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Characteristics of Polyvinyl Alcohol-Coated Ramie Fiber as a Biodegradable Fishing Gear Material

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Abstract

Ghost fishing refers to the phenomenon of lost synthetic fishing gear in aquatic environments, posing a serious threat to marine ecosystems because these materials are difficult to degrade and continue capturing fish uncontrollably. Synthetic fishing gear has high durability but negatively impacts ecosystems when lost. One alternative to mitigate this issue is the use of biodegradable materials such as ramie fiber. However, ramie rope has drawbacks, including lower breaking strength and limited durability. This study aimed to improve the performance of ramie rope by coating it with polyvinyl alcohol (PVA), which is hydrophilic, biodegradable, and environmentally friendly. The study was conducted by coating 3mm ramie ropes with PVA solution followed by seawater immersion testing for 10 weeks to evaluate changes in mechanical properties and technical service life. The results showed that PVA coating increased the rope's breaking strength by 38.97% and elongation by 32.59%. In addition, the technical service life of PVA-coated ramie rope was longer (7 months and 1 week) compared to the control rope (5 months and 1 week). These findings indicate that PVA coating can improve the mechanical performance and durability of ramie rope, making it a potential biodegradable material for environmentally friendly fishing gear.

Keywords: biodegradable fishing gear, fish traps, ghost fishing, polyvinyl alcohol, ramie ropes

1. Introduction

Ghost fishing is the phenomenon of lost fishing gear continuing to operate in aquatic environments without control from fishers (Lively and Good, 2018; Beneli et al., 2020; Le Gué et al., 2025). Fishing gear commonly used by fishers is typically made from synthetic materials, as these are considered to have a longer service life, higher breaking strength, and greater resistance to degradation compared to natural materials (Komarudin et al., 2023). Several types of synthetic materials—such as polyamide (PA), polyester (PES), polyethylene (PE), polyvinyl chloride (PVC), and polyvinyl alcohol (PVA)—are among the most frequently used in the construction of fishing gear components (Ramos, 2018; Le Gué et al., 2025).

Although synthetic materials are advantageous, their excessive use negatively impacts the environment. Synthetic fishing gear takes a long time to degrade when lost in aquatic environments (Mulyani et al., 2023). To mitigate ghost fishing, research on biodegradable fishing gear materials is necessary to develop materials that decompose more easily in aquatic environments. Biodegradable materials are natural substances that can be broken down by microorganisms into simpler, environmentally friendly compounds without leaving harmful residues (Drakeford et al., 2023).

The application of biodegradable materials as an alternative for fishing gear materials is expected to reduce the likelihood of ghost fishing phenomena, use of biodegradable materials such as natural fibers derived from plants, animals, and minerals (Elfaleh et al., 2023). Natural fibers have advantages over synthetic fibers, such as being lighter in weight,

capable of being processed naturally, environmentally friendly, and possessing relatively high strength and stiffness (Cai et al., 2024). However, natural fibers have disadvantages compared to synthetic fibers, including lower tensile strength and susceptibility to decay (Krisnafi et al., 2024). One type of natural fiber that is widely utilized is plant fiber. Plant fibers are natural fibers composed of cellulose. One natural fiber that has potential to be used as a biodegradable fishing gear material is ramie fiber (Mudi and Shaw, 2025).

Ramie fibers can be utilized in various fishing gear applications, such as in longline fishing materials (Pattiasina et al., 2020), as raw materials for lead lines, sinker ropes, and float lines in gillnets (Komarudin et al., 2023). Ramie fibers have the advantages of being easily obtainable, environmentally friendly, having good sinking speed, excellent resistance to bacterial and fungal attacks, and better absorption capacity compared to synthetic fibers (Mudi and Shaw, 2025). Therefore, to enhance the tensile strength and durability of ramie ropes, polyvinyl alcohol is used as a coating material.

