Mechanical Absorption of Sugarcane *(Saccharum officinarum)* Bagasse as Wound Dressing Alternatives

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ABSTRACT

Hospitals and clinics create a significant amount of medical waste, particularly from supplies such as wound dressings, contributing to environmental pollution. Considering that these supplies are composed of non-biodegradable materials, their prevalence in healthcare is a growing concern. Addressing this, one promising alternative is through plant materials such as sugarcane *(Saccharum officinarum)*. However, minimal research and findings regarding sugarcane's potential for mechanical absorption and its extraction process are available. Moreover, research focusing on the local setting, particularly in Region 11, remains lacking. With this, the study aims to determine whether sugarcane bagasse can work as a wound dressing alternative by forming sample sheets as a platform to place water droplets. The researchers used three different samples: pure sugarcane bagasse, sugarcane bagasse cured with polyester resin, and a commercial brand X. Using the AATCC Test Method 79, the level of absorbency and absorption rate was determined within these samples. The results indicated that pure sugarcane bagasse exhibited high levels of absorbency and absorbency rate, exhibiting similar results to Brand X. This key finding implies that sugarcane, in its pure form, has the potential to serve as an alternative material for gauze pads available in the market due to its absorption rate and level of absorbency. Hence, future research may further explore sugarcane bagasse as a viable material in the medical industry.

Keywords: sugarcane bagasse, gauze pad, polyester resin, quantitative, descriptive-developmental, Philippines

INTRODUCTION

Background of the Study

Finding alternatives to basic first aid supplies highlights the importance of investing in primary care, thereby reducing the harm an individual may experience due to insufficient first aid and disparities in accessibility (Naria-Maritana et al., 2020). Wound dressings play a pivotal role in improving the overall treatment of patients and reducing treatment costs, thus their prevalence and use over the years (Britto et al., 2024). However, assessing the state of first aid in the post-pandemic era based on an analysis from Feng et al. (2024), the resulting increase in the demand for first aid products raises current issues in accessibility and affordability, as not many people are willing to afford them due to deficiencies in structure, function, and material insufficiency to produce such supplies. Despite their communal need today, disaster responsiveness remains affected by the lack of accessible wound dressings at home or the workplace (Al Hasan et al., 2020). Thus, this perspective mandates an initiative for innovations that use accessible resources for replicable and effective wound dressings.

To emphasize, a cross-sectional study conducted by Ge et al. (2022) examining 9,344 residents in Central and Western China revealed that only less than a quarter, specifically 2,156 of them, have a first aid kit prepared at

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home, meaning there is significantly less access to materials and supplies to treat home-based injuries in these areas. Likewise, the United States Census Bureau's Household Pulse Survey (HPS) highlights the drastic number of about 38.8 million Americans who lack treatment supplies due to shortages of supplies, afflicting their mental and physical health during emergencies (Beleche & Kolbe, 2024). Similarly, an adopted descriptive cross-sectional research by Ogundeji et al. (2023) studying the families of patients in three hospitals in Nigeria found that wound dressing and care is too expensive for an average family of five to ten members, since over 50% of the respondents earn less than the usual middle-class salary of 50,000 Nigerian Nairas (₦50,000) per month, compared to the dressing's cost estimated to be between 9,000 to 27,000 Nigerian Nairas (₦9,000 - ₦27,000) per piece, creating a stark difference for the capacity and affordability to the family.

In Ilocos Norte, Philippines, a study by Castro et al. (2024) shows that non-healing chronic wounds caused by the inaccessibility and inability of the family to afford wound dressings have caused a significant mortality rate, often prevalent in between 1.51 and 2.21 cases per 1,000 individuals. These findings highlight the need for accessible, affordable, and effective wound care products, as specified by the Statista Market Forecast (2024), wherein the Philippines' aging population and a growing number of chronic disease cases are increasing the demand for wound care products by 0.91%, leading to requests from consumers for more developed, user-friendly, and reasonably priced wound care solutions. However, using available, organic materials may address the growing number of inaccessible first aid products, as a study conducted in Manila by Suarez et al. (2024) stated that gauze pads made out of coconut fibers exhibit antimicrobial activity in 50% to 30% of the extracts, confirming that wound dressings are essential for protecting wounds and helping the healing process.

In Mindanao, Pelone and Arellano (2024) found that the residents of Tagum City did not possess a first aid kit due to financial limitations despite recognizing their importance, which confirms that not all can afford first aid. Similarly, a study of 50 respondents in Monkayo, Davao De Oro by Manucang and Caina (2024) showed that most people are equipped with first aid; however, they highlighted how the lack of first aid impacts the safety of the farmers. In connection with this, it is possible to utilize natural and organic resources to produce alternatives, such as sugarcane, a plant that belongs to a grass family called Poaceae, known for its bioactive properties, which is used by the Mamanwa tribe of Surigao del Norte and Agusan del Norte as an ethnomedicine (Nuneza et al., 2021). Moreover, this is supported by Madjos et al. (2021), who reviewed sugarcane and determined that it contains anti-inflammatory, analgesic, anti-hyperglycemic, diuretic, and hepato-protective properties and is used as folkloric medicine for hepatitis and diabetes in the Zamboanga peninsula.

This study proposes to address these issues by exploring sugarcane bagasse as a potential alternative for wound dressing materials. Sugarcane, known scientifically as Saccharum officinarum, is a prevalent crop in Region 11 that produces tons of industrial waste that could be utilized as a viable solution to its waste (Ramirez et al., 2020). Its processed fibers, known as sugarcane bagasse, are hydrophilic and can undergo multiple modifications, hence its potential as a versatile application material (Mahmud et al., 2021). Consequently, Ramphul et al. (2020) investigated cellulose-based derivations from sugarcane bagasse, which confirmed their potential as scaffolds in tissue engineering, such as tissue repair, due to their hydrophilic nature, allowing specific cells, such as keratinocytes, to populate on their surface. Further, a study showed that bagasse fibers mixed with cotton and viscose as a non-woven fabric coated with selected herbs, such as lemon, demonstrated an increase in antibacterial and antimicrobial effect, one of which is against Escherichia coli, or E. Coli (Devi et al., 2022). Furthermore, Hassan et al. (2023) found that sugarcane bagasse-derived paper displayed a high tensile strength, wherein, if coated with bismuth oxide, it enhances wound healing activity and could be a potential wound dressing material.

