, leaving the door slightly open to allow moisture to escape more easily. Regularly inspect and rotate the banana peels to ensure even drying. The drying process requires a duration of 24 hours, during which the peels are deemed dry if they attain a state of crispness and brittleness. Ensure that the dehydrated banana peels have fully cooled down prior to placing them in a hermetically sealed container situated in a cold and arid area. To begin, collect clean and deboned fish carcasses, ensuring the removal of any adhering flesh. Thoroughly wash the bones to eliminate residual scales and other impurities. Arrange the fish carcasses in a single layer on the prepared sheet, ensuring some space between pieces for proper air circulation. Preheat your oven to a low temperature of 60°C allowing for gentle dehydration while preserving nutritional content. Periodically check and flip the banana peels to ensure even drying. The drying process may take 24 hours, and the peels are considered dry when they become crisp and brittle. Allow the dried fish carcasses to cool completely before storing them grind the bones into a coarse powder into 65 m particle size and put in an airtight container placed in a cool, dry location.

Figure 3.3.2.1: Waste banana peel *Musa sp.*

Figure 3.3.2.2: Fish bone carcasses.

(source: *Harmagidun*, 2024)

Figure 3.3.2.3: Banana peel powder.

Figure 3.3.2.4: Fish bone powder.

3.3.3 Paper making process.

In the paper-making process, start by pouring 1000 ml of filtered water into a measuring cylinder. Transfer all the banana powder, fish bone powder and waste carton box into a blender, adding half of the filtered water and blending for 2 minutes. Combine this solution with the remaining purified water and stir thoroughly. Take 500 ml of the mixture and proceed to set up the hand sheet machine.

After allowing the water to rise in the machine, gently pour in the pulp mixture, wait for 30 seconds, and then press the machine button to drain the water. Once water removal is complete, place blotting paper on the pulp, rolling it to adhere. Subsequently, carefully lift the blotting paper with the pulp and position it on the hand sheet pressing machine, followed by the couch plate.

Attach the top of the pressing machine to the couch plate to eliminate excess moisture. After 4 minutes, detach the top of the pressing machine and the couch plate, gently separating the blotting paper from the pulp. Allow the formed paper to air dry for several hours or until completely dry.

Figure 3.3.3.1: Hand sheet machine and presser machine.

3.3.2 Paper production.

Paper coding	Quantity	WASTE CARTON BOX (WCB) (g)	POWDER WASTE BANANA PEEL (WBP) (g)	POWDER FISH BONE(FB) (g)
5WCB0WBP0FB	1	5 grams	-	-
5WCB0WBP1FB	1	5 grams	-	1 gram
5WCB0WBP3FB	1	5 grams	-	3 grams
5WCB1WBS0FB	1	5 grams	1 gram	-
5WCB3WBP0FB	1	5 grams	3 grams	-
5WCB5WBP3FB	1	5 grams	5 grams	3 grams
5WCB3WBP3FB	1	5 grams	3 grams	3 grams
5WCB1WBP3FB	1	5 grams	1 gram	3 grams

Table 3.3.4.1: Tables of Parameters waste banana skin and fish bone papers production.

3.3.5 Testing Methods of physical and mechanical properties.

3.3.5.1 Color reader.

Color reader tests are crucial in the paper industry to ensure consistent and high-quality paper products. Color readers and other advanced color measurement techniques are often used in these tests to precisely quantify the color attributes of the paper samples. According to (Spectrophotometer for Color Measurement of Paper, 2024) color readers are responsible for precisely measuring a diverse variety of color properties. The factors often assessed are hue, which represents the prevailing color tone, brightness, which reflects the amount of light reflected by the paper surface, and color intensity, which quantifies the vividness or saturation of colors After turning on the color reader, it must be calibrated to provide accurate color readings. Place the device on the calibration standard to begin calibration. The color reader measures colors after calibration. Measure a color by placing the device on top of the region. Color reader test findings are crucial due to their significance in assessing product quality, ensuring compliance with industry standards, and meeting the diverse color requirements of various applications such as graphic design, printing, and packaging.

Figure 3.3.5.1.1: Color reader Konica Minolta

3.3.6 Stereo microscope.

A stereo microscope, which is a kind of optical microscope, enables the observation of objects in three dimensions at low magnification. Alternative names for this apparatus are dissecting microscope and stereomicroscope. According to (Spectrophotometer for Color Measurement of Paper, 2024) stereo microscopes produce an image by illuminating the object with incident light, while compound microscopes provide a three-dimensional image by employing transmitted light. Stereo microscopes use two separate optical channels for each eyepiece, similar to the binocular vision of the human eye, in order to provide a sense of depth. Instruments with a wide field of view, an upright non-reversed picture, and a considerable working distance the space between the specimen and the objective lens are suitable for conducting first evidence inspections and manipulating tiny objects. Materials are readied for meticulous examination beneath a microscope or for utilization in a comparative or analytical apparatus. Due to the significant working distance and exploitation of reflected light, specimens seldom need preparation for examination, which is an additional advantage. Examining the object under the microscope and closely observing it stereo microscopes are particularly well-suited for the identification of paper fibers. The stereo microscope is ideal for examining the organization, characteristics, and composition of paper fibers with excellent clarity due to its ability to provide magnification ranging from low to intermediate levels. This methodology is used across several sectors, including forensic science, quality assurance, and paper production.

Figure 3.3.6.1: A stereo microscope.

(source: Kiara Marie Fleischer, 2019)

3.3.7 Tensile strength test.

Figure 3.3.7.1: Uniform testing machine for tensile strength and tear determination.

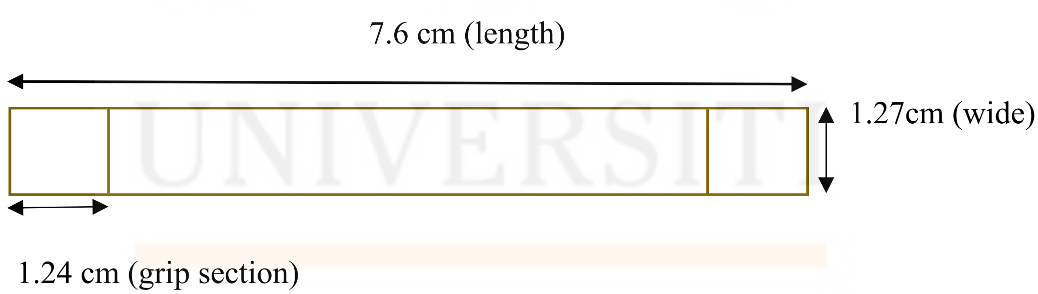


Figure 3.3.7.2: Illustration tensile paper film.

Tensile strength testing, which forces an item to its breaking point, is a common mechanical test. Tensile strength is measured by progressively applying tensile force to an object until it breaks, according to Yalcin (2021). The stress-strain test is common.

A controlled force is applied to an item to measure its stretching or deformation. Divide the greatest force applied to an object by its initial cross-sectional area to calculate tensile strength. The stress-strain curve shows how tension impacts resistance variations, according to Szewczyk et al. (2006). It also shows product efficacy, equation was used to compute the tensile strength and elongation at break. 3.3.7.3 (Wendimagen Meshesha Fanta, 2019)

(3.3.7.3)

Tensile strength (tensile stress) formula:

$$Tensile\ strength = \frac{H}{D}$$

Whereas,

H_{max} = Load at proportional limit (N)

D = cross sectional area of the film (mm^2)

(3.3.8.4)

$$\text{Elongation at break (mm)} = \frac{Fmax}{Ao}$$

Whereas,

Fmax = Elongation at maximum limit (mm)

Ao = initial length of film (mm)

Young's modulus is calculated by comparing the applied stress to the strain in the elastic portion of a stress-strain curve. Tensile strength measures a material's stress vulnerability, whereas Young's modulus measures its stiffness. Structure, composition, and other factors may affect a material's properties. Equation was used to compute the young's modulus of tensile test at 3.3.8.5 (Williams, 2022)

(3.3.7.5)

Young's modulus formula:

$$\text{Young's modulus} = \frac{Deflection}{initial\ length}$$

Young's modulus and tensile strength vary by substance. Compared to wood or fiber-based composites, regular paper has lower tensile strength. Tensile strength testing aids material selection, quality control, and structure. Paper's tensile strength is a solid measure for assessing boxes and other paper-based items. Tests may be done by breaking paper strips under controlled settings. This approach shows paper durability. ISO and TAPPI are important organizations that supply paper strain testing criteria.