Polyvinyl alcohol (C_2H_4O) is a synthetic thermoplastic polymer produced through the hydrolysis process of polyvinyl acetate ($C_4H_6O_2$) (Feldman, 2020). During this hydrolysis process, polyvinyl acetate ($C_4H_6O_2$) is broken down into polyvinyl alcohol (C_2H_4O), resulting in a polymer structure with a main carbon chain containing hydroxyl (-OH) groups on each monomer unit (Madhuranthakam et al., 2024). Polyvinyl alcohol material has the characteristics of being non-toxic, hydrophilic, soluble in water, biocompatible, and capable of biodegrading in aquatic environments (Havstad, 2020). The coating process using polyvinyl alcohol is employed because polyvinyl alcohol offers advantages such as good durability, transparency, high elasticity, biocompatibility, and excellent water resistance (Liu et al., 2022).

The coating of polyvinyl alcohol on ramie ropes is expected to enhance their tensile strength and elongation, making them suitable alternative material for fishing gear components. This is achieved by sealing the gaps and pores of the ramie fibers with the coating. This method also aims to slow down the degradation rate of ramie ropes and increase the technical lifespan of ramie ropes coated with polyvinyl alcohol. Research on biodegradable gear materials is essential, particularly to prevent the phenomenon of ghost fishing. The study of biodegradable fishing gear materials aims to identify optimal physical and mechanical properties for their use as substitutes in fishing gear, while being easily biodegradable when lost, thereby reducing the impact of ghost fishing.

2. Method

2.1. Study Period and Location

This research was conducted from August to November 2024 at the Fishing Gear Laboratory and the Integrated Laboratory, Department of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, IPB University.

2.2. Materials and Equipment

The tools and materials used in this study were based on laboratory-scale requirements. The tools and materials employed in this study are presented in (Table 1).

Table 1. Materials and equipment used in the study. This table summarizes the instruments, materials, and software used for specimen preparation, seawater immersion, mechanical testing, and data analysis of polyvinyl alcohol-coated ramie rope specimens.

No.	Tools and Materials	Function
1.	Portable stove	Heating the polyvinyl alcohol solution
2.	Pan	Container for dissolving polyvinyl alcohol
3.	Scissors	Cutting specimen materials
4.	Digital balance	Measuring specimen mass
5.	Ruler	Measuring specimen length
6.	Container Box	Container specimen immersion in seawater

No.	Tools and Materials	Function
7.	Graduated cylinder	Measuring solution volume
8.	Infrared Thermometer	Measuring solution temperature
9.	Aquarium Pum	Circulating water flow inside container box
10.	Refractometer	Measuring seawater salinity
11.	Plastic container	Container for specimen immersion in polyvinyl alcohol solution
12.	Zoom Stereo Microscope (Olympus SZ61)	Observing microscopic physical properties of specimens
13.	Universal Testing Machine (Hung Ta HT-2402)	Testing tensile strength and elongation of specimens
14.	Software Microsoft Excel	Processing mechanical property data
15.	Software Statistical Product and Services Solution (SPSS) software	Processing statistical data
16.	Ramie Rope Ø 3 mm	Natural fiber specimen to be coated with polyvinyl alcohol
17.	Polyvinyl Alcohol Powder	Coating material for ramie rope
18.	Glycerin Solution	Plasticizer in the preparation of polyvinyl alcohol solution
19.	Seawater	Immersion medium for technical service life testing

2.3. Experimental Procedure

The experimental procedure began with the preparation of ramie rope specimens and the polyvinyl alcohol (PVA) coating solution. The prepared PVA solution was poured into a coating container containing the ramie rope specimens, where they were soaked for 48 hours. After the 48 hour coating process, the specimens were dried by hanging them indoors, away from direct sunlight. Following the one-week drying period, observations of the physical properties of the ramie rope were conducted, including color, stiffness, tactile impression, and diameter, using an Olympus SZ61 microscope. Mechanical property testing of the ramie rope, including breaking strength and elongation, was carried out using a Universal Testing Machine. The data obtained from the physical and mechanical property observations were then processed using Ms Excel and Statistical Product and Service Solutions (SPSS) software.

2.3.1. Specimen Preparation Procedure

The procedure began by cutting the ramie rope into lengths of 400 mm (40 cm), consisting of 300 mm (30 cm) as the gauge length between grips for each specimen, and 50 mm (5 cm) on each end as the portion held by the grips during testing (Komarudin et al., 2023).

