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DESIGN AND DEVELOPMENT OF SUSTAINABLE TRAVEL NECK PILLOW WITH DETACHABLE MEDICATED PATCH FOR CERVICAL PAIN

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ABSTRACT

Extensive trips on vacation can end up leaving you with neck pain and muscle tightness. This can result in slouching or falling asleep in obstinate positions, which can cause your spine to lose its natural curve and your head to fall towards your chest. All this can lead to back, shoulder, and neck pain. The neck pillow occipital curve design relieves up to 65% pressure from the neck and also maintains the neck's physiological condition. In this study, the neck pillow is designed with standard measures and developed using sustainable natural fibers (cotton and kapok) and fabric (bamboo knitted). Additionally, the medicated herbal patch is used to reduce the cervical pain that comes during the travel period. Datura Metel leaves and seeds are traditional herbal painkillers used for neck pain. Azadirachta indica and Curcuma longa composite dyes were used for the accessory finishing. Kapok fiber and cotton fiber are used as fillers in the neck pillow. It offers excellent support and comfort, which can help alleviate neck pain. Bamboo-knitted fabric is used as the outer layer of the neck pillow. It has good sweat-absorbing ability and a soft texture. Cotton-spun lace nonwoven fabric is used as the outer patch layer, filled with herbal powder and finished with extracted herbal oil. Cotton-spun lace nonwoven fabric is kind to the skin and feels soft with good absorption. The standard tests were obtained for antimicrobial efficacy, FTIR, and liquid/oil absorption. The results obtained are good and have met the needs for product manufacturing.

KEYWORDS: *Datura Metel* Leaves powder, *Datura Metel* seeds with Mustard oil, Cotton and Kapok Fibre, bamboo Knitted fabric, and Spun lace nonwoven textile material.

1. INTRODUCTION

Cotton is a natural cellulosic fiber and the most widespread among all the textile fibers. About 48% of cotton fiber is consumed as clothing material in the apparel industry for a number of its unique characteristics, such as softness, versatility, absorbance, hydrophilic nature, comfort permeability, biodegradability, no static electricity, and breathability. [1]

Neck pillows' core filling is made of cotton and kapok fiber. The seeds of kapok trees (Ceiba pentandra) are encased in a silky fiber called kapok, which has a silk-like sheen and a yellowish or light-brown tint. While cotton fiber is lignified and not affixed to the seed grains, kapok fiber is made up of single-celled plant hairs.

The major constituents of kapok fiber, an organic seed fiber that is highly lignified, are cellulose, lignin, and xylan.[2]. According to several accounts, kapok fiber has a distinct chemical makeup. According to one study [3], the chemical composition of kapok fiber was 64% cellulose, 13% lignin, and 23% pentosan on a weight basis. However, another study discovered that kapok fiber was made up of 35% cellulose,21.5% lignin, and 22% xylan, with a high ratio. [4]

Bamboo Knit Fabric is naturally bacteria and odor-resistant and is a practical yet eco-friendly choice. True to a natural fiber, bamboo knits are previously absorbent and breathable. The strong point of bamboo adds to the durability of the fabric and is found to work well for those who are allergic to other natural fibers. This ability to stretch by stitch rearrangement adds to the comfort of wearing garments, which, among other factors, is affected by properties such as extensibility, air permeability, and heat insulation of garments made from knit fabrics. The knitted loops leave the needles, the spacing of courses and wales decreases, and the fabric shrinks in both directions, thus affecting the properties of knitted fabric [5]. A U-shaped travel neck pillow is a type of pillow that is designed to support the head and neck while traveling. It is usually made of memory foam or other soft materials and has a curved shape that fits around the neck. A travel neck pillow is a pillow which is intended to create support for the head and neck while someone is traveling. In addition to reducing the risk of injury, these pillows can also increase comfort and safety [6].

Nonwovens (spunlace) are extensively used in the medical field and in protection against biological agents in other sectors. Nonwoven materials with improved finishes such as liquid repellent, virus-proofing, and bacterial resistance [7]. This process does not use any chemicals or binders, making the fabric safe, natural, and eco-friendly. Cotton spun lace nonwoven fabric Kind to the skin and feels soft. Spun lace non-woven fabric is used in the preparation of the patch for the absorption of oil.