3.3.8 Tear test.

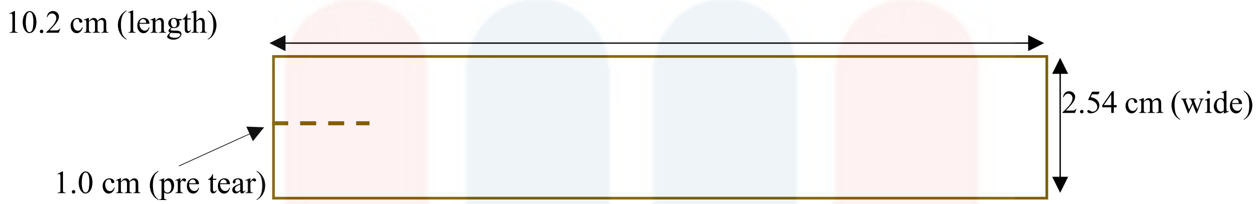


Figure 3.3.8.1: Illustration tear paper film.

The tear test is a mechanical assessment that measures the ability of a material to withstand forces exerted during tearing. According to (Popil, 2018) During this experiment, the material is first divided into a notch, and then a force is exerted in a direction perpendicular to the material's plane in order to propagate the tear along the notch. Equation was used to compute the tear test at 3.3.8.2 (Md. Shafiqul Islam et al., 2019)

(3.3.8.2)

Tear test formula:

$$Tensile\ strength = \frac{G}{J}$$

Whereas,

G_{max} = Load at proportional limit (N)

J = cross sectional area of the film (mm^2)

(3.3.9.3)

$$\text{Elongation at break (mm)} = \frac{Rmax}{Uo}$$

Whereas,

Rmax = Elongation at maximum limit (mm)

Uo = initial length of film (mm)

Tear tests usually relate Young's modulus to tear strength indirectly. Young's modulus (E) measures a material's stiffness by increasing the elastic region's initial stress-strain curve slope by two. The power required to shatter a material in a trial determines its tear strength, which correlates with its tearing resistance. Both qualities are affected by material behavior, but differently. Young's modulus measures stiffness and elastic deformation, whereas rip strength measures plastic deformation and tearing resistance. Thus, Young's modulus and tear strength are not mathematically related. The two traits depend on material and structural factors. Equation was used to compute the young's modulus of tear test at 3.3.8.4 (Moebs et al., 2016)

(3.3.8.4)

Young's modulus formula:

$$\text{Young's modulus} = \frac{Deflection}{initial\ length}$$

The tear resistance and toughness of the material are determined by measuring the force needed to start and maintain the tear. The tear test's capacity to measure a material's ability to withstand tearing pressures is a crucial characteristic in materials that may encounter ripping, such as textiles, films, packaging, and paper goods. Understanding the material's resistance to tearing is crucial for maintaining quality standards and assuring its intended performance.

CHAPTER 4

4.0 RESULT AND DISCUSSION

4.1 Physical test (appearance)

According to (University of Wisconsin–Stevens Point, Stevens Point, WI, USA & Ring, 2004) in paper commerce, look determines grade and suitability (for diverse purposes). Visual qualities of paper determine its aesthetic appeal, printability, and commercial acceptability. Several factors determine paper looks. varied applications need varied paper colors and tints. Especially for high-quality printing and packaging, materials must be consistent and attractive. Both flawlessness and roughness affect printability and tactile experience. In applications like high-quality periodicals and advertising materials, flawless, homogeneous papers are used for crisp, clear printing. For paper to look good, it must be clean and free of stains, flecks, and discolorations. Uses requiring a faultless visual appearance need clean and defect-free paper. To ensure that paper fulfills and surpasses the visual criteria required by its numerous uses, the industry assesses paper looks in several ways.

PAPER CODING	GRAM WCB (Waste carton box), FB (Fish bone), WBS (Waste banana skin)	APPEARANCE
5WCB0WBP0FB		• Smooth • Slightly pale brown
5WCB0WBP1FB		• Slightly smooth • Slightly pale brown

5WCB0WBP3FB		• Slightly coarse • Slightly pale brown
5WCB1WBP0FB		• smooth • pale brown
5WCB3WBP0FB		• smooth • Slightly dark brown

5WCB5WBP3FB		• Slightly smooth • Dark brown
5WCB3WBP3FB		• Smooth • Slightly dark brown
5WCB1WBP3FB		• Smooth • Slightly brown

Table 4.1: Appearance of paper.

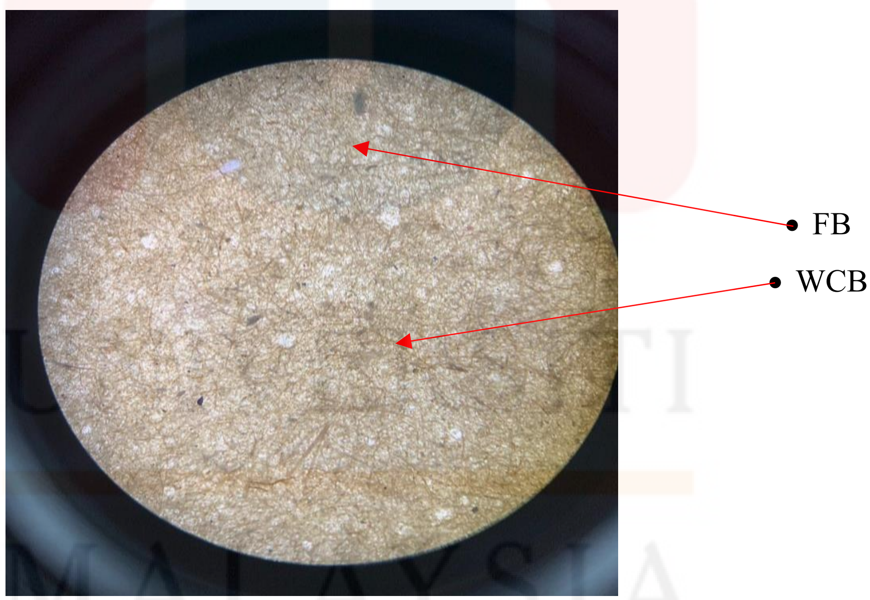
By mixing Waste Carton Box (WCB), Fish Bone (FB), and Waste Banana Peel (WBP), each paper creation has a distinctive appearance. The paper, labeled "5g WCB," is flawless and light brown. This means the paper is primarily a Waste Carton Box, giving it a perfect, light brown appearance. The paper's texture gets somewhat finer and preserves a faint brown tint when "5g WCB + 1g FB" is employed, showing that Fish Bone improves fineness. When transitioning to