Despite the aforementioned studies on sugarcane bagasse, there remains a lack of research concerning its mechanical absorption and the process involved in extracting sugarcane fibers. Moreover, in the available variations of sugarcane bagasse studies, there is an inadequacy in tackling its mechanical properties, specifically its absorption as a medical scaffold, such as a wound dressing alternative. Furthermore, this lack of research on sugarcane bagasse methods extends to the Philippine setting, specifically in Region 11. Thus, the researchers investigated the mechanical absorption of sugarcane bagasse as a wound dressing alternative to fill in the methodological gaps and knowledge.

One of the most prevalent principles of economics is the interaction between supply and demand, reflected in real-world scenarios and fields. In correlation, creating a new avenue for supplying wound dressing products made outside the mass-acquired materials shall benefit the following. First aid respondents can acquire these alternative wound dressings as a backup resource in case of a shortage in these supplies. Consequently, school clinics can utilize these products in institutions, considering that student turnout due to minor accidents requires more primary first aid supplies to address this necessity. Emphasizing a world where many medical products are made with non-biodegradable resources and piled into waste, this innovation allows the development of wound dressings out of organic and accessible ingredients, particularly when endorsed to pharmaceutical companies and the wide Filipino population.

The research aligns with a Catholic community's core values, which promote faith, excellence, and service. It also aligned with the United Nations Sustainable Development Goals (SDGs) by promoting health, innovation, and sustainability. It aligns with SDG 3: Good Health and Well-being, as this study explores improving wound health accessibility. Along with that, it also adhered to SDG 9: Industry, Innovation, and Infrastructure through the advancement of medical innovation. Additionally, it aligned with SDG 12: Responsible Production and Consumption, as this research promotes the reutilization of agricultural waste. In achieving this ethical standard, this study highlighted innovation while remaining responsible both medically and towards the impact on the environment.

To share the findings of this research, the proponents must ensure the following dissemination measures to their respective beneficiaries. First, during the study, the researchers must verify their materials and procedures with the experts in the field to verify their processes and ensure the project's credibility. Second, once the final paper and product are complete, the researchers shall present their findings to a panel of research consultants, wherein revisions can be made based on their suggestions. After this, the researchers may summarize their revised paper into a large poster to be presented to different school communities through research forums with the help of faculty members and students. Moreover, the researchers may share their findings with the local community through research conferences. If made possible, the researchers may also publish their work on different scholarly websites like ResearchGate and Google Scholar, allowing them to contribute to the body of knowledge worldwide. Thus, to maintain credibility and reliability, this research aims to bridge the gap in wound dressing materials by investigating the potential of sugarcane bagasse as a sustainable, accessible, and effective alternative.

Statement of the Problem

This study aimed to generate a wound dressing structure using sugarcane *(Saccharum officinarum)* bagasse as its main material. Furthermore, it was measured for effectiveness by identifying the level of mechanical absorption using different product compositions.

Specifically, it answered the following questions:

1.What composition of an alternative wound dressing is utilized in:
1.1 Pure sugarcane bagasse (PSB);
1.2 Sugarcane bagasse cured with polyester resin (SCB-PER); and
1.3 Commercial brand (X) gauze pad?
2.To what extent can the level of absorbency using AATCC Test 79 reach for:
2.1 Pure sugarcane bagasse (PSB);
2.2 Sugarcane bagasse cured with polyester resin (SCB-PER); and
2.3 Commercial brand (X) gauze pad?
3.For how long is the absorption rate using AATCC Test 79 in:
3.1 Pure sugarcane bagasse (PSB);
3.2 Sugarcane bagasse cured with polyester resin (SCB-PER); and
3.3 Commercial brand (X) gauze pad?

Conceptual Framework

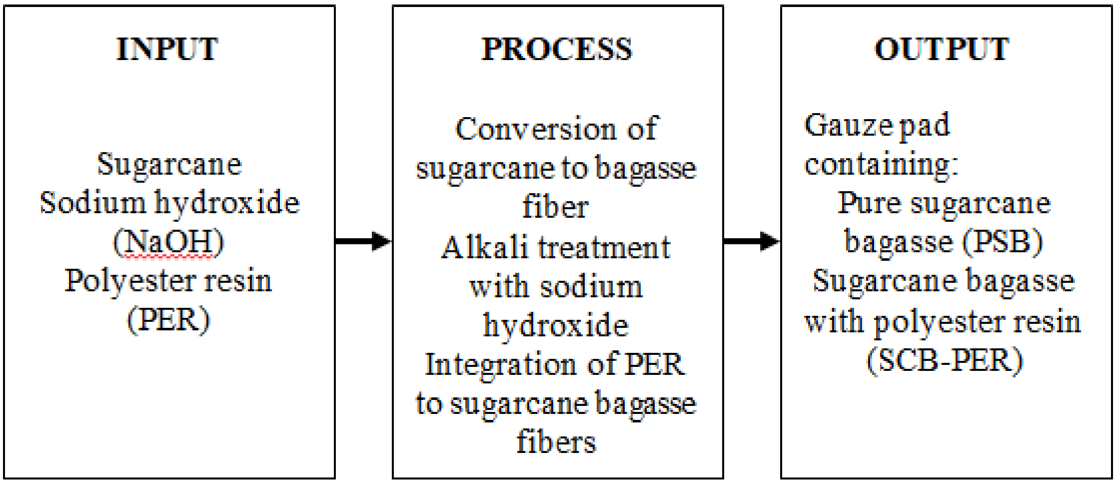

Fig 1. Conceptual framework of the study

The mechanical absorption of sugarcane bagasse as an alternative gauze pad was tested using different components, as listed in the input, as seen in Figure 1. By undergoing the processes listed, an expected output of a gauze pad composed of pure sugarcane bagasse (PSB) and sugarcane bagasse cured with polyester resin (SCB-PER) is expected.

The research utilized three main inputs for the development of the gauze pads. Firstly, the researchers intend to use raw sugarcane stalks to convert into sugarcane bagasse, which is sundried sugarcane fibers, as the main input for the study. Secondly, the fibers were incorporated with sodium hydroxide (NaOH) and formulated with distilled water to form an alkali solution. Lastly, the created group was divided into two groups. This first group included the untreated sample, the sugarcane bagasse in pure form. In contrast, another separated sample group was cured using polyester resin (PER).

The process of developing gauze pads from raw sugarcane comprises 3 main phases. The first phase involved the conversion of sugarcane to bagasse fibers through rinsing using distilled water and sun-drying for a specified amount of time. Then, the second phase involves soaking the extracted fibers in an alkali treatment with sodium hydroxide for four hours and water before rinsing and sun-drying once again. Lastly, to include a comparative group, PER was integrated into sugarcane bagasse fibers by grinding it into a fine powder, placing it in a mold, compressing it, and then curing it to create the pad.