Datura stramonium (DS) is an annual plant belonging to the family *Solanaceae*. *Datura stramonium* is a foul-smelling, erect, free-branched herb that forms a bush up to 2–5 feet tall [8]. *Datura Metel* reduces pain and inflammation. Due to its strong pain-relieving and anti-inflammatory effects, Datura is extensively used to provide relief in cases of painful conditions like arthritis, muscle spasms, etc [9]. *Datura Metel* leaves and seeds are herbal painkillers for neck pain. It is used to prepare herbal oil using datura seeds.

Mustard oil, used as a traditional edible oil in most parts of India for centuries, is well known for its medicinal properties. *Mustard oil* is rich in monounsaturated fatty acids, which could mean that it benefits cardiovascular health (blood vessels). It also contains a compound that may have anti-inflammatory properties [10].

The medicinal utilities have been described, especially for neem leaf [11]. Neem leaf and its constituents have been confirmed to exhibit immunomodulatory, anti-inflammatory, antihyperglycemic, antiulcer, antimalarial, antifungal, antibacterial, antiviral, antioxidant, antimutagenic, and anticarcinogenic properties. Turmeric is a perennial herbaceous plant that reaches up to 1 m (3 ft 3 in) tall [12]. Highly branched, yellow-to-orange, cylindrical, aromatic rhizomes are found. Turmeric powder is about 60–70% carbohydrates, 6–13% water, 6-8% protein, 5–10% fat, 3-7% dietary minerals, 3-7% essential oils, 2-7% dietary fiber, and 1-6% curcuminoids. Turmeric possesses several biological activities, including anti-inflammatory, antioxidant, anticancer, antimutagenic, antimicrobial, antiobesity, hypolipidemic, cardioprotective, and neuroprotective effects [13]. The natural neem and tumeric dyes are applied to the patch belt for anti-microbial properties.

2.MATERIAL AND METHODS

2.1 Selection and Collection of Plant Fibres

2.1.1 Cotton Fiber

The soft, fluffy staple fiber known as cotton develops around the seeds of Gossypium cotton plants, which belong to the *Malvaceae* family of mallow plants, in a protective shell known as a boll. The fiber is nearly entirely composed of cellulose, with trace amounts of waxes, lipids, pectin's, and water. Pillows made of organic cotton provide outstanding comfort and support, which can help reduce neck pain. By moulding to the shape of your head and neck, the natural fibers support healthy spinal alignment and lessen pain. The location of cotton fiber is in the Ganeshapuram neighbourhood of Coimbatore.

Fig 1: Cotton fibre

2.1.2 Kapok Fiber

The fruits of the kapok tree are the source of renewable grain fiber known as kapok fiber. It is extremely hydrophobic, light in bulk, fluffy, and brilliant yellowish-brown in color. Because kapok pillows are bouncy and breathe well, they provide your head with superb, flexible support. Everyone will like sleeping on this kind of pillow because it is firm yet still comfortable. The Ganeshapuram neighbourhood of Coimbatore is home to the kapok fiber locality.

Fig 2: Kapok fibre

2.2 Selection and Collection of fabrics

2.2.1 Natural bamboo knitted fabric

Made by knitting fibers obtained from bamboo pulp, bamboo knit fabric is a supple, breathable, and environmentally responsible textile. Its exceptional absorbency, inherent shine, and hypoallergenic qualities, which guarantee comfort and style in every thread, are its distinctive features. Soft, flowy summer dresses that scream comfort, breathable sportswear, and cozy undergarments may all be made with bamboo knit fabric. The bamboo knit fabric is procured from the Tiruppur district of Tamil Nadu.

Fig 3: Bamboo knitted fabric

2.2.2 Nonwoven spun lace

Nonwoven spun lace is a type of fabric that is made by entangling fibers together using high-pressure water jets. It is also known as spunlacing or hydroentangling. Nonwoven spun lace has many advantages, such as high strength and durability, good absorbency and softness, high porosity and permeability, no adhesives or chemicals required, and low production costs and energy consumption.

