Evaluation of polymeric coatings applied to a natural fique fiber mesh of a water harvesting fog catcher system

Evaluación de recubrimientos poliméricos para malla de fibra natural de fique en sistema atrapa nieblas para la captación de agua.

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***Abstract*—One of society's priority needs is acquiring fresh water due to high contamination levels and limited access in areas where this valuable resource is scarce. Non-traditional methods of water acquisition, such as fog catcher systems, are increasingly relevant because of their low cost and versatility. These systems use collection meshes to condense fog microdroplets. The water then undergoes filtration, adsorption, and disinfection processes to ensure its potability. Unfortunately, the materials commonly used in fog catcher meshes are synthetic, making them resistant to degradation. Consequently, natural fibers present a viable alternative for their replacement. However, the hydrophobicity of natural fibers is low, which results in limited water capture. This necessitates the development of new solutions, such as coatings, to enhance water capture efficiency. This article presents an evaluation of various polymeric coatings applied to natural fique fiber meshes installed in fog catchers, focusing on the impact of these coatings on water capture efficiency. Additionally, a mechanical and morphological characterization of the coated meshes was performed to assess their mechanical properties and adhesion. Mechanical characterization was conducted using tensile testing, which revealed improved properties in the epoxy-coated fique mesh system. Morphological analysis, using scanning electron microscopy, showed better adhesion between the epoxy and polyester resins and the natural fiber. Water capture tests conducted both in the field and in the laboratory demonstrated that the fique-epoxy coating is the most effective, increasing water uptake by 124.4% compared to uncoated fique fiber.**

***Index Terms*— Coatings, Composite, Fique, Fog catchers, Natural fiber, Water capture.**

***Resumen*—Una de las necesidades prioritarias de la sociedad es la adquisición de agua dulce debido a los altos niveles de contaminación y al acceso limitado en zonas donde este valioso recurso escasea. Los métodos no tradicionales de obtención de agua, como los sistemas atrapanieblas, son cada vez más relevantes por su bajo coste y versatilidad. Estos sistemas usan mallas colectoras para condensar microgotas de niebla. Luego, el agua pasa por filtración, adsorción y desinfección para asegurar su potabilidad. Lamentablemente, los materiales utilizados habitualmente en las mallas de los atrapanieblas son sintéticos, lo que los hace resistentes a la degradación.**

En consecuencia, las fibras naturales presentan una alternativa viable para su sustitución. Sin embargo, la hidrofobicidad de las fibras naturales es baja, lo que se traduce en una captura de agua limitada. Esto hace necesario el desarrollo de nuevas soluciones, como los recubrimientos, para mejorar la eficacia de la captura de agua. Este artículo presenta una evaluación de varios recubrimientos poliméricos aplicados a mallas de fibra de fique natural instaladas en atrapanieblas, centrándose en el impacto de estos recubrimientos en la eficiencia de captura de agua. Además, se realizó una caracterización mecánica y morfológica de las mallas recubiertas para evaluar sus propiedades mecánicas y su adherencia. La caracterización mecánica se llevó a cabo mediante ensayos de tracción, que revelaron una mejora de las propiedades en el sistema de malla de fique recubierto de epoxi. El análisis morfológico, mediante microscopía electrónica de barrido, mostró una mejor adherencia entre las resinas epoxi y de poliéster y la fibra natural. Las pruebas de captación de agua realizadas tanto en el campo como en el laboratorio demostraron que el recubrimiento de fique-epoxi es el más eficaz, ya que aumenta la captación de agua en un 124,4% en comparación con la fibra de fique sin recubrir.

***Palabras claves*— Atrapanieblas, Captación de agua, Compuestos, Fibra natural, Fique, Recubrimientos.**

I. INTRODUCTION

One of the current challenges facing humanity is the availability of clean freshwater, due to the contamination of various water sources as a result of economic expansion, industrial development, and climate change. This contamination affects the accessibility of water for essential uses such as drinking, hygiene, and food security, directly impacting public health [1].