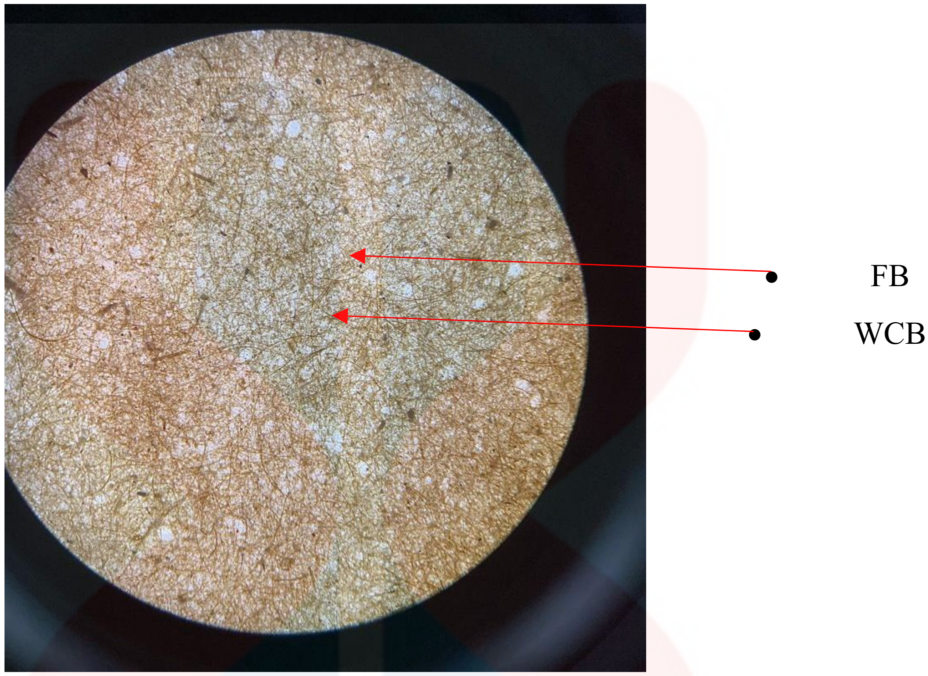
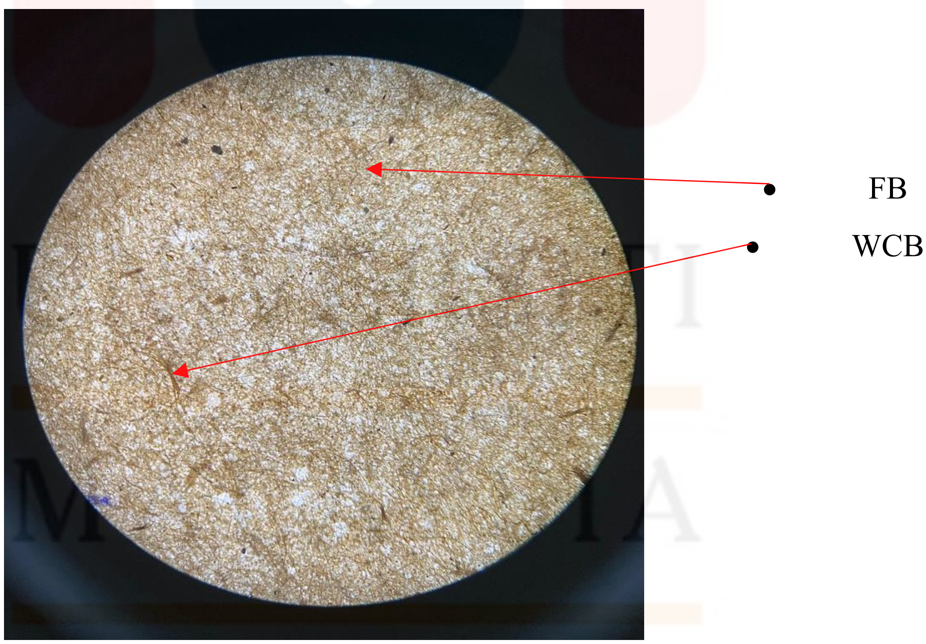
"5g WCB + 3g FB," the paper becomes somewhat rougher while keeping a moderate brown tone, indicating that the added Fish Bone roughens its appearance. Using 5 grams of Waste Carton box and 1 gram of Waste Banana Peel in the coding process produces a faultless texture and light brown hue. This shows that Waste Banana Peel somewhat lightens the color. Adding 5 grams of Waste Carton Box (WCB) and 3 grams of Waste Banana Peel (WBP) preserves the paper's texture while resulting in a darker brown color. This shows how much Waste Banana Peel darkens. A deeper, somewhat perfect texture and dark brown tone result from 5 grams of WCB, 3 grams of FB, and 5 grams of WBP. The paper's smooth texture and dark brown color indicate a balanced mix of 5 grams Waste Carton Box, 3 grams Fish Bone, and 3 grams Waste Banana Peel. Using 5 grams of Waste Carton Box, 3 grams of Fish Bone, and 1 gram of Waste Banana Peel yields a velvety consistency with a faintly brown tone, demonstrating the influence of reducing the quantity on the overall color. To conclude, our paper coding system provides valuable insights into how different combinations of WCB, FB, and WBP affect paper visual and tactile qualities. It also lists potential uses and composition characteristics.

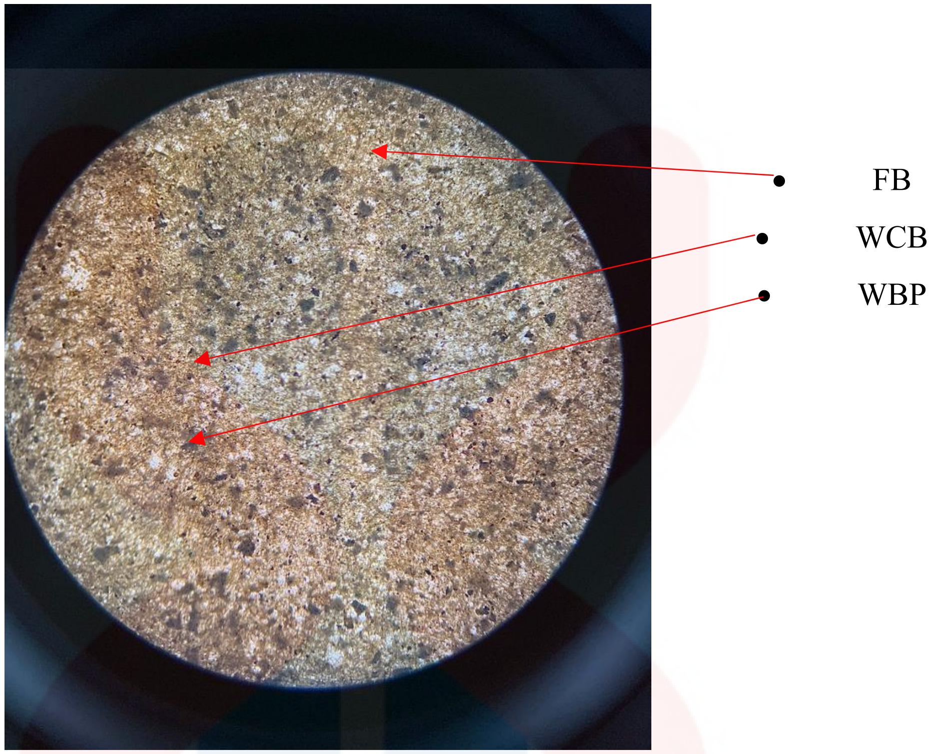
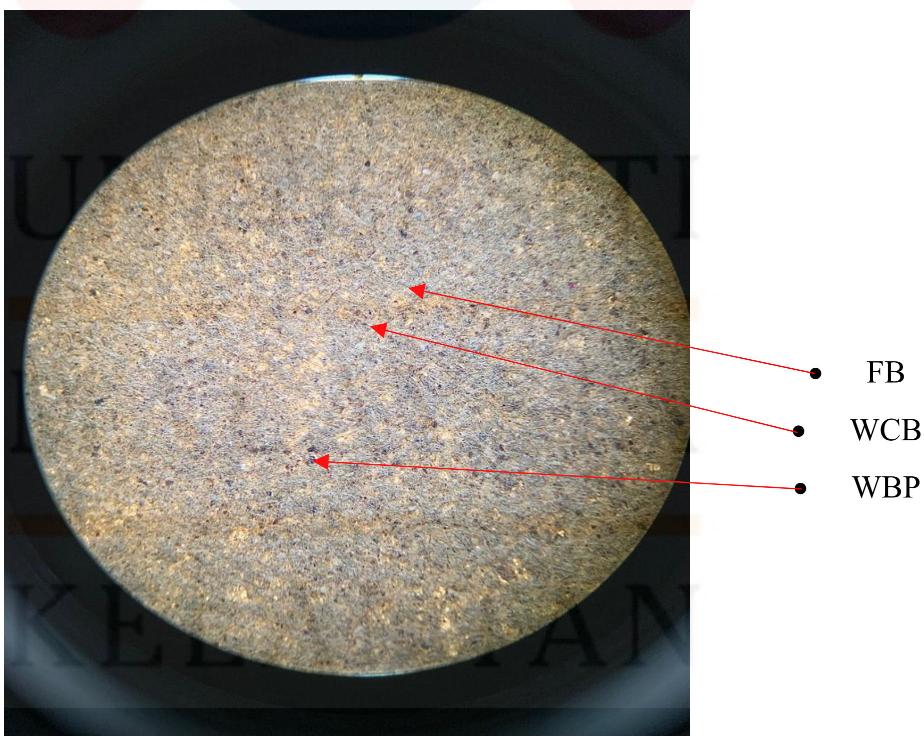
4.2 Physical test (microscope)