2.3.2. Polyvinyl Alcohol Coating Solution Preparation Procedure

The polyvinyl alcohol coating solution was prepared in a pot by mixing 10% polyvinyl alcohol powder with 100 ml of water, heated on a stove at a temperature range of 60°–90°C until a homogeneous solution was formed. Once the polyvinyl alcohol solution became homogeneous, 100 ml of glycerin plasticizer was added, acting as a plasticizer. The combination of polyvinyl alcohol powder, water, glycerin plasticizer resulted in a coating solution that was odorless and non-sticky (Komarudin et al., 2023).

2.3.3. Specimen Coating Procedure

The ramie rope was coated with the polyvinyl alcohol solution by immersing it for 48 hours. The 48-hour duration allowed the coating solution to penetrate the pores of the rope thoroughly and fill the cavities within the ramie fibers, thereby slowing down the rate of degradation and decomposition of the polyvinyl alcohol-coated rope. According to the SNI ISO 1805 (2010) guideline titled “Fishing Gear Made of Netting Materials: Determination of Knot and Mesh Breaking Force,” it is stated that immersion treatment of yarn or rope must be carried out for a minimum of 12 hours (BSN, 2010).

2.3.4. Specimen Immersion Procedure

The immersion of ramie rope in seawater aimed to determine the effect of seawater immersion on the physical properties, mechanical properties, and service life of the ramie rope specimens. The immersion was carried out in a circulating container box to simulate actual aquatic environmental conditions and to prevent the accumulation of debris in the immersion container caused by the degradation process of the specimens (Komarudin et al., 2023).

2.3.5. Physical Properties Observation Procedure

The procedure was carried out by observing changes in the physical properties of the specimens, including color, stiffness, tactile impression, and diameter. These observations were made by comparing the physical properties of the ramie rope before and after coating with polyvinyl alcohol, as well as before and after immersion treatment in seawater. (Komarudin et al., 2023).

2.3.6. Mechanical Properties Testing Procedure

The tensile strength and elongation tests of the specimens were conducted using a Universal Testing Machine (UTM). Mechanical property observations were carried out over 11 repetitions (11 weeks), with 30 ramie rope specimens tested each week—15 specimens coated with polyvinyl alcohol and 15 specimens without the polyvinyl alcohol coating (BSN, 2010).

2.4. Data Analysis

Data analysis in this study was conducted to address three main objectives. First, to determine the physical and mechanical properties of ramie ropes coated with polyvinyl alcohol, a combination of qualitative descriptive analysis, normality testing using the Shapiro-Wilk method, and significance testing through a Completely Randomized Design (CRD) with Analysis of Variance (ANOVA). Second, to examine the effect of seawater immersion on the technical lifespan of polyvinyl alcohol-coated ramie ropes, linear regression and correlation analyses were performed, also utilizing CRD with ANOVA. Third, to provide recommendations for the application of polyvinyl alcohol-coated ramie ropes as biodegradable fishing gear material in efforts to prevent ghost fishing in trap fisheries, was conducted using descriptive analysis (Komarudin et al., 2023).

3. Results and Discussion

3.1. Physical and Mechanical Characteristics of Ramie Rope

Physical characteristics of ramie fiber as a biodegradable fishing gear material were determined through observation and examination, while to understand the mechanical characteristics, testing using a Universal Testing Machine (UTM) is required. In this study, the results obtained related to the physical and mechanical characteristics of ramie fiber are presented in more detail as follows:

3.1.1. Physical Characteristics of Ramie Ropes

The ramie fiber specimens used have an S-twist. Komarudin et al., (2023) suggests that the direction of the twist in the rope depends on the rope maker's tradition and the intended use of the rope. The type of twist in the ramie fiber rope used in this study falls into the 'Soft' twist category, as it has a twist angle ($<40^\circ$), which is 25.15° . Understanding the direction of the twist and the twist category is essential for determining the physical and mechanical characteristics of the rope (Ekuyando et al., 2025), and is useful in determining the application when designing a fishing gear (Komarudin et al., 2023). The direction of the twist in the ramie fiber rope is clearly shown in **(Figure 1)**.

The observation results of the physical properties showed a difference in diameter between the control specimens and the treated specimens. The diameter of the ramie fiber rope coated with polyvinyl alcohol (treatment) was higher compared to the ramie fiber rope that

was not coated with polyvinyl alcohol. The diameter of the ramie fiber rope coated with polyvinyl alcohol ranged from 3.50 to 4.00 mm, with an average of 3.80 mm. The diameter of the ramie fiber rope without polyvinyl alcohol coating (control) was 3.00 mm (± 0.1 mm). Based on the ANOVA test conducted, a P-value of 0.9×10^{-4} (< 0.05) was obtained. This indicates that the polyvinyl alcohol coating has a significant effect on increasing the rope diameter.