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This contamination affects the accessibility of water for essential uses such as drinking, hygiene, and food security, directly impacting public health [1].

In the world, fresh water represents 3% of the existing total, making it difficult to obtain since 70% of it is present in the form of glaciers and snow in high mountains [2]. In this context, new ways of obtaining fresh water that are practical and at low cost have been explored.

Among the emerging non-traditional methods of water acquisition, the most prominent are rainwater harvesting, groundwater collection, desalination, and atmospheric water recovery, with the latter being the most significant due to its low cost and versatility [3].

The system commonly used to capture water from the air is known as fog catcher, which provides an accessible water supply at high altitudes [4]. Its operation consists of the condensation of atmospheric water vapor that is present in the air, concentrating it into drops of liquid water, known as dew [5].

Fog catchers are generally made of polypropylene or polyethylene meshes known as Raschel meshes. This material is used due to its high hydrophobicity, this being one of the most important parameters in the efficiency of this type of system [6], together with its high commercial availability, low price and good mechanical behavior [7].

The latest research in this type of devices is focused on the development of bio-inspired designs for increased water capture and the development of new materials [8]. Unfortunately, polypropylene and polyethylene are materials of synthetic origin and therefore remain inert to degradation, which leads to their accumulation creating serious environmental problems [9].

A material that can replace the synthetic fibers that make up the meshes of conventional collectors are natural fibers, since they have high mechanical resistance, high rigidity, low density and high availability at a low cost. In addition to the above, production requires little energy, is carried out with low emission of toxic fumes and with less abrasive impact on the processing equipment [10] [11].

However, the problem with natural fibers to be applied in fog catcher systems is that they have a hydrophilic nature, absorbing the water present in the air without allowing it to be used, and are further degraded by microorganisms and sunlight [12].

In order to increase the efficiency of fog catchers, research has focused on the use of surface coatings that increase the hydrophobicity of the systems, mainly applied to fibers made of synthetic materials [13] [14]. Additionally, research is limited to comparisons of different synthetic textile meshes and fog catchers in the laboratory or in the field [15]. However, there is not enough information on studies where an application in fog-catching systems with natural fibers and coatings is performed.

Fique fiber is extracted from the leaves of the plant of the same name. It is a resistant and versatile material that is grown mainly in Colombia, Ecuador and Mexico. It belongs to the agavaceae family, this fiber has a length of 1.5 to 2 meters and is known for its hardness. Traditionally, it is used to make ropes and sacks. In addition, fique is ideal for packing coffee for export due to its ability to preserve freshness. In a more innovative approach, yarns and textile bases have been developed from fique fiber, offering a sustainable alternative to traditional fibers and contributing to the economic development of rural communities in Latin America [16].

It is for this reason that in this article the evaluation of different polymeric coatings applied on a natural fiber mesh of fique installed in a fog catcher was carried out, knowing the influence of the use of these coatings on the level of water capture in the laboratory and in the field. Additionally, a mechanical characterization was carried out to know the resistance to external forces that can be caused by the environment and a morphological characterization was also carried out to know the adhesion of the coating with the natural fiber. Although natural fibres such as fique represent a sustainable alternative to synthetic fabrics due to their renewable and biodegradable nature, they require the application of a polymer coating to improve their hydrophobic properties. Although this coating, which is of synthetic origin, reduces their degradability, the controlled integration of this material on a natural and biodegradable fibre allows a significant reduction in the amount of polymer used compared to conventional plastic fabrics, thus reducing their environmental impact.

II. MATERIALS AND METHODS

A. Materials

As a natural material for the meshes, fique fiber was used in a weaving configuration, which presented a 0/90 braid configuration, with a double fiber in the warp and a double fiber in the weft. This fiber was extracted from packaging used to transport coffee. Fig. 1 shows the fiber used.

Fig. 1. Fique fiber used

Four different types of commercial polymeric coatings were used in order to identify which of these allowed the greatest amount of water capture when the fique fiber mesh was coated and used in the fog catchers. The general characteristics of each of the coatings are mentioned below.