The output expected from the input and process consisted of a gauze pad made from sugarcane bagasse with different components. The pure sugarcane bagasse (PSB) was composed of only sugarcane bagasse waste, washed with distilled water, and sun-dried. This determined the mechanical absorption of sugarcane bagasse in its pure form. On one hand, the sugarcane bagasse with polyester resin (SCB-PER) is a sugarcane bagasse treated with an alkali solution and cured with polyester resin (PER). This helped determine the mechanical absorption of sugarcane bagasse when cured with PER as a comparative group.

METHODOLOGY

Research Design

This study utilized a quantitative research design, specifically the descriptive-developmental approach. Quantitative research design focuses on forming generalizations by collecting numerical data from the study sample (Ghanad, 2023). To extract new knowledge, the design employs statistical tools to analyze the information and determine the relationship between the variables (Leavey, 2022). Meanwhile, the descriptive approach lies under quantitative research, which defines a variable by identifying its characteristics from the collected and analyzed numerical data (Siedlecki, 2020). Moreover, the descriptive-developmental approach, as defined by Ibrahim (2016), is the systematic process of discovering new knowledge to impact the process of developing new methods to enhance a product and its qualities and hone the developer's skill in creating innovations.

The descriptive-developmental design was applied in this study as it was the most appropriate design for describing the mechanical absorption using different product compositions. The study sought to document, describe, and develop the production of the material in the study. Therefore, the researchers employed a descriptive-developmental research design to develop an innovation that can benefit the identified problem using scientific concepts and available resources. Hence, this design matched how its characteristics can be used for further research.

Research Locale

This study was conducted in a Catholic school in Mindanao, specifically in Davao City, in Region XI. Mindanao is among the three major island groups in the Philippines, the second-largest after Luzon.

Further, the Catholic institution where the study was conducted offers three levels of education through the administration of a religious institution: basic education, higher education, and graduate school. The school's location was suitable for the study as the researchers aimed to investigate the mechanical absorption of sugarcane bagasse as a wound dressing alternative from a local perspective. Furthermore, the school was geographically accessible and known for its high-end facilities, laboratories, and advanced technologies, making it a suitable and appropriate location for scientific research, testing, and analysis.

Materials and Methods

The researchers obtained the sugarcane bagasse waste samples from a partner Davao City establishment. Additionally, 5% sodium hydroxide (NaOH) was obtained from a school laboratory in the same area, while the polyester resin was acquired from an outsourced. The AATCC 79 test method determined the mechanical absorption of the sugarcane (Saccharum officinarum) bagasse as a wound dressing alternative at a chemistry laboratory in a Catholic school in Davao City. Further, the experiment was conducted simultaneously on three samples: a pure sugarcane bagasse fiber, a sugarcane bagasse mixed with polyester resin, and a commercial brand X.

1) Collection of Sugarcane Bagasse Waste: The sample was collected from a partner establishment in Davao City. In choosing the partner establishment, the researchers focused on establishments that handle raw sugarcane. It was handled properly and placed in a large black bag. Further, the sample collection was conducted in the afternoon, at 3:00 pm, and was preserved by the researchers.

2) Preparation of Pure Sugarcane Bagasse (Sample 1): The sample was soaked in warm water and rinsed with distilled water. Afterward, it was sun-dried for a total of 2 days.

3) Preparation of Sugarcane Bagasse (SCB) cured with Polyester Resin (PER) (Sample 2): The sample was soaked in warm water and rinsed with distilled water. After, it was sundried for 4 hours before being ground into 3-4 cm particles.

4) Treatment of Sugarcane Bagasse (SCB) with Alkali Solution: The 5% NaOH was mixed with 100 mL of distilled water to produce the alkali solution for the SCB treatment. The SCB was soaked in the alkali solution for four hours. After the treated SCB was washed with distilled water and pre-dried in sunlight for 1 hour. Then, the SCB is oven-dried for 4 hours.

5) Curing of the Sugarcane Bagasse (SCB) and Polyester Resin (PER) (Sample 2): The SCB was ground into fine powder and mixed into the polyester resin until the mixture was homogeneous. It was then poured into a mold and compressed at 160 degrees Celsius for 1 hour and 30 minutes. Finally, it was sun-dried for another 30 minutes.

6) Preparation of the Commercial Brand (X) gauze pad (Sample 3): The sample was obtained from a local pharmacy and stored securely.

7) Testing of Absorbency Rate using the AATCC 79 test: Each sample was placed under a buret containing distilled water. There were five trials where the researchers measured the time using a stopwatch to determine the absorbency of each sample. In each trial, the water is dropped in different locations.

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Data Gathering Procedure

The researchers experimented with a series of procedures to ensure the study's credibility and reliability were aligned with the findings. Specifically, the following procedures demonstrated the experiment's social value, transparency, and efficacy. Firstly, the researchers acquired permission from the principal to experiment on the school premises through a formal letter. A letter was also provided to the laboratory directors to acquire permission to use the facilities and equipment in the laboratory and to ensure the safety of the researchers while experimenting within the premises. Further, a letter for the partner establishments was provided to ensure the formality and security of the partnership. Moreover, the researchers gathered the needed materials from the secured partnerships and the outsourced. The researchers adhered to the procedures and methods by referring to the guidelines. Finally, the researchers tested the products for the study's specified variables.

Statistical Tools

The researchers used descriptive statistical analyses to describe the experiment’s findings. Specifically, the researchers utilized the mean to analyze the results.

1) Percentages: This was used to determine the amount of materials in the composition of the samples.
2) Mean: The mean determined the average time it takes for each sample to absorb the water during the five trials. This way, the researchers can determine which sample can absorb the fastest.
3) Absorbency Rate: Adapted from the AATCC Test Method 79, a buret, distilled water, and a stand were used to test the absorbency of the three samples. Additionally, the time it takes for the water to pass through the fiber and be absorbed was noted during the five trials using a stopwatch. Then, the data was analyzed by calculating the average time per sample.

Ethical Considerations

The researchers followed guidelines to protect the rights and welfare of the involved parties. These principles are essential to creating a study environment wherein the individuals involved are protected from risks and harm throughout the study process.

This study was aligned with the United Nations Sustainable Development Goals (UN-SDGs), the JEEPGY framework, and Laudato Si by promoting sustainability and healthcare innovation. It supports SDG 3: Good Health and Well-Being, SDG 12: Responsible Consumption and Production, and SDG 9: Industry, Innovation, and Infrastructure. Meanwhile, under the JEEPGY framework, it promoted Justice by ensuring easy access to eco-friendly medical care, Economy by encouraging the act of recycling, Education as it enlightened the students and future generations regarding how we can utilize organic materials for first aid, Governance by encouraging hospitals and clinics to implement policies about going green, and Youth by being an inspiration to creative and innovative solutions to everyday problems. Furthermore, this study also catered to Laudato Si, specifically the first key principle, “Care for Our Common Home,” as the researchers aimed to reduce waste and encourage environmental sustainability.