Ramie fiber ropes coated with polyvinyl alcohol and ramie fiber ropes without polyvinyl alcohol coating exhibit differences in color and texture. The color of the ramie fiber rope in the uncoated specimen is light brown, while the ramie fiber rope coated with polyvinyl alcohol is dark brown. This color difference occurs due to the chemical interaction between polyvinyl alcohol and the natural components in the ramie fibers, such as lignin and cellulose (Tan et al., 2015). Lignin is a naturally dark-colored component and can undergo oxidation or photochemical reactions when exposed to light or certain chemicals, resulting in a color change to a darker shade (Wang et al., 2023).

The ramie fiber rope without polyvinyl alcohol coating has a soft surface texture and flexible stiffness, while the ramie fiber rope coated with polyvinyl alcohol has a rough texture and rigid (stiff) stiffness. The difference in surface texture between the two specimens occurs due to the influence of the polyvinyl alcohol coating. The polyvinyl alcohol coating on the treated ramie fiber rope covers the entire surface of the rope and dries, resulting in a rough texture on the ramie fiber rope.

3.1.2. Mechanical Characteristics of Ramie Ropes

Mechanical characteristics of the ramie ropes material were evaluated based on the values of breaking strength and elongation. Breaking strength is defined as the maximum load the rope can withstand just before failure. Elongation refers to the maximum deformation the material undergoes before breaking during testing (Ayunda et al., 2017). The breaking strength of ramie fiber ropes coated with polyvinyl alcohol (treatment) and those without coating (control) is illustrated in more detail in (Figure 2).

The normality test using the Shapiro-Wilk method showed that the ramie fiber ropes coated with polyvinyl alcohol and those without coating were normally distributed, with P-values of 0.518 and 0.360, respectively (> 0.05). The ANOVA (Analysis of Variance) results indicated that the breaking strength of ramie fiber ropes with and without polyvinyl alcohol coating differed significantly, with a P-value of 3.1×10^{-4} (< 0.05). The average breaking strength of the ramie rope coated with polyvinyl alcohol was 35.90 kgf, while the uncoated ramie rope had an average breaking strength of 25.83 kgf. The application of polyvinyl alcohol coating increased the breaking strength of the ramie rope by 38.99%.

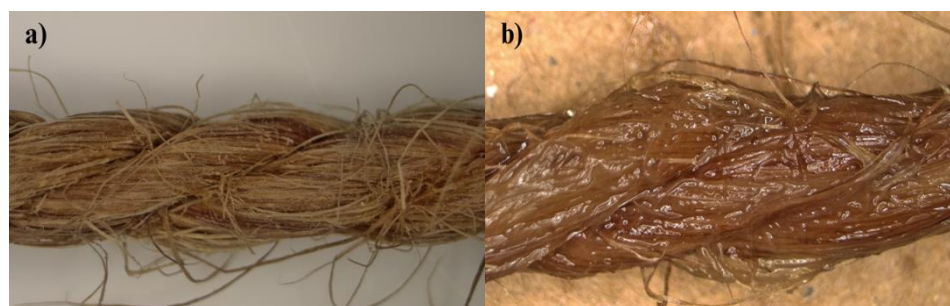


Figure 1. Physical appearance of Ramie Rope; (a) before coating polyvinyl alcohol, (b) after coating polyvinyl alcohol.

The increase in breaking strength of ramie fiber rope coated with polyvinyl alcohol is presumed to result from the formation of hydrogen bonds between the polyvinyl alcohol and the ramie fibers. These hydrogen bonds form because polyvinyl alcohol contains hydroxyl (-OH) groups that interact with the hydroxyl groups of cellulose in the ramie fibers (Yudhanto et al., 2020). The formation of hydrogen bonds enhances the adhesion between the polyvinyl alcohol layer and the ramie fibers, thereby increasing the breaking strength of the coated

rope. In addition to breaking strength, another mechanical property analyzed in this study was the tensile stress of the ramie fiber rope.