- Epoxy resin: The percentage of resin-catalyst applied by volume was 1:1 respectively. The resin was acquired from the company Ingequimicas of Bucaramanga, Santander, Colombia.
- Asphalt emulsion (EUCD): The resin was applied diluted in a ratio of 1 to 3 by volume of water. Curing was carried out for 48 hours at room temperature. The resin applied was Sika brand asphalt emulsion.
- Impercryl: This resin is formulated with styrene acrylic resins, plasticizers and ceramic particles. The application was direct with one coat. The resin brand used was P-7 of Poliescol in white color.
- Polyester: The polyester resin applied was pre-accelerated, catalyzed at 3% by weight with methyl ethyl ketone peroxide (MEK peroxide). The resin was purchased from the company Ingequimicas of Bucaramanga, Santander, Colombia, reference 856.

B. Characterization of meshes with coatings

Four fique-coating meshes were evaluated, presenting the configuration shown in Table I, and an additional configuration of uncoated fique mesh was also analyzed, as well as an additional poly-shade mesh (Raschel), which is the one usually used in this type of fog-catching devices.

TABLE I.
CONFIGURATION OF FIQUE-COATING SYSTEMS

Material	Description
Material 1	Fique mesh coated by epoxy resin
Material 2	Fique mesh coated by asphalt emulsion
Material 3	Fique mesh coated by impercryl
Material 4	Fique mesh coated with Polyester
Material 5	Uncoated fique mesh
Material 6	Polyshade mesh (Raschel)

The different coatings were applied on the fique fabrics by means of conventional brushes, superficially covering the natural fibers with the synthetic resins. All the resins were cured for 72 hours at room temperature, and the product was applied in a single layer on the fique fiber mesh.

To quantify the amount of polymer deposited on the natural fibers, a mass analysis of the applied coatings was performed. For this purpose, three representative fragments of each mesh, measuring 8 cm × 8 cm, were weighed before and after the polymer application using a Highland HCB602H precision digital balance. This procedure enabled the determination of the average mass of polymer added per sample.

Mechanical characterization was carried out by means of the tension test following the ASTM D4595-17 standard, this standard was developed for geotextiles, however, as expressed by Dios Rivera *et al*. [17], it is the most appropriate standard to characterize this type of materials since there is no specific standard for the evaluation of textiles in fog-catching systems.

Although the primary function of the fique fiber meshes in fog water harvesting systems does not require high mechanical strength, the tensile properties of both coated and uncoated meshes were evaluated in this study to assess their structural integrity under environmental conditions. Natural fibers are exposed to wind loads, handling, and long-term weathering, which can cause mechanical degradation over time. Therefore, understanding the effect of polymeric coatings on the tensile behavior provides relevant information about the durability and stability of the meshes during prolonged outdoor exposure, even if mechanical performance is not a critical design requirement.

The tests were carried out on a 10 KN MTS model C43.104 universal machine. The results obtained present the tensile stress (maximum force per unit width) on deformation applied to 5 specimens of each system with a geometry of 40 mm wide by 200 mm long, as established in the standards. The results presented are the average of those obtained on the five test specimens. The strain rate was defined as 11% /min with an ambient temperature of 21.2 +/- 1.2°C and a humidity of 63.2 +/- 1.2 %. It is important to note that the specimens were tested in their dry state, meaning they had only absorbed the moisture naturally present in the laboratory environment. Fig. 2 shows the mechanical characterization of material 2.