The research ensured that the sugarcane bagasse alternative served as an alternative product to be used in terms of wound dressing and in minimizing waste during the wound dressing procedure. On the one hand, sugarcane bagasse deteriorates faster than cotton and bandages. On the other hand, disposing of it became easier as it is biodegradable; burying it after use is an option that can be explored.

This ethical consideration addressed the potential risks, benefits, and safety measures in conducting this study. It examines the challenges and advantages that researchers may encounter during data collection and experimentation while emphasizing the safety precautions implemented throughout the research process. The study primarily benefits local communities, as the data serves as a foundation for developing an eco-friendly wound dressing alternative, contributing to medical advancements and environmental sustainability.

The researchers ensured that the study would be conducted in a suitable place with the equipment and materials for testing sugarcane bagasse as an alternative wound bandage. These included laboratory equipment,

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sterilization tools, wound testing materials, and software for data analysis. The researchers also had access to consultations with advisers who guided them in conducting the study.

RESULTS AND DISCUSSION

After a series of experiments and laboratory sessions, this chapter highlights the necessary information gathered by the researchers about the formulated product, including its composition and two specific properties compared to other related samples. Intended to be a developmental standpoint for creating more complex structures and products, the information summarized in the results contains the needed information to explore the product and the potential abilities to use sugarcane bagasse as an alternative gauze pad material. Hence, the researchers present the following findings from the study’s results.

Characterization of Sugarcane Bagasse Fibers

Fig 2. Photo samples of (a) sugarcane bagasse fibers, (b) polyester resin, and (c) polymer hardener

The sugarcane bagasse (SCB) [Figure 2 (a)] fibers obtained from a partner company were divided into two samples. On one hand, the first sample was dried to reduce moisture and prevent microbial growth and degradation. On the other hand, a complementary sample set was dried to reduce moisture and compressed to form and shape into a flat sheet. It was then mixed with polyester resin and hardener [Figure 2 (b) and (c)], which was used to bind the sample’s fibers and slow their degradation process, which was eventually cut to an average width and length of 2.6 inches and 1.9 inches sheet pieces, respectively, used as samples.

Product Composition of Each Sample

Table 1 Composition of the Product Samples

Product Component	**PSB**	**SCB-PER**	**Brand X**
Sugarcane bagasse	**100%**	**19.53%**	**-**
Polyester resin	**-**	**78.13%**	**-**
Hardener	**-**	**2.34%**	**-**
Cotton	**-**	**-**	**100%**
Total Composition	**100%**	**100%**	**100%**

Table 1 presents the composition of the samples: pure sugarcane bagasse (PSB), sugarcane bagasse mixed with polyester resin (SCB-PER), and brand X. PSB was made entirely of sugarcane bagasse, washed and sundried for four days. Meanwhile, the SCB-PER comprised 19.53% sugarcane bagasse treated with an alkali solution, 78.13% polyester resin, and 2.34% hardener obtained from an outsourced. The sugarcane bagasse and polyester resin ratio was 1:4, wherein 6 grams were mixed with 24 grams of polyester resin. Finally, the brand X gauze pad was premade by a company and was obtained from an outsourced, it was composed of cotton fiber.

Sugarcane bagasse is abundant in cellulose, hemicellulose, and lignin, containing about 32-45%, 20-32%, and 17-32% of the said components, respectively (Kumar et al., 2021). These components are hydrophilic; hemicellulose, especially, has been discovered to have a positive correlation between the amounts present and the ability to absorb moisture (Mohammed et al., 2023). Similarly, cotton also showed a strong capability for absorbing water in a study by Ahmad et al. (2021), where composites of cellulose hydrogels reinforced with nonwoven cotton fabrics for wound dressing applications yielded an increase in fluid absorbency by 31.7%. This implies that the composition of the natural fibers is integral and directly affects the limits of the fibers regarding fluid absorption and their potential in developing wound dressings.

Level of Absorbency of Each Sample Using AATCC Test Method 79

Shown in Table 2 are the levels of absorbency for each of the four samples of PSB, SCB-PES, and brand X. These were gathered from the average drops each sample could hold before water would leak from the samples, meaning that it exceeded the amount of water it could hold. Additionally, the AATCC 79 test method was used to gather the results using a buret to ensure uniform amounts of water droplets were administered to the sheets. The results indicated that PSB could hold until 37.5 drops, compared to SCB-PER and brand x with 15 and 22.75 drops, respectively. This means that the PSB had the highest level of absorbency based on how many drops of water it took before any observable dripping drops.

Table 2 Level of Absorbency Using Aatcc Test 79

Product	**PSB**	**SCB-PER**	**Brand X**
Sample 1	74 drops	9 drops	51 drops
Sample 2	30 drops	11 drops	18 drops
Sample 3	25 drops	27 drops	15 drops
Sample 4	21 drops	13 drops	7 drops
Total Average	**37.5 drops**	**15 drops**	**22.75 drops**

Correlatively, a study by Unno et al. (2020) discussed that any porous material, such as cotton, contains pores throughout the material. Further, the permeability of fluid, such as water, through a fabric, such as cotton, is related to fabric porosity, which is affected by the sizes and distribution of pores in a material (Kalazić et al., 2023). Moreover, the amount of water absorbed at atmospheric pressure is referred to as water absorption (Golewski, 2023); hence, the total amount of water absorbed by a material is measured as its level of absorbency due to the pores' capability of holding water droplets.

1) Pure Sugarcane Bagasse (PSB): This material held a range of 21 to 74 droplets from each of the four samples, eventually showing that it could hold an average of 74 drops from five trials. Meanwhile, sample two had an average of 30 droplets, closely followed by 25 for the third sample. Lastly, the fourth sample averaged 21 water droplets from the test method. Overall, the total average for the PSB was 37.5 drops, indicating potential as an alternative gauze pad based on its absorbency level.

Similarly, in research conducted to investigate the effect of ultrasonication on the moisture absorption rate of tapioca starch and sugarcane bagasse fibers by Asrofi et al. (2021), the increased absorption ability of sugarcane bagasse is credited to the alkalization of the fibers, which was explained to disintegrate the bonds between the components found in bagasse, leading to an increase in cellulose content, which improves the fiber's mechanical properties.

2) Sugarcane Bagasse Cured with Polyester Resin (SCB-PER): This material showed averages ranging from 9 to 27 droplets. For the first sample, the SCB-PER held nine drops of water. On the second sample, it held up to 11 drops. The third sample held 27 drops of water, and the final sample held 13 drops. The total average for SCB-PER landed at 15 drops, showing the lowest average absorbency level.