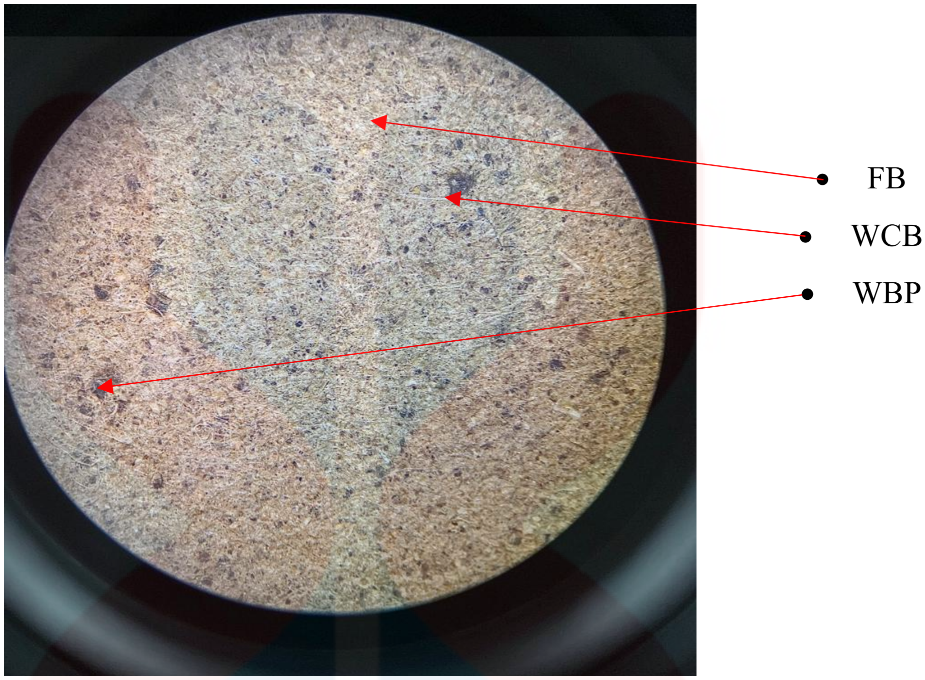
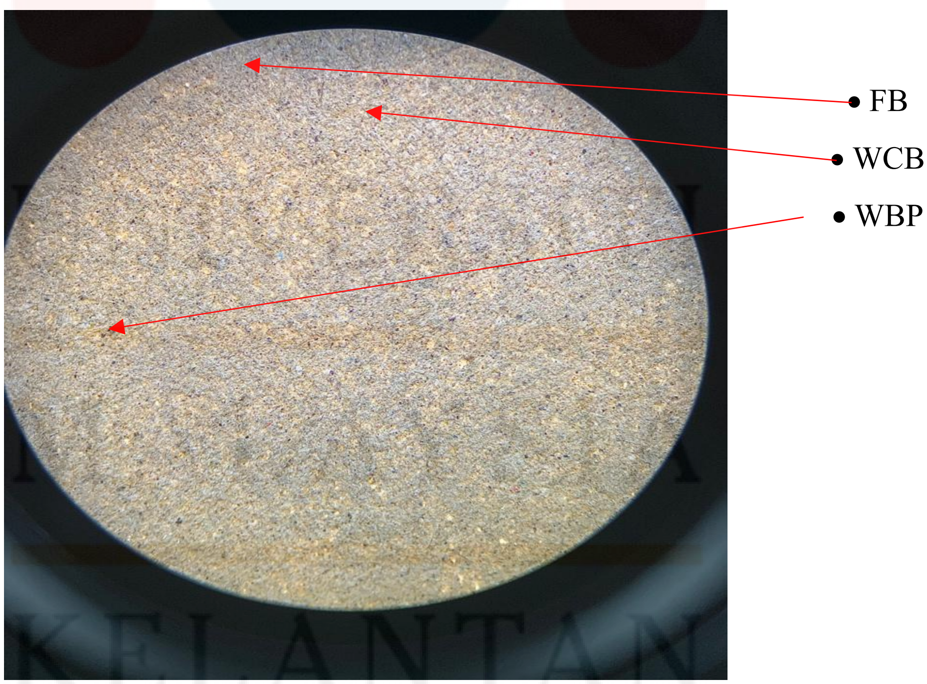
4.2.1 stereo microscope

Images are produced in three dimensions with modest magnification by use of stereo or dissecting microscopes. In order to provide depth perception and allow for more realistic three-dimensional examinations, stereo microscopes employ two optical channels per ocular. (Kwon et al., 2010)

PAPER CODING	Appearance of WCB fiber, WBP fiber and FB filler in paper using stereo microscope.
5WCB0WBP0FB	

5WCB0WBP1FB	
5WCB0WBP3FB	

5WCB1WBP0FB	
5WBP3WBP0FB	

5WCB5WBP3FB	
5WCB3WBP3FB	

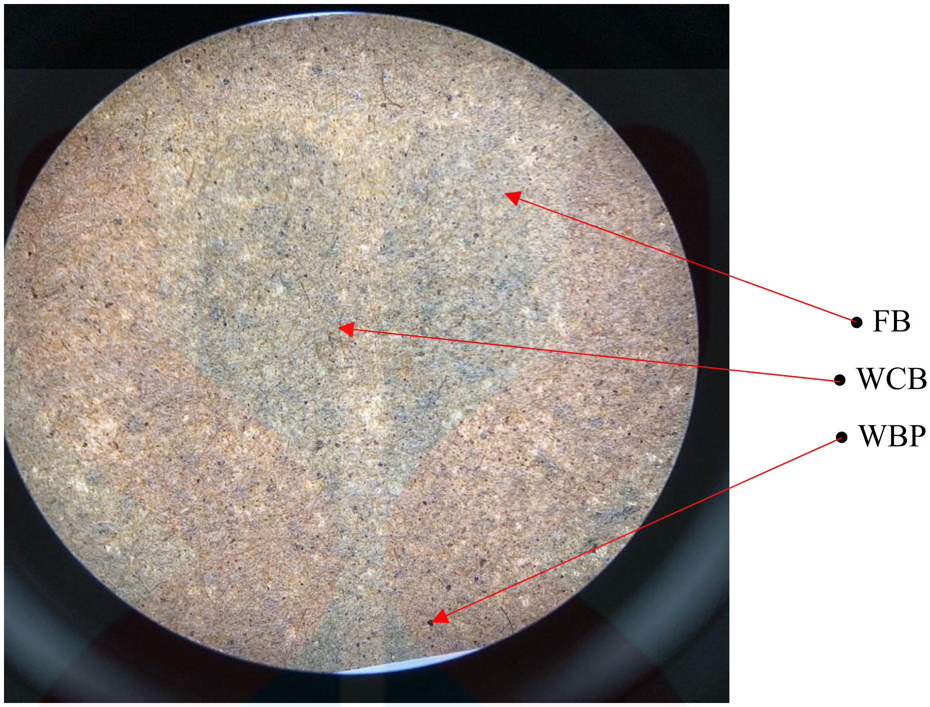
5WCB1WBP3FB	

Table 4.2.2: Appearance of paper using stereo microscope.

Paper samples from different blends have different qualities. Specimen 1 exhibits a normal tint, consisting only of discarded carton box material. The suitability of this paper for usage is compromised due to its abundant porosity, low cellulose fiber content, and major presence of damaged fibers. This occurred due to the use of fibers obtained from wasted box material in the production of recycled paper that is softened by 1 gram of fish bone powder in Specimen 2. Fibers are the biggest change, with pure waste cardboard having huge, irregular fibers and the fish bone powder combination having smaller, uniformly dispersed ones, affecting porosity. Fish bone powder fills holes in pure cardboard, reducing porosity.

Sample 3, a cardboard-fish bone powder combination, is light brown with dispersed darker flecks and finer, more uniform fibers than waste carton box. The paper's porosity and smoothness lie between waste carton box and the featuring 3 grams of fish bone powder. Specimen 4 cardboard, fish bone powder, and banana peel is light brown with darker specks. The uniformly distributed fibers and shorter, thicker fibers, probably from the banana peel, lead to moderate porosity. Smoother than pure prior sample but not as smooth as sample with extra fish bone powder.

Specimen 5, with banana peel in the mix, is light brown with finer, more fibers and uniformly distributed fibers but moderate porosity. Specimen 6, which contains banana peel, is light brown with subtle white flecks, finer and more uniformly distributed fibers, and a smoother but not entirely smooth surface.

Banana peel adds irregular dark black specks on paper. Specimen7, a cardboard-banana peel combination, with fibers of varying thicknesses and reduced porosity. The banana peel and fish bone powder may explain the darker specks on the light brown paper. Fibers, banana peel particles, and fish bone powder pieces are evenly distributed across the paper. Finally, Specimen 8 with 1 gram of banana peel powder has somewhat fewer darker flecks and rough texture than with 3 grams. These findings demonstrate how additive combinations affect paper sample color, fibers, porosity, surface roughness, and appearance.