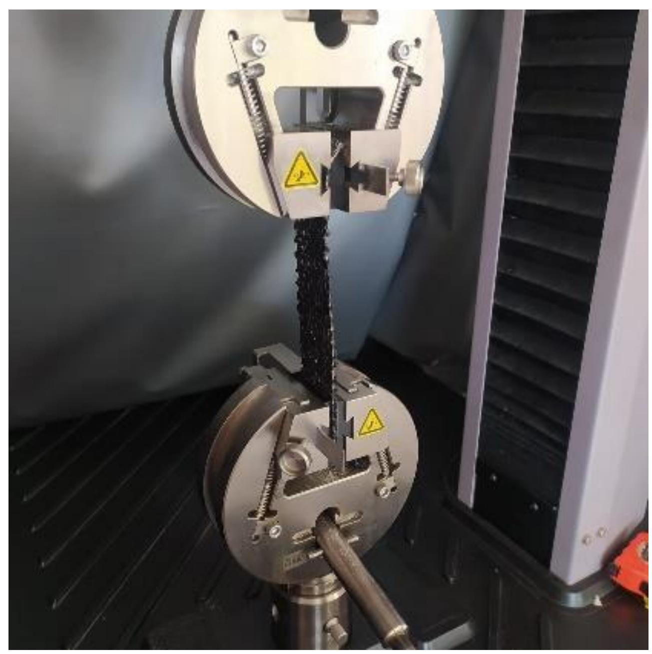

Fig. 2. Mechanical characterization

Additionally, a morphological characterization of the mesh materials was performed using scanning electron microscopy. Samples smaller than 3 cm² (the size limit required by the equipment) were coated with gold to enhance conductivity, utilizing a Cressington Model 108 Auto/SE sputtering system. Fig. 3 presents the samples and their coating.

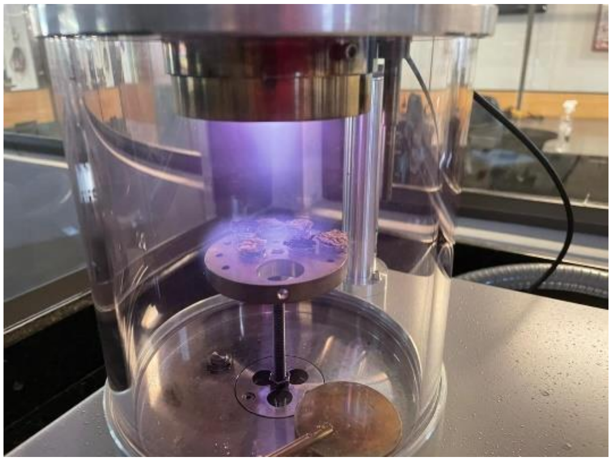

Fig. 3. Meshes coated with gold

The study was carried out with a Tescan scanning electron microscope model MIRA 3 FEG-SEM with a secondary electron detector model A65c SED. Images were taken at 200X, 500X and 1000X magnifications.

The water capture test of the coated mesh materials was performed in the laboratory, using the setup designed by Rajam et al. [13] and Wang [14] as a reference. In this procedure, fog was generated using an ultrasonic humidifier, submerged in 3 liters of water stored in a polymeric cubicle. Additionally, a fan operating at 3600 revolutions per minute was used to increase the outflow velocity of the fog. A plastic tube was installed in the cubicle to direct the flow over the different test samples of each system. Fig. 4 shows the schematic used in the laboratory test.

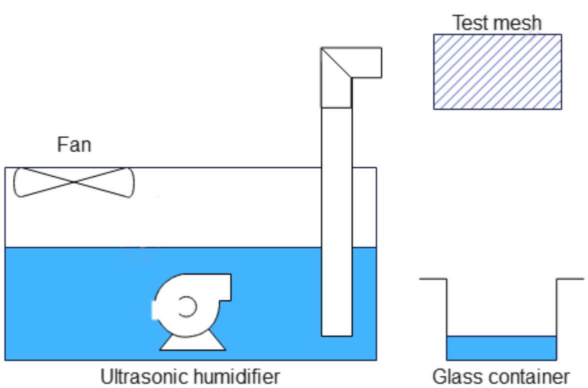

Fig 4. Schematic of the laboratory test

A glass container was installed under the samples of each of the systems to collect the drained water. The different materials were installed 5 cm from the pipe outlet. Each sample was exposed to the fog generated by the device for 60 minutes, the amount of water collected was weighed with a digital balance to obtain the results. The samples evaluated had a geometry of 12 cm by 12 cm.