These findings are supported by dissertations coming from Obiukwu et al. (2024), wherein it was found that the SCB-PES samples exhibited a lower absorption rate than the pure SCB due to the poor adhesion of sugarcane particles and the polyester, which led to the formation of voids and fractures on the microscopic levels, allowing water to enter but not truly adhere to the fibers, thus, showing why the SCB-PER exhibited a lower absorption average than the rest.

3) Commercial Brand X Gauze Pad: A commercial brand X gauze pad held a range of 7 to 51 drops of water for the four samples. It could hold 51 drops for the first sample, eight drops for the second sample, 15 drops of water for the third sample, and seven drops for the last sample. Overall, it could hold an average of 22.75 drops of water, showing a higher average than the SCB-PER but lower than the pure SCB. This meant that using this commercial brand is a mediator in water absorption, requiring minimal processing compared to raw products to reach a standard water absorption level.

In one such case, a study by Yunusa et al. (2025) explored developing biodegradable, eco-friendly materials to create reusable menstrual pads, wherein they found that a combination containing cotton, such as a combination of cotton and bamboo fleece or cotton fleece and bamboo fleece, exhibited the highest absorbency, capable of absorbing 190 mL, and 207 mL, respectively. However, from the comparative study of water absorption among different natural fibers of Begum et al. (2021), it was shown that untreated cotton fibers had the least water absorption, most likely because of the natural oil and wax covering their surface that acts as a barrier to the uptake of water. This conflicts with the findings where the treated pure sugarcane bagasse showcased a higher absorption average than the commercial gauze pad made out of cotton, meaning that absorption among raw materials may vary depending on their species and composition.

Absorption Rate of Each Sample Using AATCC Test Method 79

As outlined in Table 3, the absorption rate, also known as the duration during which the sample absorbs liquid droplets within its fibers and gaps, varies according to the composition of the sample. Based on the AATCC Test 79, a buret set-up was used to measure the absorption duration of a water droplet for each sample. Using a stopwatch, five trials were conducted on four PSB, SCB-PER, and brand X samples to record and calculate the average duration taken per piece.

The results indicated that the average time it takes for PSB to absorb the water droplets completely is 1.80 seconds (s), which is faster than SCB-PER's 5.36 s. Additionally, brand X has obtained a total average of 1.68 s. This illustrates that brand X had the shortest time completely absorbing the water droplets among the three samples. This indicates that the PSB made out of pure sugarcane bagasse had a higher absorbency rate as compared to the SCB-PER and is only a little lower than brand X, indicating that its pure form has the potential to serve as an alternative gauze pad due to its absorption.

Table 2 Level of Absorbency Using Aatcc Test 79

Sample 1	**PSB**	**SCB-PER**	**Brand X**
Trial 1	2.60 s	7.73 s	1.89 s
Trial 2	1.43 s	7.97 s	1.33 s
Trial 3	0.80 s	5.67 s	1.15 s
Trial 4	1.43 s	9.36 s	1.20 s
Trial 5	0.94 s	7.91 s	0.80 s
Sample Average Time	**1.44 s**	**7.73 s**	**1.27 s**
Sample 2	**PSB**	**SCB-PER**	**Brand X**
Trial 1	2.16 s	3.88 s	0.98 s
Trial 2	4.20 s	6.84 s	0.42 s

Trial 3	2.33 s	4.93 s	2.54 s
Trial 4	1.56 s	4.71 s	2.05 s
Trial 5	2.16 s	6.57 s	2.01 s
Sample Average Time	**2.48 s**	**5.38 s**	**1.6 s**
Sample 3	**PSB**	**SCB-PER**	**Brand X**
Trial 1	0.98 s	3.38 s	1.31 s
Trial 2	1.12 s	6.49 s	1.57 s
Trial 3	1.76 s	6.06 s	1.64 s
Trial 4	1.32 s	2.80 s	1.67 s
Trial 5	1.27 s	5.23 s	2.32 s
Sample Average Time	**1.29 s**	**4.79 s**	**1.70 s**
Sample 4	**PSB**	**SCB-PER**	**Brand X**
Trial 1	2.10 s	2.62 s	2.44 s
Trial 2	2.11 s	4.67 s	1.50 s
Trial 3	2.52 s	2.85 s	2.01 s
Trial 4	1.92 s	4.64 s	2.32 s
Trial 5	1.24 s	2.81 s	2.36 s
Average Time	**1.97 s**	**3.52 s**	**2.12 s**
Overall Average time	**1.80 s**	**5.36 s**	**1.68 s**

Coincidentally, hemicellulose accounts for the absorption capacity of sugarcane bagasse, with it being 30% of its structure and its hydrophilicity (Zafeer et al., 2023); hence, pure sugarcane bagasse displays natural absorption abilities. One key point that research from Chougala et al. (2025) stated was that this high cellulose content is also responsible for its compatibility with polymer matrices, which, if undergone treatment, could enhance mechanical properties, such as water absorption. This hemicellulose present in sugarcane bagasse is also observed in areca fibers, which were recorded as the highest absorbent in the study of Begum et al. (2021) as compared to raw cotton fibers; however, when alkali-treated, it proves to be a good water absorber. Although cotton and sugarcane fibers are comparable in water absorption capacity, their compositions and treatments remain integral to their potential as wound dressings, such as gauze pads.

1) Pure Sugarcane Bagasse (PSB): PSB had a 1.44-second average for the first sample, followed closely by the second sample's average at 2.48 seconds. Similar results from the first sample were observed in the third and fourth samples, with PSB being a fast absorbent at 1.29 seconds and 1.97 seconds average, respectively. This shows the consistency of PSB in terms of its absorption rate based on the results shown.

This is supported by the study of Obiukwu et al. (2024), which showed that the pure sugarcane exhibited better water absorption than the other samples. The study further states that the bagasse fibers' hydrophilicity, due to their chemical properties, is responsible for their greater water absorption capacity. A study by Adila et al. (2023) also supports its indication that sugarcane bagasse has a strong absorption capacity due to its composition, particularly its high cellulose and lignin content. Moreover, sugarcane bagasse fibers comprise hydrophilic cellulosic fibers, hence their moisture absorption (Ali et al., 2024). Meanwhile, Sa'idu and Magaji (2024) discovered that among different plant biomass, sugarcane bagasse exhibits a high water absorption and retention capacity at 71.70% as compared to the other waste biomass. This indicates that pure sugarcane bagasse may be a potential adsorbent, given its composition and water retention capacity.