Fig 4: Nonwoven spun lace fabric

2.3 Selection and Collection of herbs

2.3.1 *Datura Metel* leaves powder and seeds

Datura stramonium, known by the common names thorn apple, jimsonweed (jimson weed), devil's snare, or devil's trumpet, is a poisonous flowering plant of the nightshade family *Solanaceae*. It is a species belonging to the Datura genus and Datura tribe. Its likely origin was in Central America, and it has been introduced in many world regions. It is an aggressive invasive weed in temperate climates and tropical climates across the world. *D. stramonium* has frequently been employed in traditional medicine to treat a variety of ailments.

Due to Datura's potent anti-inflammatory and pain-relieving properties, it is frequently used to treat painful illnesses like arthritis and muscle spasms. The leaves and seeds of *Datura Metel* are herbal remedy for neck pain. Datura plant was collected from the locality of Coimbatore district in Tamil Nadu.

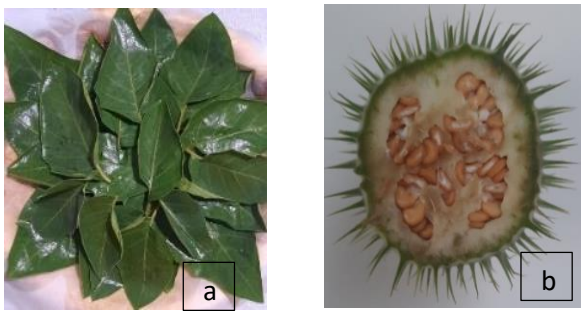

Fig 5: (a)*Datura Metel* leaves and (b)Datura Metel seeds

2.4 Selection and Collection of Natural oil

2.4.1 Mustard oil

Due to its high selenium and magnesium content, mustard oil has anti-inflammatory qualities. It also aids in lowering body temperature and energizing sweat glands. It is used in conventional medicine to treat strains, sprains, and arthritis-related discomfort.

Fig 6: Mustard oil

2.5 Selection and Collection of Fragrance oil

2.5.1 Jasmine Fragance

Jasmine fragrance oil is a heady, fragrant jasmine type. It is said to be an aphrodisiac and has a strong, feminine floral scent. It was highly used for the treatment as by aroma theraphy. It was procured from the locality of town hall of Coimbatore, in Tamil Nadu.

Fig 7: Jasmine fragrance

2.6 Design and Development of the product

2.6.1 Processing of Herbal components

The materials are datura metel leaves, datura metel seeds, and mustard oil. First, datura metel leaves and datura metel seeds are picked, and then the leaves and seeds are washed in normal water to remove mud and other dust particles. Then the leaves are kept on the plate for the drying process. Datura metel leaves should be dried for 15 days. Then the leaves are collected in the container for grinding as a powder. The leaf powder is sieved, and the datura metel leaf powder is stored in a container for the following process: Then the datura metel seeds and mustard oil are used to make an effective oil. In the process of making effective oil, first the oil should be pre-heated well, and then the datura metel seeds are added to the mustard oil and boiled well. Then the oil is extracted with the datura metel seeds, and then the effective oil is ready.

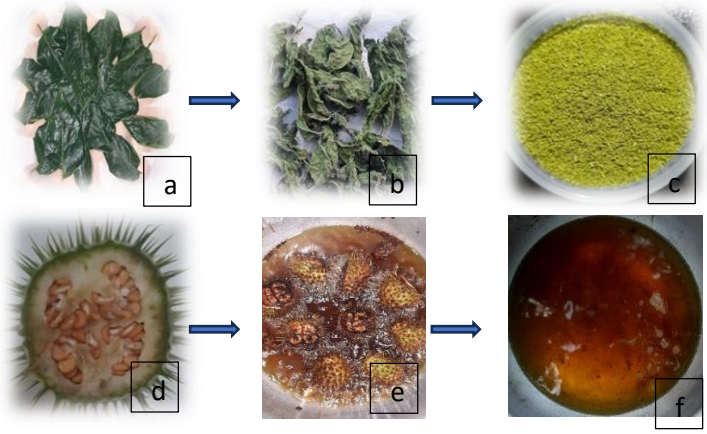

Fig 8: *Datura Metel* leaves and Datura Metel seeds

a. *Datura Metel* leaves
b. Dried *Datura Metel* leaves
c. *Datura Metel* leaves powder
d. *Datura Metel* seeds
e. *Datura Metel* seeds and Mustard oil
f. The oil extraction