C. Construction and evaluation of fog catchers

Six flat type fog catchers were constructed using different mesh materials. The meshes used for each of the fog catchers were 1 m wide by 1.5 m high. The lateral supports were made of 2.5 m high bamboo wood pillars embedded in the ground. At the bottom of the mesh, 1-meter-long PVC gutters with a diameter of 110 mm were installed, through which the captured fluid precipitated towards the storage tank by gravity due to the inclination of the gutter of approximately 30°. Each fog catchers configuration was installed one after the other in order to keep the water collection conditions as repeatable as possible.

The application of the coatings for each of the meshes of the systems that contained fique fiber was carried out manually with a brush and on both sides (front and back), replicating what was done with the materials. Fig. 5 shows the application process.

Fig. 5. Coating application process

The mesh anchoring system to the supports was made using stainless steel cables and tensioners with a diameter of 5.16 mm. Fig. 6 shows the fog catchers that were manufactured and installed.

Fig. 6. Fog catchers manufactured and installed

The water collection with the fog catcher systems was carried out in the municipality of Floridablanca, Santander, Colombia (7.03835, -73.07218). The region has a tropical climate. The climatological parameters for the two-month period during which the tests were conducted are shown in Table II.

TABLE II.
CLIMATOLOGICAL PARAMETERS

Parameters	Month 1	Month 2
Maximum temperature (°C)	28.88	27.77
Average temperature (°C)	23.57	23.21
Minimum temperature (°C)	18	20
Precipitation (mm)	180	195
Average Humidity (%)	87%	86%
Wind Speed (mph)	4.82	4.24

It should be noted that the climatological data were obtained from a weather monitoring station located very close to where the fog-catching systems were installed. Fig. 7 shows the monitoring station.

Fig. 7. Monitoring station

The water captured by the fog catchers was stored in plastic containers, recording the volume of water captured, in milliliters, every 3 days. A total of 10 measurements were obtained for each fog catchers, however 2 measurements were discarded as they were affected by rainfall precipitation in the area. The results show the average of the 8 endorsed measurements.

D. *Statistical analysis*

In order to define if the differences obtained between the results of the mechanical characterization of the different systems and water capture in the six types of fog catchers were statistically significant, an analysis of variance (ANOVA) was used, in which if the P value is less than the significance level (defined as 0.05), it is concluded that at least one mean of the mechanical properties and water capture of the systems is different. Additionally, Scheffe's post hoc tests were performed to perform multiple comparisons of the means and to recognize which of them was different.

III. RESULTS

A. *Characterization of meshes*

Table III shows an increase in the mass of the fique meshes after the application of polymeric coatings, which varies according to the type of resin used. This increase reflects the amount of polymeric material adhered to the natural fibers.

TABLE III.
QUANTIFICATION OF POLYMER MASS DEPOSITED ON FIQUE FIBER MESHES.

Material	Initial Mass (g)	Final Mass (g)	Coating Mass (g)	Coating Mass (%)
Material 1	3.22 ± 0.8	4.15 ± 1.1	0.93	28.9
Material 2	3.14 ±1.1	3.68 ± 0.9	0.54	17.2
Material 3	2.91 ± 0.7	3.62 ± 0.8	0.71	24.4
Material 4	3.23 ±0.5	4.24 ± 0.4	1.01	31.3

The results show an increase in the mass of all fique meshes after the application of the polymeric coatings, suggesting the formation of a layer on the natural fibers. Among the materials evaluated, Material 4 exhibited the highest mass gain. This behavior is attributed to the high solid content of the polyester resin, which promotes greater deposition and retention of the coating on the fibers.

In contrast, Material 2 recorded the lowest mass increase, due to the high water content of the asphalt emulsion used. During the curing process, this water evaporates, leaving a lower amount of solids adhered to the fiber.

Meanwhile, Material 1 (coated with epoxy resin) and Material 3 (coated with Impercryl) showed intermediate increases. The epoxy resin, like the polyester resin, has a considerable solid content, although slightly lower, which explains its behavior. In the case of Impercryl, an acrylic-based coating, its lower mass gain is also related to its high water content, similar to the asphalt emulsion, which upon evaporation reduces the amount of solid material retained on the fibers.