Stress refers to the deformation of an object caused by external forces acting upon (Komarudin et al., 2023). The stress of the rope represents the ratio between breaking strength and the linear density of the rope (tex). Statistically, the stress values of ramie fiber ropes coated with polyvinyl alcohol and those without coating differed significantly, with a P-value of 3.11×10^{-4} (<0.05), indicating that the application of polyvinyl alcohol has a significant effect on the stress of ramie rope. The polyvinyl alcohol coating increased the stress of the ramie rope by 39.02%. A comparison of the stress values between coated and uncoated ramie fiber ropes is shown in (Figure 2).

Stress value of ramie fiber ropes coated with polyvinyl alcohol has an average of 0.014 kgf/tex. Stress value of ramie fiber ropes without polyvinyl alcohol coating are lower, with an average of 0.007 kgf/tex. The polyvinyl alcohol coating also affects the elongation of the ramie rope. Elongation refers to the ability of the rope to stretch or elongate under a specific load before returning to its original shape or breaking (Wan et al., 2018). The elongation of ramie fiber ropes with and without polyvinyl alcohol coating can be seen in (Figure 2).

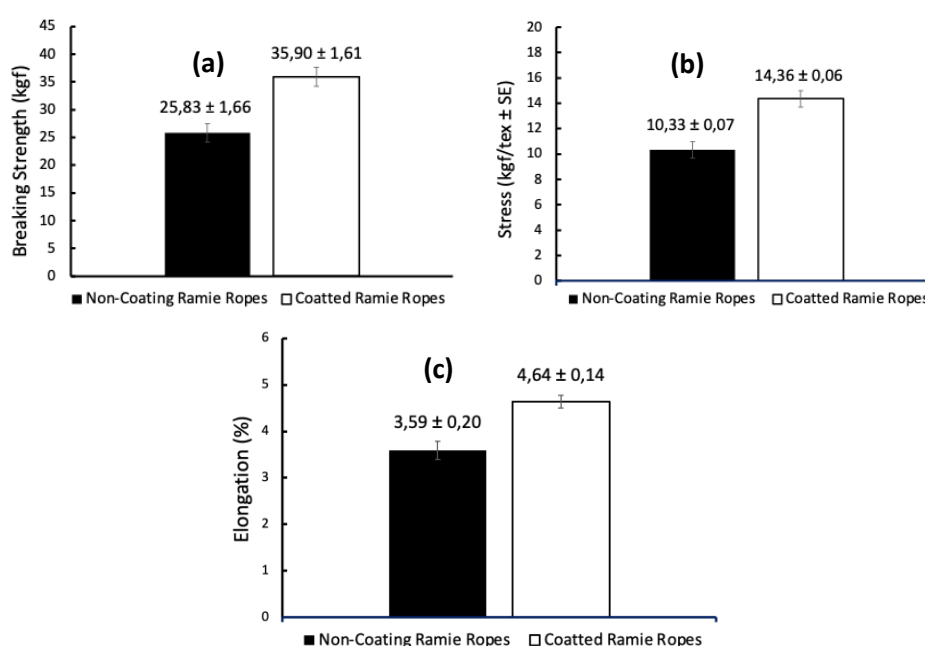


Figure 2. Results of the mechanical characteristic test of ramie ropes: (a) breaking strength, (b) stress, and (c) elongation, comparing non-coated and coated ramie ropes. These results indicate that the coating treatment improved the mechanical performance of ramie ropes, particularly in terms of strength, stress resistance, and elongation capacity.

Normality test using the Shapiro-Wilk method showed that the ramie fiber ropes coated with polyvinyl alcohol and those without polyvinyl alcohol coating were normally distributed, with P-values of 0.416 and 0.779, respectively (>0.05). The ANOVA (Analysis of Variance) results indicated that ramie fiber ropes with polyvinyl alcohol coating and those without coating had significantly different elongation values, with a P-value of 1.7×10^{-4} (<0.05). These statistical results show that the polyvinyl alcohol coating process significantly affects the elongation of ramie fiber ropes. The ramie ropes coated with polyvinyl alcohol exhibited an average elongation of 4.64%, while the ropes without the coating had an average elongation of 3.59%. The average elongation values indicate that the polyvinyl alcohol coating increases the elongation of ramie fiber ropes by 32.59%.