2.6.2 Patch Layer process

In this process, the outer layer of the patch is made of nonwoven spun lace, and the inner layer is stuffed with datura metel leaf powder. Then the effective herbal oil is used in the form of the padding mangle method. Then the herbal patch is used in the padding mangle method for neck pain. The herbal patch is attached to the belt, and it can be attached to a travel neck pillow. The herbal patch can be used three to four times by applying the mangle method to the patch. The belt can be washed after using herbal patch. Natural dye is applied to the belt by using neem leaf extraction and turmeric powder. Neem leaf and turmeric powder have anti-inflammatory and anti-microbial properties. In the process of making natural dye, the neem leaf extract and turmeric powder are boiled by adding salt. After boiling, the fabric is socked into the natural dye. It should be socked for 2 hours and then washed in normal water. then dry the fabric in the shadow. then the fabric is patterned to stitch as a belt. The natural dye
belt can be washed up to five times.

Fig 9: Herbal patch, oil, and Patch belt

2.6.3 Neck pillow Pattern, Cutting, Stitching and process

- The length of the pillow is 27 inches.
- The width of the pillow is 9 inches.
- The length of the patch is 5 inches and the width of the patch is 3 inches.
- Then, next is to cut the pattern in the fabric.
- Accessories needed for stitching neck pillow are fabric, foam, and velcro.
- Stitching process is overlock stitching.
- The outer layer of the neck pillow is bamboo knitted fabric and the inner layer of the neck pillow is poplin fabric and Cotton fiber and kapok fiber are the core layer of the travel neck pillow.
- Then next is to stuff the cotton fiber and kapok fiber into neck pillow cover and the belt is stitched in the sewing machine.
- The travel neck pillow and patch belt is ready.

Fig 10: Pattern layout

Fig 11: U-shaped travel neck pillow

2.6.4 Finishing

Padding mangle method is done to the herbal medicated patch.

2.6.5 Final Product

Fig 12: Final product: Travel neck pillow with herbal patch

2.6.6 Cost of the product

S.No	Particulars	Cost per pillow and patch (Research Purpose)	Cost of 1 Unit (100 nos.) for commercial production
1.	Cost of the fabric	Rs.500	Rs.750
2.	Cost of the herb	Rs.300	Rs.450
3.	Cost of the finish	Rs.1000	Rs.1500
4.	Cost of the stitching	Rs.500	Rs.1000
	TOTAL	Rs.2300	Rs.3700

3. TESTING

3.1 FTIR Test

Evaluation of Herbal finished Fabrics for FTIR

Fourier-transform infrared spectroscopy is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid, or gas. An FTIR spectrometer simultaneously collects high-resolution spectral data over a wide spectral range. FTIR can be used to identify the presence and number of herbal extracts on fabrics, as well as the functional groups and bonds that are involved in the coating process.

3.2 Antimicrobial Test

Preparation of the Bacterial Inoculum

Stock cultures were maintained at 4° C on slopes of nutrient agar and potato dextrose agar. Active culture for experiments were prepared by transferring a loop full of cells from stock cultures to test tubes of 50ml nutrient broth bacterial cultures were incubated with agitation for 24hours and at 37°c on shaking incubator and fungal cultures were incubated at 27°c for 3-5 days. Each suspension of test organism was subsequently stroke out on nutrient agar media and potato dextrose agar. Bacterial cultures then incubated at 37°c for 24 hours and fungal incubated at 27°c for 3-5 days. A single colony was transferred to nutrient agar media slants were incubated at 37°c for 24 hours and potato dextrose slant were incubated at 27°c for 3-5 days. These stock

cultures were kept at 4°c. For use in experiments, a loop of each test organism was transferred into 50ml nutrient broth and incubated separately at 37°c for 18-20 hours for bacterial culture.