However, it is important to note that the observed mass increase is mainly associated with the amount of material deposited and does not necessarily reflect the uniformity or quality of the coating adhesion.

Table IV shows the results obtained from the tensile mechanical tests performed on the meshed materials coated with the different polymers.

TABLE IV.
TENSILE TEST RESULTS

Material	Tensile Strength (N/m)	Tensile Modulus (N/m)
Material 1	35550 ± 6098	603697 ± 34325
Material 2	9275 ± 674	143093 ± 47275
Material 3	13792 ± 1102	190142 ± 88387
Material 4	31308 ± 6972	498374 ± 49683
Material 5	8375 ± 3340	120412 ± 32605
Material 6	2658 ± 253	10416 ± 1116

All systems showed an improvement in tensile stress when the coatings were used, compared to the uncoated fique mesh system. The best performance was obtained by the epoxy resin-coated fique mesh system, which showed an increase of 324.4% compared to the uncoated fique fabric. This was followed by the polyester resin coated system with an increase of 273.8%.

The fique fiber mesh systems exhibited a higher tensile strength than the poly-shade mesh, this is due to the fact that although natural fibers usually have lower mechanical properties than polymeric fibers [18], there were more natural fibers that were supporting the load due to the configuration and manufacture of the fique fabric used. According to Singh *et al*. [19] the higher the fiber volume fraction, the better the mechanical behavior. Fig. 8 shows the configuration and quantity of the fibers of the fique fabric and the poly-shade mesh. The results obtained for the polyshade mesh are in the order of those reported by Rivera *et al*. [20], the results of fique could not be compared since there are no studies where they were characterized with the standard used in the study.

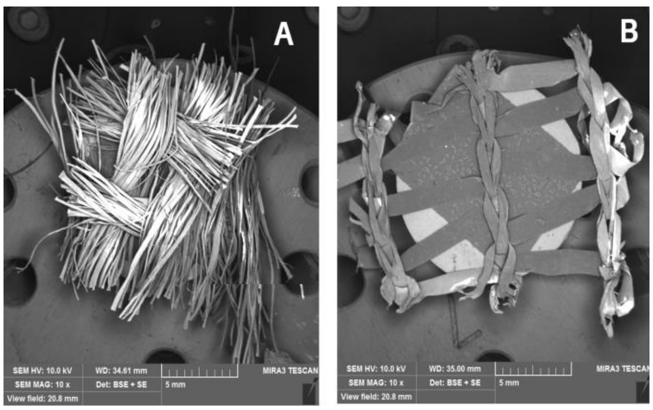

Fig. 8. Woven configuration. A) Fique fiber, B) polyshade

The coatings used made all the meshed systems stiffer compared to the uncoated fique fabric. The highest tensile modulus was presented by the fique mesh coated with epoxy resin being 401.36% higher than the uncoated fique fiber fabric and the lowest was presented by the fabric coated with asphalt emulsion, however, being also higher than the uncoated fabric by 18.83%.

Table V shows the ANOVA tests where the significant differences between the means of the different mechanical properties of the meshed systems were evaluated.

TABLE V.
ANOVA TEST FOR MECHANICAL PROPERTIES

Property	Source	Sum of squares	Mean square	FO	P
Tensile	Residual	2.70 E+9	5.39 E+9	32.8	<0.001
Strength	systems	1.97 E+8	1.64 E+7		
Tensile	Residual	6.36 E+11	1.27 E+11	33.8	<0.001
Modules	systems	4.51 E+10	3.76 E +9		

As can be seen, a P value of less than 0.05 is obtained for both tensile stress and modulus of elasticity, indicating that at least one of the coated meshed systems had a statistically different mean from the others.

Post hoc tests show that the system coated with epoxy resin and the one coated with polyester have no statistically significant differences between them in their tensile stress and modulus of elasticity; however, there are differences with the other mesh systems. Additionally, the asphalt emulsion, impercryl, uncoated fique fabric and polyshade systems have no statistically significant differences between them in their tensile modulus and stress.