2) Sugarcane Bagasse Cured with Polyester Resin (SCB-PER): Meanwhile, SCB-PER on the first sample had an average of 7.73 seconds. The second sample garnered a 5.38-second average, which came last for the absorption rate in both the first and second samples. Similar results were garnered for the third trial, with SCB-PER having a 4.79-second average. However, its absorption rate had improved on the fourth sample, garnering a 3.52-second average. This indicates that although the absorption rate was consistent, it was longer than the PSB.

A study conducted by Obiukwu (2024) emphasized that sugarcane bagasse-polyester composites have a slower absorbency rate than PSB, supporting the results found in Table 3. In contrast, a study by Zulkipli et al. (2022) emphasized that alkali-treated sugarcane bagasse mixed with polyester resin had enhanced adhesion; however, adding SCB increased its water absorption. Similarly, Shamsuddeen et al. (2024) stated that polyester resin composites reinforced with an increased load of sugarcane bagasse fiber showed increased water absorption.

In addition, a study by Motaleb et al. (2023) comparing water hyacinth and sugar bagasse with polyester composites states that SB composites with polyester showed higher water absorbency than water hyacinth composites. This shows that sugarcane bagasse with polyester indeed has higher absorbency. Moreover, a study by Chen et al. (2021) showed that increasing the weight of sugarcane bagasse fibers in composites inhibited increased water absorption. This indicates that the absorption of sugarcane bagasse mixed with polyester resin depends on the amount of fibers loaded in the resin mixture; hence, when there are few, absorption may not be observed.

3) Commercial Brand X Gauze Pad: Finally, Brand X garnered a 1.27 seconds average, faster than the PSB. This was also observed for the second sample, with its absorbency rate being 1.6 seconds on average. The third sample's average absorption was closely similar to the first at 1.70 average seconds. Moreover, the fourth sample garnered a 2.12-second average.

In a study by Zheng et al. (2020), hemostatic materials used in one type of gauze pad have high water absorption properties, which signifies that they can rapidly absorb blood. Moreover, Sahoo et al. (2024) found similar results in their study, where they discovered that modified cotton gauze had good moisture absorption, allowing it to absorb water more than nine times its weight. Further, modified cotton gauzes showed good breathability and retention, which contributed to their fast absorption ability. This confirms the collected data in Table 3, where there is consistency in Brand X having a speedy absorption rate.

CONCLUSION AND RECOMMENDATIONS

Conclusions

Within a series of sessions involving the processing and experimentation of the sugarcane bagasse, the results of the experiments conducted led to the following conclusions:

1. The composition of the samples tested varied. The pure sugarcane bagasse (PSB) was made of 100% sugarcane bagasse waste, while the sugarcane bagasse mixed with polyester resin (SCB-PER) was made of 19.53% sugarcane bagasse, 78.13% polyester resin, and 2.34% hardener. Finally, the brand X gauze pad was obtained from an outsourced source and was 100% cotton.
2. The level of absorbency using AATCC Test 79 for pure sugarcane bagasse is 37.5 drops, while for the sugarcane bagasse cured with polyester resin, it was 15 drops. Meanwhile, the gauze pad for the commercial brand X was 22.75 drops. This indicates that the PSB had the highest level of absorbency based on how many drops of water it took before any observable drippings. Hence, exploring the capabilities of raw materials in testing these properties without the interference of external ingredients may lead to more significant results.
3. The absorption rate using AATCC 79 for pure sugarcane bagasse is 1.80 seconds. Meanwhile, for sugarcane bagasse cured with polyester resin, the average is 5.36 seconds, while the commercial brand X gauze pad garnered 1.68 seconds. This shows that resin and hardener in the fibers may decrease their absorption rate, leading to a less efficient absorption rate. This may serve as a foundation for sugarcane bagasse, in its pure form, to have the potential to serve as an alternative gauze pad due to its rapid absorption rate.

Recommendations

In line with the formulated conclusions by the researchers, they have also drawn the recommendations that are as follows:

1. Future researchers should consider the study as a basis for creating more complex structures using sugarcane, focusing more on its other properties, such as mechanical durability, antimicrobial efficacy, biocompatibility, and degradation rate in various environmental conditions would provide a more holistic understanding of the material's suitability as a wound dressing.

2. Future researchers should also explore the possibilities of sugarcane bagasse as an alternative gauze pad by conducting more varied tests and comparing it to other fibers to further analyze its effectiveness as an alternative absorbent material.
3. Future studies that tackle similar topics may consider enhancing the statistical significance of the results by incorporating inferential statistics, such as t-tests and ANOVA, depending on the nature of the data.
4. Future studies may explore the feasibility of sugarcane bagasse mixed with other materials to find a suitable composition for an alternative gauze pad.
5. The Department of Agriculture should conduct more inclusive research on sugarcane and its properties to discover its potential as an alternative for gauze pads and other probable items.
6. Learning sessions on Science and Health Research for high school students in the Philippines must focus on utilizing locally available species, such as sugarcane, as primary examples to ensure authenticity and productivity in terms of using them for innovations.
7. Future studies should explore commercialization potential, user acceptance, and integration into public health supply chains, especially in resource-poor settings.