4.3 Physical test (color reader)

4.3.1 color reader

The paper color reader test uses a colorimeter or spectrophotometer to quantify and assess paper color. This examination analyzes paper color, saturation, and brightness. It provides measurable data for paper quality control. In utilizes that need color constancy between paper batches, the color reader is crucial. (Lucas et al., 2015)

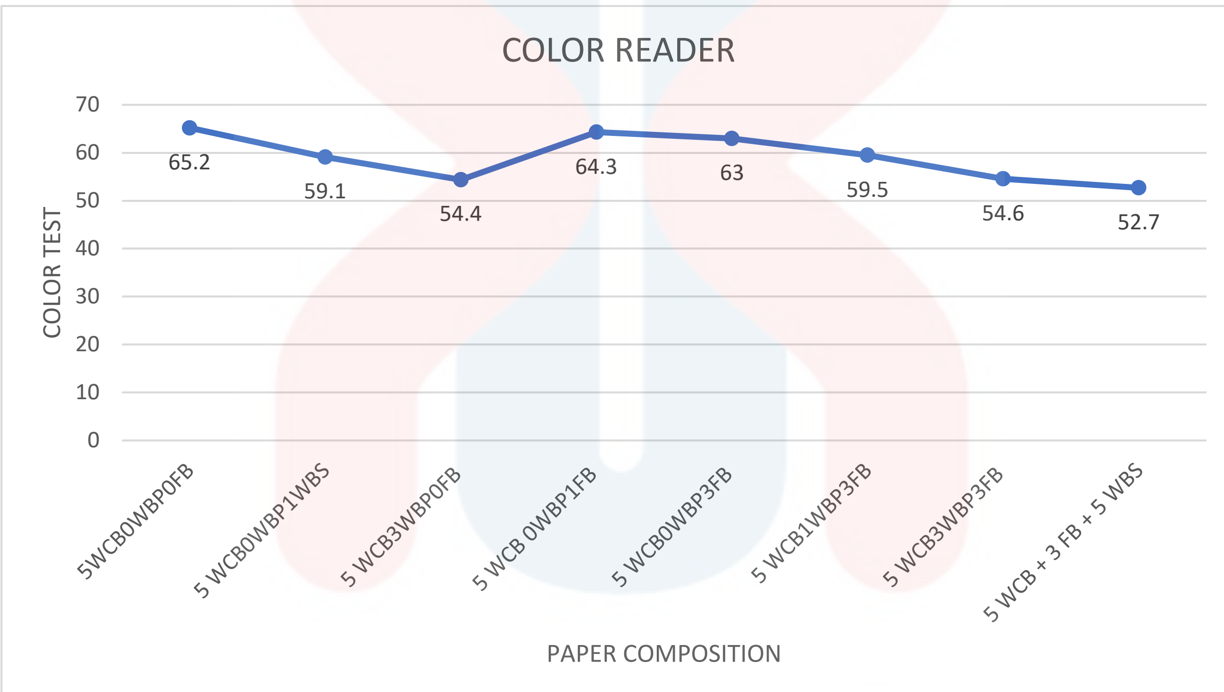


Figure 4.3.2: Color reader test graph shown.

The Color Reader data shows how the colors behave in different types of paper, which are made up of different amounts of Waste Carton Box (WCB), Fish Bone (FB), and Waste Banana Peel (WBP). With the number "5 WCB" and a Color Reader rating of 65.2, it gives you a starting point to compare against. Adding one part of Waste Banana Peel to a mix of "5 WCB + 1 WBP" makes the number drop to 59.1, which means the color is becoming lighter. When 5 parts of Waste Carton Box (WCB) and 3 parts of Waste Banana Peel (WBP) are added, the color reading drops to 54.4. This means that adding WBP makes the color softer.

When one part Fish Bone is added to the "5 WCB + 1 FB" mixture, the color number goes down to 64.3, but it stays close to the original color. When you mix 5 WCB (Waste carton box) and 3 FB (Fish Bone), you get a color reading of 63, which means there has been a small but noticeable change. "5 WCB + 1 WBP + 3 FB" is mixed with 3 parts Fish Bone. The color reading is 59.5, which means it is leaning toward a lighter hue. Putting together the 5 waste carton boxes, 3 fish bones, and 3 waste banana Peel gives a color reading of 54.6, which is lighter than the standard color. The color number of "5 WCB + 3 FB + 5 WBP" is interesting because it is the lowest possible. It is 52.7, which means it is lighter and possibly more neutral.

To sum up, the hue Reader data shows that "5 WCB + 3 FB + 5 WBP" is the best color mix for making paper when you want a lighter, more neutral color. Compared to other formulas, this one has the least amount of color strength. This makes it perfect for uses that need a lighter hue, like packing or printing materials where color consistency is very important.

4.4 Mechanical test (Tensile strength test)

4.4.1 Tensile

The tensile strength test examines paper's ability to withstand stretching or pulling forces. Within demonstration, a paper specimen is subjected to a gradually increasing force until it breaks. The applied force and resulting elongation are documented. Tensile strength is an important aspect in the paper industry since it reflects the paper's capacity to resist tearing and stretching while being handled or under normal handling and usage conditions. (Yalcin,2021).

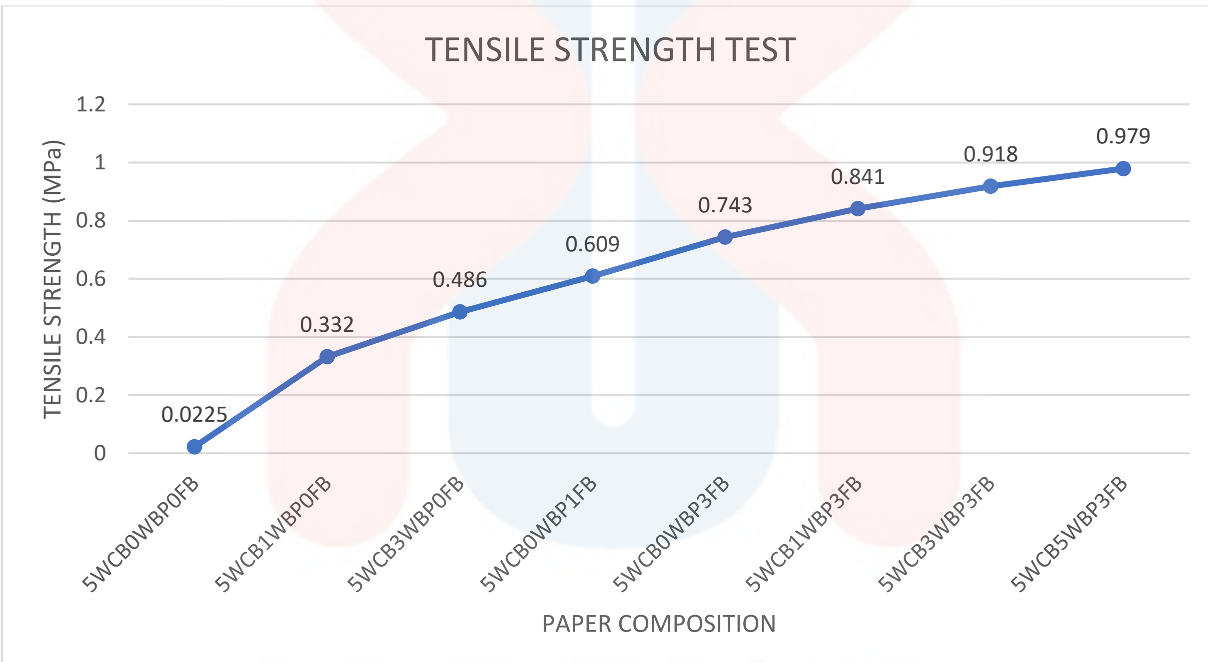


Figure 4.4.2: Tensile strength test (MPa) graph shown.

A comprehensive understanding of the mechanical characteristics of different paper compositions may be achieved by comparing the results obtained from tensile strength testing. The paper labeled "5WCB0WBP0FB" has the lowest tensile strength of 0.0225. It is composed entirely of waste carton box (WCB) without any extra components. The current composition fails to meet the required tensile strength due to inadequate reinforcement. By including Waste Carton Box (WCB), the tensile strength of "5WCB1WBP0FB" is enhanced to 0.486, while that of "5WCB3WBP0FB," which also contains WCB, rises to 0.332.

These findings suggest that the addition of WCB enhances the tensile strength of the paper, and that increasing the concentration of WCB leads to a corresponding increase in paper strength. Incorporating fish bone into the mixture enhances the tensile strength even further. The inclusion of FB has a notable impact on the mechanical characteristics, shown from the increased tensile strengths of "5WCB0WBP1FB" at 0.609 and "5WCB0WBP3FB" at 0.743. The compositions "5WCB1WBP3FB," "5WCB3WBP3FB," and "5WCB5WBP3FB" have much higher tensile strengths, measuring 0.841, 0.918, and 0.979, respectively.