Scanning electron microscopy analysis of the different fique mesh systems with epoxy resin, asphalt emulsion, Impercryl, and polyester resin coatings are shown in Fig. 9, 10, 11 and 12, respectively.

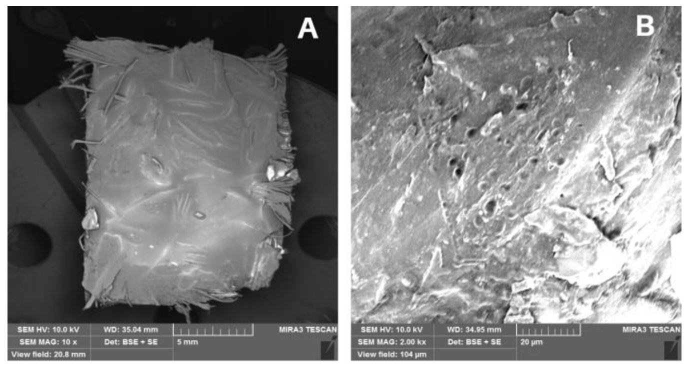

Fig. 9. Electron microscopy of epoxy resin coating. A) 10X, B) 2000 X

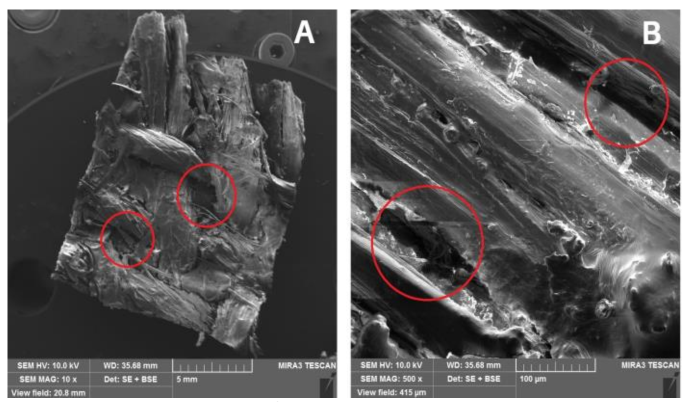

Fig. 10. Electron microscopy of the asphaltic emulsion coating. A)10 X, B)500 X

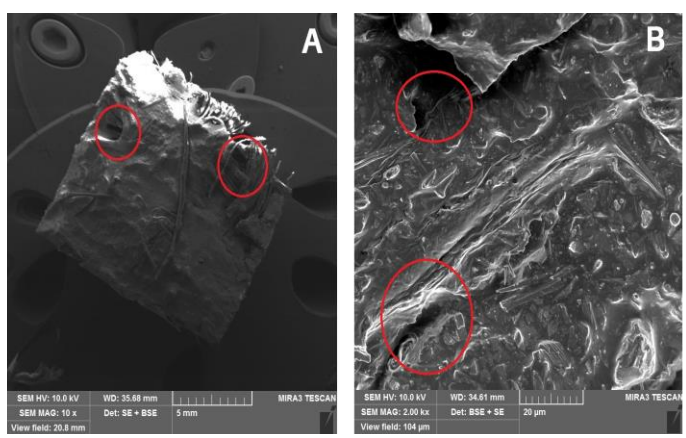

Fig. 11. Electron microscopy of the impercryl coating. A) 10 X, B) 2000 X

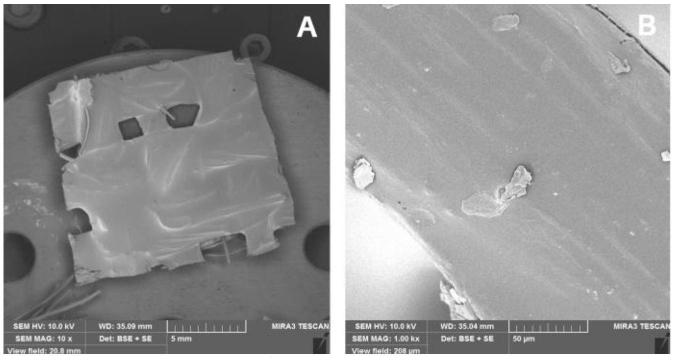

Fig. 12. Electron microscopy of the polyester resin coating A)10 X, B) 1000 X

A low compatibility between the fique fiber with the asphalt emulsion and with the impercryl coating is evidenced, presenting cracks and spaces where the resin did not have good adherence with the fibrous surface. This can be attributed to the nature of their functional groups, which do not form strong interactions with the hydroxyl groups present in the fique fiber. Additionally, the mass analysis confirmed that materials with lower adhesion also exhibited lower mass, suggesting that the amount of deposited polymeric material influences crack formation. This indicates that both chemical compatibility and material quantity affect adhesion performance. However, with respect to the epoxy and polyester resin, the morphological analysis infers that there was a better adhesion with the fique, since it presents a wide, smooth and compact surface. This improved adhesion is likely due to the reactive epoxide groups in the epoxy resin, which form strong covalent bonds with the hydroxyl groups of the natural fiber, and to the crosslinking reaction of polyester resin catalyzed with MEK peroxide, which enhances rigidity and adhesion. It should be noted that the polymer resin-natural fiber adhesion is not so good due to the hydrophilic characteristics of the fibers and the hydrophobic nature of the matrix together with the impregnation process used, which was manual [21].