REFERENCES

1. Adila, H., Wisnu, W., Handayani, E. T., Fathin, H. R., & Rusdianto, A. S. (2023). Effectiveness of sugarcane bagasse adsorbent combined with aquaponics system as an innovation for absorbing contaminants in sugar industry wastewater. International Journal on Food, Agriculture, and Natural Resources, 4(4), 70–76. https://doi.org/10.46676/ij-fanres.v4i4.234
2. Ahmad, F., Mushtaq, B., Butt, F. A., Zafar, M. S., Ahmad, S., Afzal, A., ... & Ulker, Z. (2021). Synthesis and characterization of nonwoven cotton-reinforced cellulose hydrogel for wound dressings. Polymers, 13(23), 4098.https://doi.org/10.3389/fphar.2020.00155
3. Al Hasan, D., Monger, E., & Brightwell, R. (2020). Medical emergencies requiring first aid at home: A population-based survey study. Disaster Medicine and Public Health Preparedness, 16(1), 132-138. https://doi.org/10.1017/dmp.2020.193
4. Ali, H., Dixit, S., & Alarifi, S. (2024). Development and characterization study of bagasse with stubble reinforced polyester hybrid composite. Journal of King Saud University - Science, 36(1). https://doi.org/10.1016/j.jksus.2024.103231
5. Asrofi, M., Sapuan, S. M., Ilyas, R. A., &, Ramesh, M. (2021). Characteristics of composite bioplastics from tapioca starch and sugarcane bagasse fiber: Effect of time duration of ultrasonication (Bath-Type), Materials Today: Proceedings, 46, 1626-1630. https://doi.org/10.1016/j.matpr.2020.07.254
6. Begum, H. A., Tanni, T. R., & Shahid, M. A. (2021). Analysis of Water Absorption of Different Natural Fibers. Journal of Textile Science and Technology, 7(4), 152-160. https://doi.org/10.4236/jtst.2021.74013
7. Beleche, T., & Kolbe, A. (2024). Medical product shortages in the United States: Demographic and geographic factors and impacts. Office of the Assistant Secretary for Planning and Evaluation. https://aspe.hhs.gov/reports/medical-product-shortages
8. Britto, E. J., Nezwek, T. A., Popowicz, P., & Robins, M. (2024). Wound dressings. In StatPearls. StatPearls Publishing. https://pubmed.ncbi.nlm.nih.gov/29261956/
9. Castro, A., Domingo, A., Cariaga, J., Gamboa, F., Castro, A. C., Pascua, A. N., Fabia, J. Z., Gann, P. J., Santos, B., & Agrupis, S. (2024) Wound healing efficacy of cellulose hydrogel on ICR mice: A morphoanatomical, histological and genomic study. Preprints.org. https://doi.org/10.20944/preprints202409.1941.v1
10. Chen, R. S., Chai, Y. H., Olugu, E. U., Salleh, M. N., & Ahmad, S. (2021). Evaluation of mechanical performance and water absorption properties of modified sugarcane bagasse high-density polyethylene plastic bag green composites. Polymers and Polymer Composites, 29(9). https://doi.org/10.1177/09673911211049058
11. Chougala, V., Gowda, A. C., Nagaraja, S., & Ammarullah, M. I. (2024). Effect of chemical treatments on mechanical properties of sugarcane bagasse (Gramineae saccharum officinarum L) fiber based biocomposites: a review. Journal of Natural Fibers, 22(1). https://doi.org/10.1080/15440478.2024.2445571

12. Colina, I. (2020). Medical wastes in Davao Region soar with COVID-19 pandemic. In MindaNews. https://mindanaodailymirror.ph/Main/full_article/medical-wastes-in-davao-region-soar-with-covid-19-pandemic10462
13. Devi, M. & Karpagavalli, V. (2022). CONVERSION OF BAGASSE FIBRE INTO NON-WOVEN DISPOSABLE MEDICAL TEXTILES. International Journal of Advanced Research in Science Communication and Technology, 7(3). https://ijoret.com/Volume7/issue3/IJORET-V7I3P1.pdf
14. Feng, M., Feng, Z., Liao, X., Huang, S., & Tao, J. (2024). Analysis of the design of household first aid kits. Scientific and Social Research, 6(5). https://doi.org/10.26689/ssr.v6i5.6875
15. Ge, P., Zhang, J., Lyu, K., Niu, Y., Li, Q., Xiong, P., Liu, J., Yang, Y., Deng, Y., Li, X., Yu, W., Yin, M., Sun, X., Han, S., & Wu, Y. (2022). The current status and factors related to the preparation of home first-aid kits in China. Frontiers in Public Health, 10. https://doi.org/10.3389/fpubh.2022.1036299
16. Ghanad, A. (2023). An Overview of Quantitative Research Methods. INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS, 6(8), 3794-3803. https://doi.org/10.47191/ijmra/v6-i8-52
17. Glogowska, K., Paczkowski, P., & Gawdzik, B. (2022). Assessment Study on the Solvent Resistance of Low-Density Polyethylene with Pumpkin Seed Hulls. ResearchGate. https://www.researchgate.net/publication/366605461_Assessment_Study_on_the_Solvent_Resistance_of_Low-Density_Polyethylene_with_Pumpkin_Seed_Hulls
18. Golewski, G. L. (2023). Assessing of water absorption on concrete composites containing fly ash up to 30 % in regards to structures completely immersed in water. Case Studies in Construction Materials, 19. https://doi.org/10.1016/j.cscm.2023.e02337
19. Hassan, M., Diab, M. A., Abd El-Wahab, M. G., Hegazi, A. H., Emwas, A., Jaremko, M., & Hagar, M. (2023). Bismuth Oxide Composite-Based Agricultural Waste for Wound Dressing Applications. Molecules 2023, 28, 1-17. https://doi.org/10.3390/molecules28155900
20. Ibrahim, A.A. (2016). Definition Purpose and Procedure of Developmental Research: An Analytical Review. Asian Research Journal of Arts & Social Sciences, 1(6), 1-6. https://doi.org/10.9734/ARJASS/2016/30478.
21. Kalazić, A., Badrov, T., Schwarz, I., & Brnada, S. (2023). Incorporating Variable Porosity into the Determination of Effective Permeability in Interchanging Double Cloth Woven Fabrics Using Darcy's Law. Polymers, 15(14). https://doi.org/10.3390/polym15143048
22. Kumar, A., Kumar, V., & Singh, B. (2021). Cellulosic and hemicellulosic fractions of sugarcane bagasse: Potential, challenges and future perspective. International Journal of Biological Macromolecules, 169, 564-582. https://doi.org/10.1016/j.ijbiomac.2020.12.175
23. Leavy, P. (2022). Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches. Guilford Publications. https://doi.org/10.1111/fcsr.12276
24. Madjos, G. G., & Ramos, K. P. (2021). Ethnobotany, systematic review and field mapping on folkloric medicinal plants in the Zamboanga peninsula, Mindanao, Philippines. Journal of Complementary Medicine Research, 12(1), 22–61. https://doi.org/10.5455/jcmr.2021.12.01.05
25. Mahmud, M. A., & Anannya, F. R., (2021). Sugarcane bagasse-A source of cellulosic fiber for diverse applications. Heliyon, 7(8). https://www.cell.com/heliyon/fulltext/S2405-8440(21)01874-0
26. Manucang, S. A. T., & Caina, M. A. (2024). The level of disaster awareness and preparedness of San Jose vegetable farmers in Monkayo, Davao de Oro: Basis for Extension Intervention. International Journal of Research and Innovation in Social Science. (2024). https://rsisinternational.org/journals/ijriss/articles/the-level-of-disaster-awareness-and-preparedness-of-san-jose-vegetable-farmers-in-monkayo-davao-de-oro-basis-for-extension-intervention/
27. Mohammed, M., Jawad, A. J. A. M., Mohammed, A. M., Oleiwi, J. K., Adam, T., Osman, A. F., ... & Jaafar, M. (2023). Challenges and advancement in water absorption of natural fiber-reinforced polymer composites. Polymer Testing, 124, 108083. https://doi.org/10.1016/j.polymertesting.2023.108083
28. Motaleb, K. Z. M. A., Abakevičienė, B., & Milašius, R. (2023). Development and Characterization of Bio-Composites from the Plant Wastes of Water Hyacinth and Sugarcane Bagasse: Effect of Water Repellent and Gamma Radiation. Polymers, 15(7), 1609. https://doi.org/10.3390/polym15071609