The increase in elongation observed in ramie fiber ropes coated with polyvinyl alcohol and plasticized with glycerin is likely due to the plasticizing effect of glycerin, which enhances the flexibility of the polyvinyl alcohol polymer chains (Tijani et al., 2024). Glycerin reduces polyvinyl alcohol's rigidity by weakening its intermolecular bonds. This modification allows

the polyvinyl alcohol polymer chains to move more freely, thereby increasing the flexibility of the material and enabling the ramie fiber rope to stretch more effectively without premature failure (Musiol et al., 2020). During tensile testing, fluctuations in the elongation of the ramie fiber ropes were observed. These fluctuations are attributed to the composition of short fibers (staple fibers) in the rope, which contribute to instability during testing (Komarudin et al., 2023). Furthermore, the rope's twist type, classified as weak (soft), results in a loosely arranged structure, which leads to weaker fiber bonds within the twist (Krisnafi et al., 2024).

3.2. Effect of Soaking on the Service Life of Ramie Rope

To assess the influence of seawater immersion on the durability of ramie fiber ropes, specimens with and without polyvinyl alcohol (PVA) coating were subjected to controlled soaking conditions. The service life of fishing gear is governed by a combination of internal and external factors. Internal factors pertain to the physicochemical properties of the constituent materials, including fiber composition and chemical stability. External factors involve environmental variables such as hydrodynamic forces (currents and waves), mechanical load from catch operations, and biological degradation processes facilitated by microbial activity (Komarudin et al., 2023).

In this study, ramie fiber rope specimens were immersed for a period of ten (10) weeks in container boxes filled with circulating seawater. The seawater was not replaced during the immersion period to allow natural degradation processes to occur and to observe the rate of material deterioration. This treatment was conducted to evaluate and compare the service life of ramie fiber ropes coated with polyvinyl alcohol (PVA) and those without the coating.

3.2.1. Effect of Seawater Immersion on the Breaking Strength of Ramie Rope

Assessment of the service life was carried out by evaluating the breaking strength of ramie fiber rope specimens using a Universal Testing Machine (UTM). The trend of breaking strength over the immersion period is illustrated in Figure 3. The initial breaking strength of the ramie fiber rope coated with polyvinyl alcohol was recorded at 42.60 kgf. Throughout the seawater immersion period, the breaking strength of the coated rope exhibited a gradual decrease, although slight fluctuations were observed at certain intervals. By the 10th week, the breaking strength declined to 28.10 kgf. Similarly, the uncoated ramie fiber rope had an initial breaking strength of 34.42 kgf, which also decreased over time with comparable fluctuations. At the end of the 10-week immersion, the breaking strength of the uncoated rope was reduced to 18.68 kgf.

After comparing the breaking strength of each treatment, further analysis was conducted using regression testing to calculate the immersion period required until the breaking strength and elongation of the ramie fiber ropes were exhausted. The decrease in breaking strength for both treatments indicates that seawater immersion affects the service life of the ramie fiber ropes. Based on the regression equations between immersion time and breaking strength for both polyvinyl alcohol-coated and uncoated ramie fiber ropes, the equation for the polyvinyl alcohol-coated ramie rope is $y = -1.4952x + 43.378$, with a coefficient of determination (R^2) of 0.8616. This indicates that the relationship between the breaking strength of the polyvinyl alcohol-coated ramie rope and immersion time explains 86.16% of the variation, with the equation predicting that the rope will fail at week 29 (7 months and 1 week). In comparison, the equation for the uncoated ramie fiber rope is $y = -1.6153x + 33.908$, with a coefficient of determination (R^2) of 0.9447. This explains that the relationship between the breaking strength of the uncoated ramie rope and immersion time accounts for 94.47% of the variation, and according to the equation, the rope will fail at week 21 (5 months and 1 week).

Breaking strength of the polyvinyl alcohol-coated ramie fiber rope is higher compared to the uncoated ramie fiber rope. This may be due to the additional protection offered by the PVA coating, which enhances the mechanical properties of the rope. The polyvinyl alcohol coating creates a binding layer that protects the fibers from water exposure, thereby reducing degradation during immersion. Furthermore, the polyvinyl alcohol layer can strengthen the

bonds between fibers, enhancing capacity, flexibility, and breaking strength (Zhang et al., 2024).