Well Diffusion Method

The antibacterial activity and antifungal activity of crude extract extracts was determined by Well Diffusion method (Bauer *et al*., 1996). The 2-20µl of Nanoparticle extract was poured into the wells. After that, the plates were incubated at 37°C for 24 hours. Assay was carried into triplicates and control plates were also maintained. Zone of inhibition was measured from the edge of the well to the zone in mm. The tested cell suspension was spread on muller Hinton agar plate and potato dextrose agar. Well, were put into the agar medium using sterile forceps. plant extract was poured on to wells. Then plates were incubated at 37°c for about 24 hours and control was also maintained. Zone of inhibition was measured from the clear zone in mm. Antibacterial activity was performed by agar diffusion method. (Van der Watt *et al.,* 2001). The stock culture of bacteria *(E. coli and Streptococcus)* was received by inoculating in nutrient broth media and grown at 37 % for 18 hours. The agar plates of the above media were prepared.

Each plate was inoculated with 18 hours old cultures the bacteria were swab in the sterile plates. Cut the 5 wells Pour the extract in ratio 25 µl, 50 µl 75 µl 100 µl. All the plates were incubated at 37ºC for 24 hours and the diameter of inhibition zone was noted in Cm. Agar well diffusion method has been used to determine the antimicrobial activities and minimum inhibitory concentrations or plant extracts against Gram-positive, Gram-negative bacteria. The extracts exhibited antibacterial activities against tested microorganisms.

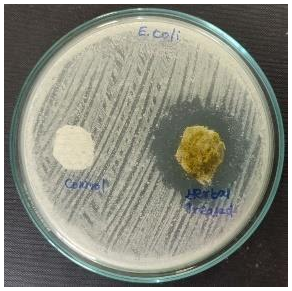

Plate 1: E. coli

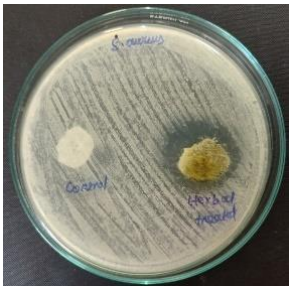

Plate 2: Staphylococcus aureus

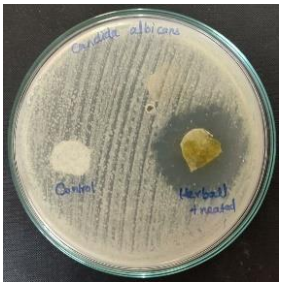

Plate 3: Candida albicans

3.3 Absorption Test (Vertical Wicking method)

An adsorption test is a method of measuring the amount of a substance that adheres to the surface of another substance. It can be used to evaluate the liquid absorption performance of herbal patches and spun lace nonwoven fabrics in terms of skin compatibility, and stability. There are different types of adsorption tests, such as static adsorption, dynamic adsorption, and desorption tests. They can be performed using various instruments, such as gravimetric analysers, spectrophotometers, chromatographs, or mass spectrometers.

Vertical wicking is a method of measuring the ability of a fabric to transport liquid moisture vertically along its surface. It is often used to evaluate the performance of fabrics that are designed to absorb and dissipate sweat, such as sportswear, diapers, or medical textiles. The vertical wicking stand can be based on different principles, such as capacitance, resistance, or optical sensors According to AATCC 1971, one of the standard methods for vertical wicking, the bottom of the fabric specimen is submerged in water and the wicking distance

is recorded at specified time intervals. The higher the wicking distance at the same interval, the better the fabric is in wicking.

Procedure of wicking test

Some factors that affect the adsorption behaviour of herbal patches and spun lace nonwoven fabrics are the type and concentration of the herb, the pH and temperature of the solution, the surface area and porosity of the fabric, and the contact time and pressure between the patch and the fabric. The vertical wicking test is a method to measure the ability of a fabric to transport liquid water, and the process is done on the herbal patch and the nonwoven spunlace fabric.

1. Cut a strip of fabric that is 1 inch wide and 12 inches long of herbal patch and nonwoven spun lace fabric.
2. Two 60-ml beakers are taken, and the beakers are filled with 60 ml of distilled water.
3. The vertical wicking stand is a device that is used to measure the vertical wicking behaviour of fabrics.
4. It consists of a stand that holds the fabric strip vertically and a dish that contains the liquid.
5. The bottom of the fabric strip is dipped into the liquid, and the height of the liquid rise along the fabric is recorded at different time intervals.
6. Measure the height to which the water was transported along the strip at intervals of 1, 5, and 10 minutes. Report the results in centimetres (cm). Higher wicking values indicate greater capability for transporting liquid water