These findings suggest that conducting experiments with different proportions of WCB, WBP, and FB might enhance the tensile strength. In summary, the findings of the tensile strength test suggest that the composition "5WCB5WBP3FB" yields the highest tensile strength. The ideal composition of the paper product will ultimately be decided by its unique specifications and intended uses.

4.4.3 tensile (young's modulus)

Tensile modulus measures a material's stiffness and resistance to deformation under tensile pressure. The phrase applies to an object's elastic deformation stress-strain relationship. Young's modulus measures a material's stretching or compressing reaction to a force. A greater Young's modulus indicates stiffness, whereas a lower modulus indicates flexibility. (Moebs et al., 2016)

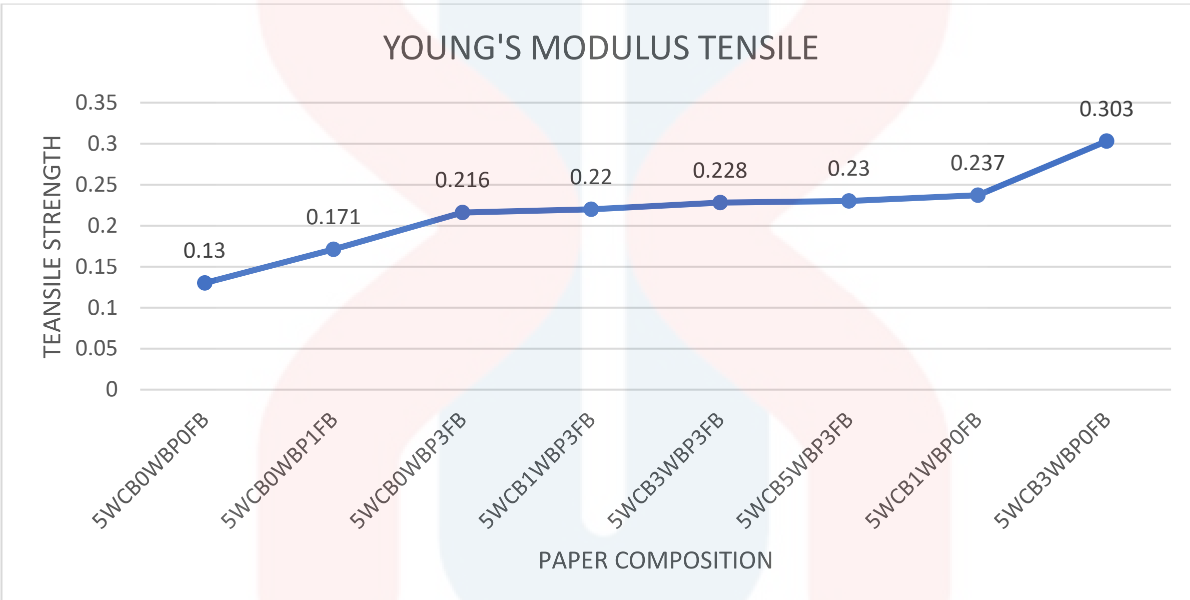


Figure 4.4.4: Tensile (young' modulus) graph shown.

An analysis of the Young's Modulus data for several paper compositions, including Waste Carton Box (WCB), Waste Banana Peel (WBP), and Fish Bone (FB), demonstrates the elasticity of each material. This document exclusively employs WCB as its only material, denoted by the initial notation "5WCB0WBP0FB." The Young's Modulus for this material is precisely 0.13. This suggests that the paper has a higher degree of flexibility and is not too stiff. The inclusion of a single FB element elevates the Young's Modulus to 0.171, as seen in the case of "5WCB0WBP1FB." With an increase in the quantity of FB, there is a corresponding rise in the Young's Modulus values, suggesting an increase in the material's rigidity and elasticity.

The compositions "5WCB1WBP3FB," "5WCB3WBP3FB," and "5WCB5WBP3FB" have comparable Young's modulus values, namely 0.22, 0.228, and 0.23, respectively. Based on these figures, the amalgamation of rigidity and flexibility improves to some extent when the WBP level rises. Conversely, the materials labeled as "5WCB1WBP0FB" and "5WCB3WBP0FB" have higher Young's modulus values, namely 0.237 and 0.303, respectively. These formulas provide more flexibility. Ultimately, the alphanumeric code "5WCB3WBP0FB," which is based on Young's Modulus data, has a propensity for elasticity. The ideal composition of the paper product will ultimately be decided by its unique specifications and intended uses.

4.5 Mechanical test (Tear test)

4.5.1 Tear test

A material's resistance to ripping forces is measured by doing the tear test for paper. This test involves tearing a standard paper sample at regular intervals using a pre-cut slit to start the rip and then measuring the effort needed to keep the tear from spreading. When evaluating the strength and durability of paper, tear resistance is very important, especially for uses where the material must remain intact after being torn. (Md. Shafiqul Islam et al., 2019)

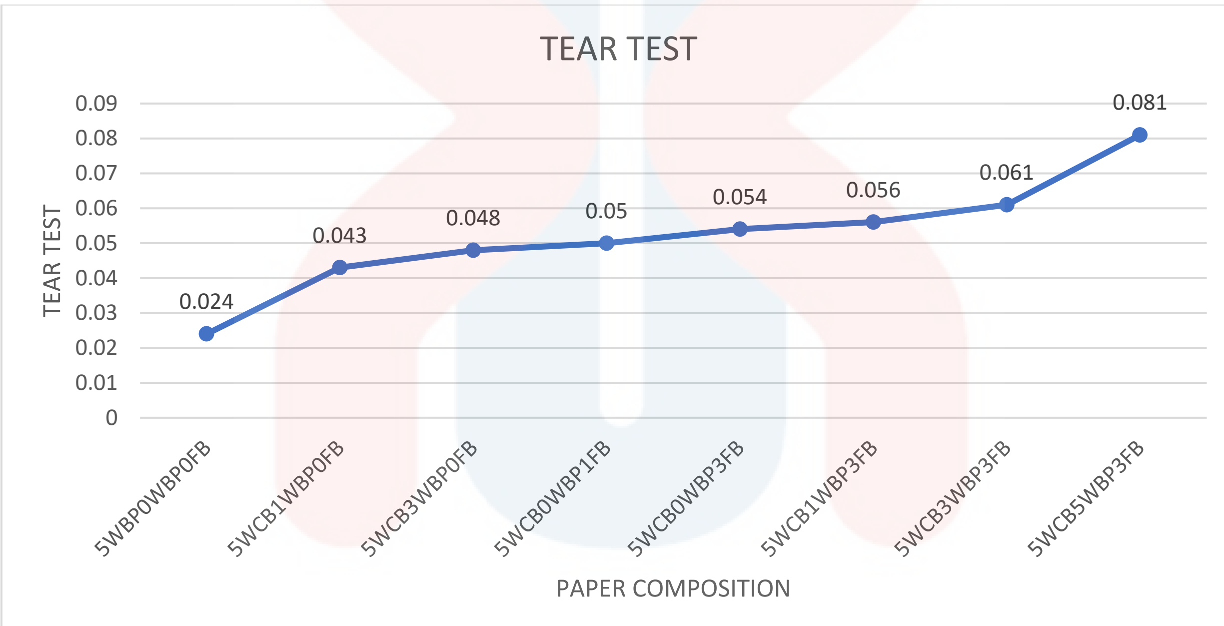


Figure 4.5.2: Tear test graph shown.

Analyzing the tear test results might provide information on the tear resistance capabilities of each paper blend. The first specimen, denoted as "5WCB0WBP0FB," comprises only of one component, namely waste carton box (WCB), and exhibits a tear test outcome of 0.024. Due to its poor tear resistance, this composition may not be the optimal selection for applications that need great tear strength.

The compositions "5WCB1WBP0FB" and "5WCB3WBP0FB" increases by 0.043 and 0.048, respectively. Consequently, it seems that WCB has a little but favorable effect on tear resistance. The tear resistance is augmented by including Waste Carton Box, Waste Banana Peel, and Fish Bone. The tear resistance is enhanced by increasing the quantity of WBP, as shown by the tear test results of "5WCB0WBP1FB" with a value of 0.05 and "5WCB0WBP3FB" with a value of 0.054.

The tear test results for compositions "5WCB1WBP3FB" and "5WCB3WBP3FB" were 0.056 and 0.061, respectively. This indicates that the inclusion of WCB, WBP, and FB further improves tear resistance. Out of all the compositions, "5WCB5WBP3FB" is notable for having the greatest tear resistance, measured at a value of 0.081. Increased quantities of WCB, WBP, and FB are linked to enhanced tear resistance.