3.2.2. Effect of Seawater Immersion on the Elongation Properties of Ramie Rope

The elongation exhibited by polyvinyl alcohol-coated ramie rope fluctuated with increasing immersion duration, particularly after the second week of immersion. Elongation of uncoated ramie rope experienced a significant decrease following immersion in seawater. A clearer comparison of the effect of immersion on the elongation of both types of rope can be observed in Figure 3. Based on the regression equations between immersion duration and breaking strength of both polyvinyl alcohol-coated and uncoated ramie ropes, the regression equation for the coated ramie rope is $y = -0.0664x + 4.9681$, with a coefficient of determination (R^2) of 0.2275. The initial elongation of the polyvinyl alcohol-coated ramie rope was 5.36%. Following immersion in seawater, the elongation of the coated rope tended to decrease, although this reduction exhibited fluctuations from week 3 to week 10. For the uncoated ramie rope, the regression equation was $y = -0.1032x + 4.9681$, with a coefficient of determination (R^2) of 0.2705. The initial elongation of the uncoated ramie rope was 4.03%. A similar trend was observed in the breaking strength of the uncoated rope, which generally decreased but also fluctuated from week 3 to week 10.

The observed fluctuation in the elongation of uncoated ramie rope is hypothesized to result from its inability to recover its original dimensions after wetting, which is attributed to the permanent plasticity characteristics of ramie fibers. Upon water absorption, the fibers undergo initial stress relaxation and microfibril restructuring, as described by Haniel et al., (2023), leading to permanent deformation within the fiber structure. Due to the relatively low elastic limit of natural fibers such as ramie, exceeding this limit causes irreversible elongation, or creep, preventing the rope from returning to its original length after drying (Tang et al., 2024). Furthermore, Komarudin et al., (2023) suggests that elongation fluctuations in both polyvinyl alcohol-coated and uncoated ramie ropes may be influenced by the heterogeneous composition of natural fibers, where the material content per unit length varies, leading to inconsistencies in fiber composition cross test specimens.

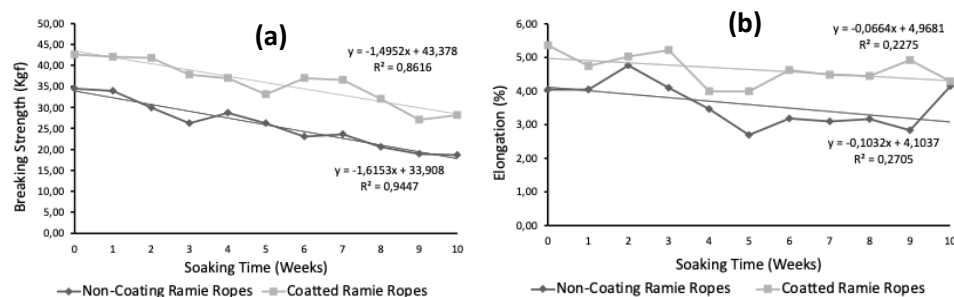


Figure 3. Effect of seawater immersion on the mechanical properties of ramie ropes during 10 weeks of soaking: (a) breaking strength and (b) elongation of non-coated and PVA-coated ramie ropes. Both rope types experienced a decrease in breaking strength during immersion, whereas elongation values showed only minor fluctuations. PVA-coated ramie ropes generally exhibited better mechanical performance than non-coated ropes throughout the soaking period.

3.3. Recommendation for the Application of Ramie Rope in Trap Fisheries

Trap nets (locally known as bubu) are traditional passive fishing gears made from materials such as rattan, wire, metal, netting, wood, and plastic, which are woven in such a way that fish entering the trap cannot escape (Puspawati et al., 2023; Sudarno et al., 2023). Trap nets are considered relatively selective fishing gears, and therefore, they do not pose a significant threat to the sustainability of aquatic habitats. This makes their continued use important for supporting sustainable fisheries (Nabiu et al., 2023). The operation of trap nets is passive in nature. One example is the crab trap, which operates by visually deceiving swimming crabs (Portunidae), leading them into the trap (Perdana et al., 2016). However, trap nets made from synthetic materials are prone to being lost or damaged in aquatic environments, which can

result in negative environmental impacts if left unattended. Losses may also occur due to the cutting or breaking actions of crustacean catch such as swimming crabs. Therefore, it is essential to develop and recommend the use of biodegradable fishing gear materials, such as polyvinyl alcohol-coated ramie rope, to mitigate the risk of ghost fishing associated with trap nets.