Fig 13: Wicking test

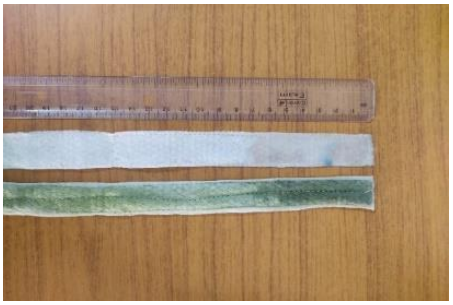

Fig 14: Wicking measurement

4. RESULT AND DISCUSSION

4.1 FTIR

The FTIR spectroscopic analysis were taken for herbal spunlace patch to find its phenolic components.

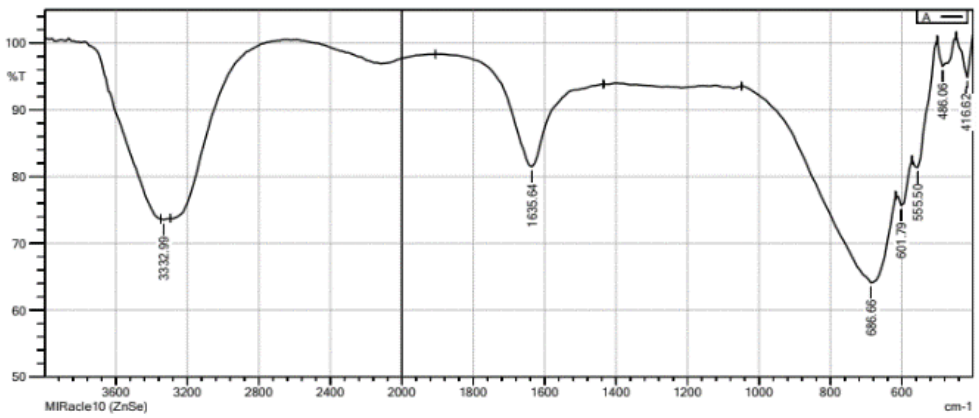

Fig 15: FTIR READING

Table 1

S.NO	PEAK READINGS	CHEMICAL COMPONENTS
1.	3332.99	O-H stretching Vibration presence of alcohols, phenols
2.	1635.64	-C=C-stretching Vibration presence of alkenes
3.	686.66	-C (triple bond) C-H:C-H bend stretching vibration presence of alkynes

Table 1: FTIR activity

The FTIR test shows seven different peaks. In this active peak is 3332.99 which determines the O-H stretching vibration ensures the presence of alcohols and phenols. The peak 1635.64 obtains C=C-stretching Vibration confirms the presence of alkenes. The peak 686.66 obtains -C (triple bond) C-H:C-H bend stretching vibration confirms presence of alkynes, and further peak are 601.79, 555.50, 486.06 and 416.62.

4.2 Evaluation of Antimicrobial Efficacy

The antimicrobial test for developed herbal patch and nonwoven spunlace fabric is to evaluate the ability of these products to prevent or reduce the growth of microorganisms like bacteria and Fungus that may cause infection, spoilage, or deterioration.

Table 2: Evaluation of Antimicrobial activity

Organisms Concentration	E.Coli	S.aureus	Candida albicans
Control	No zone	No zone	No zone
Treated	1 cm	0.9 cm	1.1 cm

In the above shown table 2 *E. coli* pertain best result as 1cm zone of inhibition when compared to *Staphylococcus aureus* as 0.9cm as well as fungal *Candida albicans* pertains good result as zone 1.1cm.