Conclusively, the tear tests demonstrate that the composition "5WCB5WBP3FB" exhibits the highest tear resistance. The ideal composition of the paper product will ultimately be decided by its unique specifications and intended uses.

4.5.3 Tear test (young's modulus)

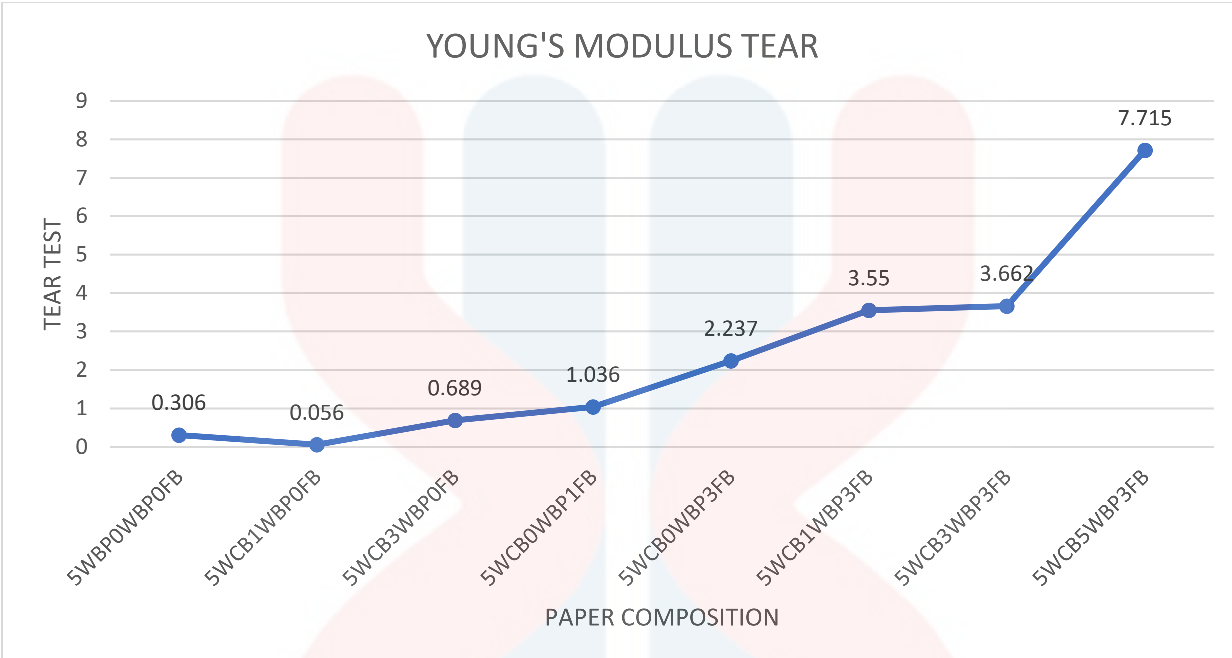


Figure 4.5.4: Tear (young's modulus) test graph shown.

Specifically, the results presented here show the effects of different ratios of Waste Carton Box (WCB), Waste Banana Peel (WBP), and Fish Bone (FB) on Young's Modulus tear resistance. The baseline performance is shown by the Young's Modulus Tear value of 0.306, which starts with the code "5WCB0WBP0FB." Adding 1 gram of Waste Banana Peel to the "5WCB1WBP0FB" material reduced the tear resistance to 0.056, which might have a detrimental effect.

The score of 0.689 for "5WCB3WBP0FB" shows that there is a significant improvement in tear resistance, which is a good thing since it is made from banana peels. With the addition of 1 gram of Fish Bone component, the tear resistance of the product "5WCB0WBP1FB" has been raised to 1.036. As an example of the positive effect of fish bone, the tear resistance of "5WCB0WBP3FB" rises dramatically at 2.237. Adding three grams of fish bone to "5WCB1WBP3FB" makes for an outstanding tear resistance rating of 3.55.

The superior tear resistance of the "5WCB3WBP3FB" product indicates a synergistic effect between the Fish Bone and Waste Banana Peel. With an outstanding tear resistance rating of 7.715, the composition "5WCB5WBP3FB" stands out for its excellent integration of all three components.

The results show that out of the four compositions tested, "5WCB5WBP3FB" has the best tear resistance, making it the clear winner for use in papermaking. Its rip resistance is significantly improved by combining scrap carton box, banana peel, and fish bone. Thus, "5WCB5WBP3FB" is ideal for uses requiring long-lasting and resistant-to-tearing paper.

CHAPTER 5

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a result, the visual, mechanical, and tactile features of paper that were manufactured from a variety of combinations of waste banana peel (WBP), waste carton box (WCB), and fish bone (FB) were discovered via the process of testing. A lighter and more neutral shade may be achieved by combining "5 WCB + 3 FB + 1WBP" according to the findings of the research, which was conducted for applications that need continual coloring. By striking a fine equilibrium amid stiffness and pliability, the mechanical qualities of "5 WCB + 3 FB + 3 WBP" are perfect for film production. This is because they are ideal for the making of films. The tear resistance test indicated that Fish Bone, specifically in its composition of "5 WCB +5WBP+ 3 FB," greatly enhances the material's resistance to tearing. As a result, Fish Bone is a perfect option for packaging and long-lasting paper products that need this quality. In the end, the manufacturing of paper from a mixture of waste carton box, fish bones, and banana skin in the appropriate proportions not only contributes to the production of paper but also demonstrates the possible uses for each component. These results lend credibility to the need to investigate strategies that might be implemented over the long run to recycle paper in a manner that is not only effective but also friendly to the environment.

5.2 RECOMMENDATION

In light of the study's choices, it is advised to go over the composition "5 grams Waste Carton Box + 3 grams Fish Bone + 1grams Waste Banana Peel " for applications needing a lighter and neutral hue with an emphasis on color constancy. This mix is notable for its optimum color properties. Moreover, for businesses that want adaptable paper characteristics, particularly in the realm of film production, it is advisable to use the blend "5grams Waste Carton Box + 3grams Fish Bone + 3grams Waste Banana Peel." This combination demonstrates a harmonic equilibrium between stiffness and flexibility. Moreover, for applications requiring strong resistance to tearing, such as packaging and long-lasting paper products, it is strongly suggested to use the composition "5grams Waste Carton Box+ 5grams Waste Banana Peel + 3grams Fish Bone". These personalized suggestions highlight the flexibility and possible uses of each mix in ecologically responsible paper making processes.

REFERENCES

1. Aly, A.-M. R., & Manal K., A.-R. (2016, april 22). *Environmental protection with sustainable products from fish bone waste*. onlinelibrary enviromental quality control. https://onlinelibrary.wiley.com/doi/abs/10.1002/tqem.21878

2. Angélica, M., Cesca, K., Poletto, P., & Débora de Oliveira. (2021). New perspectives for banana peel polysaccharides and their conversion to oligosaccharides. *Food Research International*, *149*, 110706–110706. https://doi.org/10.1016/j.foodres.2021.110706
3. Bajpai, P. (2018). *Biermann's Handbook of Pulp and Paper* (Third Edition ed., Vol. 1). https://www.sciencedirect.com/science/article/abs/pii/B9780128142400000197

4. *By Authority Of THE UNITED STATES OF AMERICA Legally Binding Document International Organization for Standardization*. (n.d.). https://law.resource.org/pub/us/cfr/ibr/004/iso.535.1991.pdf
5. *Cara Mudah Buang TuIang Ikan, Sekali Tarik Ja Semua Tulang Keluar Serentak! – Harmagidun*. (2024). Harmagidun.com. https://www.harmagidun.com/2022/04/24/cara-mudah-buang-tulang-ikan-sekali-tarik-ja-semua-tuiang-keluar-serentak/
6. Characterization of bio-polymer composite thin film based on banana ... (n.d.). https://www.researchgate.net/profile/Mohammad-Khairul-Azhar-Abdul-Razab/publication/324909032_Characterization_of_Bio-Polymer_Composite_Thin_Film_Based_on_Banana_Peel_and_Egg_Shell/links/5aeaaad80f7e9b837d3c420a/Characterization-of-Bio-Polymer-Composite-Thin-Film-Based-on-Banana-Peel-and-Egg-Shell.pdf
7. *CN102261012A - Methods for manufacturing fillers and pigments for papermaking from eggshells and resulting products - Google Patents*. (2011, April 8). Google.com. https://patents.google.com/patent/CN102261012A/en
8. Hubbe, A. M., & Gill, A. R. (2016). Fillers for papermaking. *Fillers for papermaking: A review of their properties, usage practices, and their mechanistic role*. https://bioresources.cnr.ncsu.edu/resources/fillers-for-papermaking-a-review-of-their-properties-usage-practices-and-their-mechanistic-role/