29. Naria-Maritana, M. J. N., Borlongan, G. R., Zarsuelo, M. M., Buan, A. K. G., Nuestro, F. K. A., Dela Rosa, J. A., Silva, M. E. C., Mendoza, M. A. F., & Estacio, L. R. (2020). Addressing primary care inequities in underserved areas of the Philippines: A review. Acta Medica Philippina, 54(6). https://doi.org/10.47895/amp.v54i6.2578
30. Nuneza, O., Rodriguez, B., & Nasiad, J. G. (2021). Ethnobotanical survey of medicinal plants used by the Mamanwa tribe of Surigao del Norte and Agusan del Norte, Mindanao, Philippines. Biodiversitas Journal of Biological Diversity, 22(6). https://doi.org/10.13057/biodiv/d220634
31. Obiukwu, O. O., Nwigwe, M. N., Uchechukwu, T. O., Azubuike, J., & Ekpechi, D. A. (2023). Investigation on Physicochemical Properties of Sugarcane Bagasse Fibre - Reinforced Polyester Composite. Iranica Journal of Energy & Environment, 15(4), 421-427. https://doi.org/10.5829/ijee.2024.15.04.09
32. Obiukwu, O. O., Nwigwe, M. N., Uchechukwu, T. O., Azubuike, J., & Ekpechi, D. A. (2024). Morphological, Mechanical, and Multifunctional Properties of Sugar Cane Bagasse/Polyester Composites. Iranica Journal of Energy & Environment, 15(2), 160-169. https://doi.org/10.5829/ijee.2024.15.04.09
33. Ogundeji, K., Risenga, P., & Thupayagale-Tshweneagae, G. (2023). Direct cost of wound dressing in Nigeria: Implications for catastrophic healthcare expenditure. International Journal of Africa Nursing Sciences, 19. https://doi.org/10.1016/j.ijans.2023.100597
34. Pelone, B. C. & Arellano, A. J. P. (2024). Flood Preparedness and utilization of early warning systems among households in selected flood-prone areas in Tagum City, Davao Del Norte. Davao Research Journal, 15, 34-47. https://doi.org/10.59120/drj.v15i1.149
35. Rajah, A.S., Yunusa, U., Tashi, F.T., Tukuntawa, A. S., & Abdullahi, S. O. (2025). Absorbency and performance indices of biodegradable ecofriendly materials used for reusable menstrual pads. https://www.ajol.info/index.php/bjmls/article/view/289354
36. Ramirez, M., Alcachupas, A. V. J., & Tan, C. D. G. (2020). Biodegradable straw using sugarcane bagasse. https://doi.org/10.13140/RG.2.2.35376.69124/1
37. Ramphul, H., Gimié, F., Andries, J. Jhurry, D., & Bhaw-Luximon, A. (2020). Sugarcane bagasse cellulose-based scaffolds promote multi-cellular interactions, angiogenesis, and reduce inflammation for skin tissue regeneration. International Journal of Biological Macromolecules, 156, 296-310. https://doi.org/10.1016/j.ijbiomac.2020.04.176
38. Sa'idu, A., & Magaji, A. (2024). Experimental Analysis of Water Absorption and Retention from Waste Biomass for Composite Application in Agriculture. International Journal of Research Publication and Reviews, 5(8), 3927-3930. https://doi.org/10.1088/1757-899X/995/1/012045
39. Sahoo, M., Paul, M., Kothari, P., Varanasi, M., Biswas, S., & Mitra, D. (2024). Polysaccharide-modified bactericidal and fouling-resistant cotton gauze for potential application as a wound dressing. Carbohydrate Polymer Technologies and Applications, 7, 100437. https://doi.org/10.1016/j.carpta.2024.100437
40. Shamsuddeen, R., Musa, H., Mathew, T. S., Abubakar, M. Y., & Adam, A. B. (2024). Effect of Particle Size and Fiber Loading on Some Properties of Sugarcane Bagasse Reinforced Unsaturated Polyester Composites. Kwaghe International Journal of Sciences and Technology, 1(1). 546-559. https://doi.org/10.58578/kijst.v1i1.3718
41. Siedlecki, S. L. (2020). Understanding Descriptive Research Designs and Methods. Clinical nurse specialist CNS, 34(1), 8-12. https://doi.org/10.1097/NUR.0000000000000493
42. Statista (2024). Wound Care - Philippines. Statista Market Insights. https://www.statista.com/outlook/hmo/otc-pharmaceuticals/wound-care/philippines
43. Suarez, R., Peñamante, E., Carrillo, L., Delfin, R., Gotostos, T. M., Patingan, J., Provido, A. V., Ramos, C. M., & Tugade, C. (2024). Analysis of gauze pad made from coconut tree fiber infused with guava derived phenolic compounds. IOP Conference Series: Earth and Environmental Science. https://www.researchgate.net/publication/382311959_Analysis_of_gauze_pad_made_from_coconut_tree_fiber_infused_with_guava_derived_phenolic_compounds#full-text
44. Unno, N., Yuki, K., Inoue, R., Kogo, Y., Taniguchi, J., & Satake, S. (2020). Enhanced evaporation of porous materials with micropores and high porosity. Journal of Thermal Science and Technology, 15(1). https://doi.org/10.1299/jtst.2020jtst0007

45. Zafeer, M. K., Prabhu, R., Rao, S., Mahesha, G., & Bhat, K. S. (2023). Mechanical characteristics of sugarcane Bagasse Fibre Reinforced Polymer composites: A review. Cogent Engineering, 10(1). https://doi.org/10.1080/23311916.2023.2200903
46. Zheng, W., Chen, C., Zhang, X., Wen, X., Xiao, Y., Li, L., Xu, Q., Fu, F., Diao, H., & Liu, X. (2020). Layer-by-layer coating of carboxymethyl chitosan-gelatin-alginate on cotton gauze for hemostasis and wound healing. Surface and Coatings Technology, 406, 126644. https://doi.org/10.1016/j.surfcoat.2020.126644
47. Zulkipli, N. A., Bakar, M. B. A., Mohd, S. H., & Rosdi, N. A. M. (2022). Effect of chemical treatment on physical properties of sugarcane bagasse reinforced unsaturated polyester composite. International Conference on Bioengineering and Technology, 2454(1). https://doi.org/10.1063/12.0007391