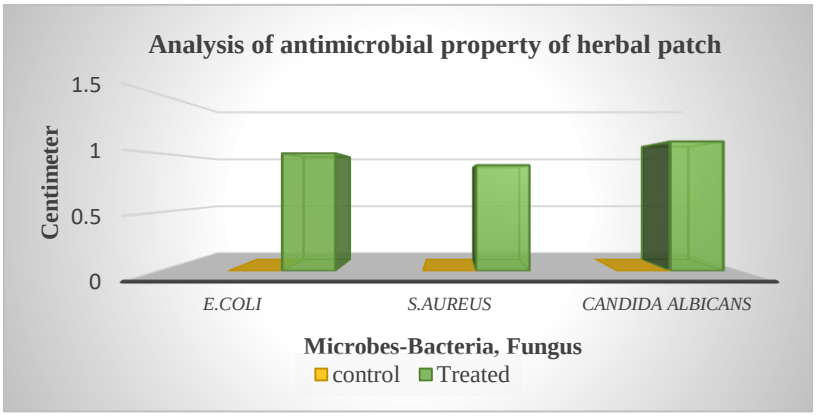

Fig 16: Graphical representation of antimicrobial activity

The give specimen having higher antimicrobial activity against to the *E. Coli*, *S. aureus ad Candida albicans* when compare with untreated fabric.

4.3 Absorption Test (Vertical Wicking method)

The vertical wicking test is a method used to measure the absorption capacity of a material. The test involves applying a known amount of the substance to the surface of the material and measuring the amount of the substance that remains on the surface after a specified period of time.

Table 3: Absorption activity

Time	5 minutes	10 minutes	15 minutes	20 minutes
Control	4.5 cm	5.2 cm	6.1 cm	7.5 cm
Herbal treated	3.5 cm	4.1 cm	4.8 cm	5.5 cm

In the above-shown table 3, control shows 4.5 cm, 5.2 cm, 6.1 cm, and 7.5 cm, and herbal treatment shows 3.5 cm, 4.1cm, 4.8 cm, and 5.5cm. Control shows higher absorbency than herbal treatment.

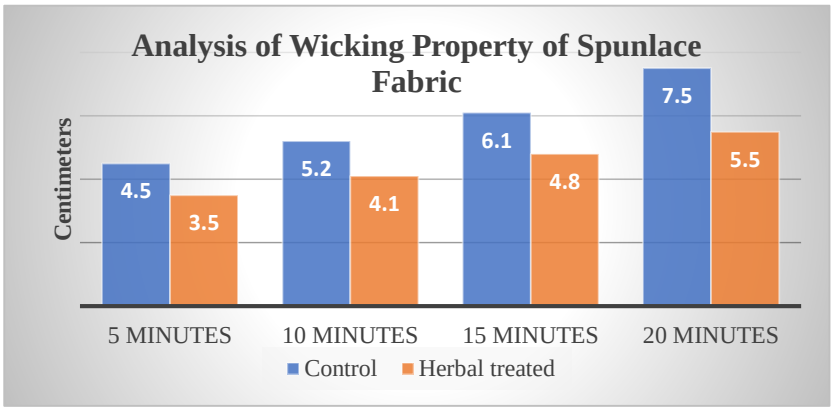

Fig 17: Graphical representation of absorption activity

The given specimen has high absorption properties in control and herbal-treated fabric. The herbal-treated fabric has lower absorption than the control because of the herbal ingredient.

5.CONCLUSION

Datura Metel is a plant that has various medicinal and toxic properties. The leaves of Datura Metel are used in traditional medicine for treating various ailments, such as asthma, fever, wounds, ulcers, and skin diseases. Mustard oil is a versatile and beneficial oil that can be used for various purposes. The stimulation also requires for the excretory system to regulate normal body functions. Thus, the travel neck pillow and medicated herbal patch is produced by using Datura Metel leaves and datura seed with mustard oil. The travel neck pillow is produced by using bamboo knitted fabric and stuffings are kapok fibre and cotton fibre. A travel neck pillow is a useful accessory that can make your journey more comfortable and enjoyable. Whether you are traveling by plane, train, car, or bus, a travel neck pillow can support your neck and head, prevent stiffness, and pain, and help you fall asleep easier. The FTIR, Antimicrobial efficacy, and Vertical wicking testing are done, and the results are positive.

Future Scope

The Datura metel leaf powder is used for dandruff hair oil, asthma medicine etc. Mustard oil with garlic and turmeric is used for rheumatism and joint pains. Mustard oil can also use as a mosquito repellent. The high amount of alpha-linolenic acid present in mustard oil helps to regulator the high cholesterol level and heart disease. Mustard oil contains alpha fatty acids that keep our hair hydrated, lively and help them to grow faster. The herbal patch can be used for joint pain and muscular pain. It can be implemented in medical textiles for muscular pain. The cotton and kapok fiber can be used as pillow fillers.

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