9. Krisman Umbu, Ibrahim, B., & Pipih Suptijah. (2019, April 30). *Hydroxyapatite Production from Cuttlebone as Bone Scaffold Material Preparations*. ResearchGate; Indonesian Society Fisheries Product Processing. https://www.researchgate.net/publication/332837393_Hydroxyapatite_Production_from_Cuttlebone_as_Bone_Scaffold_Material_Preparations

10. Kumar, V., Kalra, J., Verma, D., & Gupta, S. (2019, September). *Process and Environmental Benefit of Recycling of Waste Papers*. ResearchGate; unknown. https://www.researchgate.net/publication/342819787_Process_and_Environmental_Benefit_of_Recycling_of_Waste_Papers

11. Kwon, K.-C., Lim, Y.-T., Kim, N., & Park Gi-Chang. (2010). *High-Definition 3D Stereoscopic Microscope Display System for Biomedical Applications*. ResearchGate; Springer Nature. https://www.researchgate.net/publication/42386909_High-Definition_3D_Stereoscopic_Microscope_Display_System_for_Biomedical_Applications

12. Lucas, J., Lucas, P., Thierry Le Mercier, Alain Rollat, & Davenport, W. (2015). Applications of Rare Earth Luminescent Materials. *Elsevier EBooks*, 281–318. https://doi.org/10.1016/b978-0-444-62735-3.00015-2

13. Mishra, S., Prabhakar, B., Kharkar, P. S., & Pethe, A. M. (2022). Banana Peel Waste: An Emerging Cellulosic Material to Extract Nanocrystalline Cellulose. *ACS Omega*, *8*(1), 1140–1145. https://doi.org/10.1021/acsomega.2c06571

14. Naeem, M. A., Muhammad Qasim Siddiqui, Mushtaq, M., & Wei, Q. (2019, January 8). *Insitu Self-Assembly of Bacterial Cellulose on Banana Fibers Extracted from Peels*. ResearchGate; Taylor & Francis. https://www.researchgate.net/publication/330250909_Insitu_Self-Assembly_of_Bacterial_Cellulose_on_Banana_Fibers_Extracted_from_Peels

15. NIK YUSUF, N. A. A., ROSLY, E. S., MOHAMED, M., ABU BAKAR, M. B., YUSOFF, M., SULAIMAN, M. A., & AHMAD, M. I. (2015, august). *Waste Banana Peel* *and Its Potentialization in Agricultural Applications: Morphology Overview*. Materials Science Forum. https://www.researchgate.net/publication/283894172_Waste_Banana_Peel_and_Its_Potentialization_in_Agricultural_Applications_Morphology_Overview

16. Niskanen, K., Sirviö, J., & Wathén, R. (n.d.). *TENSILE STRENGTH OF PAPER REVISITED*. https://doi.org/10.15376/frc.2005.1.563

17. Norwegian Institute of Fisheries Aquaculture Research & Aquaculture Research. (2007, march). *Elsevier logo Journals & Books Go to journal home page - Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*. Chemical composition, mineral content and amino acid. https://www.sciencedirect.com/science/article/abs/pii/S1096495906004210

18. Popil, R. (2018, July 5). *Physical Testing of Paper*. Academia.edu. https://www.academia.edu/36987395/Physical_Testing_of_Paper

19. *PULP AND PAPER: BLEACHING AND THE ENVIRONMENT Australian Government Publishing Service Canberra*. (1990). https://www.pc.gov.au/__data/assets/pdf_file/0004/156712/01pulp.pdf

20. *PULP AND PAPER: BLEACHING AND THE ENVIRONMENT Australian Government Publishing Service Canberra*. (1990). https://www.pc.gov.au/__data/assets/pdf_file/0004/156712/01pulp.pdf

21. Pyar, H. (2018). Chemical Compositions of Banana Peels (Musa sapientum) Fruits cultivated in Malaysia using proximate analysis. *Research Journal of Chemistry and Environment Vol, 22*. https://worldresearchersassociations.com/SpecialIssueAugust2018/18.pdf

22. Rajan, K. (n.d.). *PREDICTING STRENGTH CHARACTERISTICS OF PAPER IN REAL TIME USING PROCESS PARAMETERS*. https://www.tappi.org/content/Events/21TAPPICon_Virtual/PC1.3.pdf

23. Rajan, K. (n.d.). *PREDICTING STRENGTH CHARACTERISTICS OF PAPER IN REAL TIME USING PROCESS PARAMETERS*. https://www.tappi.org/content/Events/21TAPPICon_Virtual/PC1.3.pdf

24. Ravi Kumar Bhatnagar, Gupta, G., & Yadav, S. (2023, January 11). *A Review on Composition and Properties of Banana Fibers*. ResearchGate; unknown. https://www.researchgate.net/publication/367023462_A_Review_on_Composition_and_Properties_of_Banana_Fibers

25. Rullifank, K. F., Roefinal, M. E., M Kostanti, L Sartika, & Evelyn. (2020). *Pulp and paper industry: An overview on pulping technologies, factors, and challenges*. *845*(1), 012005–012005. https://doi.org/10.1088/1757-899x/845/1/012005

26. S, W. A. E., & .H, E. S. V. (2018). *Natural wrapping paper from banana (Musa paradisiaca Linn) peel waste with additive essential oils*. Natural wrapping paper from banana. https://iopscience.iop.org/article/10.1088/1742-6596/1022/1/012032

27. Smith, J., Brown, A., & Jones, M. (2020). Packaging Innovation in the 21st Century. *Journal of Packaging Technology and Research, 4*(1), 45-58. https://doi.org/10.1007/s41783-019-00096-4

28. *Stereo Microscopy the Stereo Microscope*. (n.d.). http://www.microscopy-uk.org.uk/mag/artjun12/jk-stereo1.pdf

29. Szewczyk, W., Marynowski, K., & Tarnawski, W. (2006). *An Analysis of Young's Modulus Distribution in the Paper Plane*. *14*(4). http://www.fibtex.lodz.pl/58_22_91.pdf

30. Toppe, J., Sissel Albrektsen, Hope, B., & Anders Aksnes. (2007). *Chemical composition, mineral content and amino acid and lipid profiles in bones from various fish species*. *146*(3), 395–401. https://doi.org/10.1016/j.cbpb.2006.11.020

31. University of Wisconsin–Stevens Point, Stevens Point, WI, USA & Ring, G. J. F. (2004). *PAPERMAKING*. 720 PAPERMAKING /Paper Grades. https://enviro2.doe.gov.my/ekmc/wp-content/uploads/2016/08/1384850954-3-s2.0-B012145160700137X-main.pdf

32. Vijayakumar Pujar, R.M. Devarajaiah, Bheemappa Suresha, & Bharat, V. (2021). *A review on mechanical and wear properties of fiber-reinforced thermoset composites with* *ceramic and lubricating fillers*. *46*, 7701–7710. https://doi.org/10.1016/j.matpr.2021.02.214

33. Wahab, G. M. A. (2018, December). *Egyptian Journal of Petroleum*. Characterizations of El Minia limestone for manufacturing paper filler and coating. https://www.sciencedirect.com/science/article/pii/S1110062116301611?ref=cra_js_challenge&fr=RR-1

34. WULI BAO, MALLEY, D. M. O., & SEDEROFF, R. R. (1992). *Wood contains a cell-wall structural protein*. Wood contains a cell-wall structural protein. https://www.pnas.org/doi/pdf/10.1073/pnas.89.14.6604

35. Yadav, A., Kumari, R., Yadav, A., & Kumar, R. (2016, December). *Utilization for by products of banana -A Review*. ResearchGate; unknown. https://www.researchgate.net/publication/356593469_Utilization_for_by_products_of_banana_-A_Review

36. Yalcin, D. (2021, May 7). *Tensile Testing Concepts & Definitions*. ResearchGate; unknown. https://www.researchgate.net/publication/351392014_Tensile_Testing_Concepts_Definitions

37. Zaini, A. U. b., Rohaizad, Muhammad, M. A. R. b., Jasni, A. M. b., & Theis, N. A. B. (2021). *Paper from Banana Peels*. Wonder Tree: Paper from Banana Peels. https://oarep.usim.edu.my/jspui/handle/123456789/15677