Polyvinyl alcohol-coated ramie rope is a promising material for use as a substitute in fishing gear components. Its smooth surface and relatively stiff texture closely resemble the characteristics of synthetic rope currently favored by fishers. Based on interviews with trap net fishers (bubu) in Situ Burung and Kali Adem, the typical technical lifespan of foldable traps they use ranges from 1 to 2 months. This duration is sufficient for polyvinyl alcohol-coated ramie rope to remain functional before it fully degrades. The tensile strength and elongation properties of the coated rope were found to be higher than those of uncoated ramie rope. Therefore, polyvinyl alcohol-coated ramie rope can be considered a suitable alternative material for replacing certain components of trap fishing gear.

The application of polyvinyl alcohol-coated ramie rope in foldable trap nets (bubu) can be implemented as a binding material for specific parts of the trap's entrance or as a frame-tying component. In the event that the trap is lost or drifts away, the biodegradable rope will gradually degrade, resulting in structural changes to the trap. This degradation renders the trap inactive, preventing further unintended catches. The ramie rope is depicted as red lines placed at the frame bindings, trap entrance, and side fastenings. The use of ramie rope at the trap entrance is intended to ensure that once the rope degrades, the upper section of the entrance collapses downward, creating an open path for trapped species to exit and enter the trap freely. Meanwhile, the use of ramie rope as a frame and side binder is designed so that when the rope degrades, the trap loses its structural integrity and can no longer function as a confinement space for fish. This design helps ensure that abandoned or lost traps in the marine environment no longer contribute to ghost fishing incidents. An illustration of the polyvinyl alcohol-coated ramie rope installation is presented in (Figure 4).

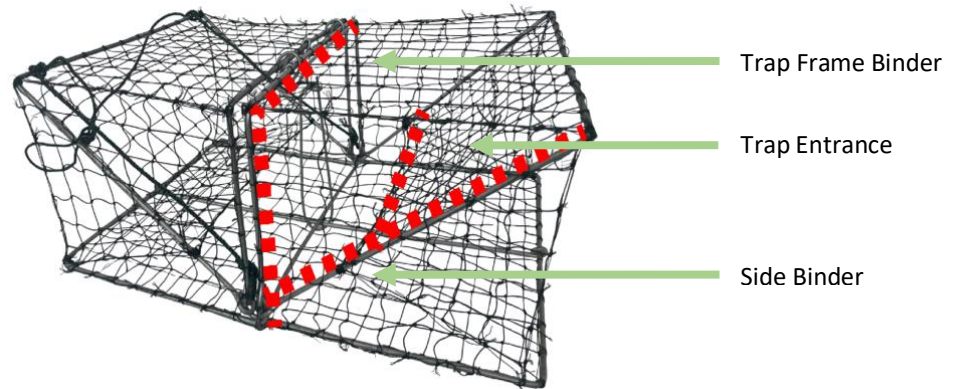


Figure 4. Illustration of the application of ramie rope on trap fishing gear (bubu), showing its use at the trap frame binder, trap entrance, and side binder. This figure highlights ramie rope was integrated into several key structural parts of the bubu, indicating potential function as a binding material in the construction of the trap.

4. Conclusion

Application of polyvinyl alcohol (PVA) coating effectively improved the functional performance of ramie rope as a biodegradable fishing gear material by enhancing its mechanical properties and extending technical service life in seawater. These improvements indicate that PVA-coated ramie rope has good potential to be used in selected components of trap fishing gear, particularly those intended to lose function after a certain period in the event of gear loss. Therefore, this material can be considered a promising alternative for supporting the development of biodegradable fishing gear and contributing to ghost fishing mitigation efforts.

Conflicts of Interest

The authors declare that there are no conflicts of interest declare.

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AI Writing Statement

During the preparation of this work, the authors used Grammarly and Google Translate to correct the grammar and helped in writing this manuscript. After using those tools, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication

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