The SEM micrographs revealed that, after the application of the polymeric coatings, the natural roughness and porous structure of the fique fibers were partially covered by the synthetic layer. This morphological change suggests a reduction in the effective surface area available for water droplet condensation. Although the coatings improved the hydrophobic behavior of the meshes, the smoother surface generated by the polymer layer may limit the anchoring points for droplet formation, potentially affecting the fog water harvesting efficiency.

The water capture tests of the coated mesh materials carried out in the laboratory showed the results presented in Fig. 13.

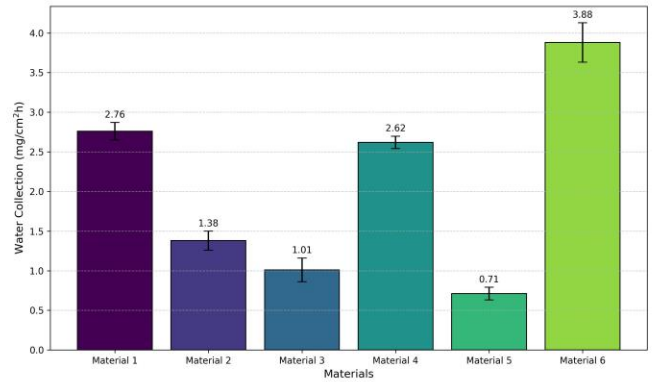

Fig. 13. Water capture testing of coated mesh materials in the laboratory.

The highest water capture was obtained in the Polyshade mesh system (Rachel), being 3.88 ± 0.258 mg/cm2h. This result was not only due to the characteristics of the Polyshade mesh material but, additionally, to the geometry and size of the mesh, since these are factors that directly affect the capture efficiency as mentioned by Vásquez et al. [22], these parameters being different in the fique fiber mesh used with the other coatings.

The use of polymeric coatings applied to the natural mesh increased the amount of water capture, with a higher percentage in the mesh with epoxy resin, where the increase obtained was 289.08% with respect to the uncoated natural fiber, followed by the mesh with polyester resin at 268.66%. The lowest growth was presented with the impercryl at 41.54%.

When the ANOVA test was applied to evaluate significant differences in water capture in the laboratory, the values shown in Table VI were obtained.

TABLE VI.
ANOVA TEST FOR WATER CAPTURE IN THE LABORATORY

Property	Source	Sum of squares	Mean square	FO	P
Water capture in lab	Residuals	30.013	6.0026	209	<0.001
	systems	0.517	0.0287		

As can be seen, a P value of less than 0.05 is obtained, so that at least one of the coated mesh systems presents a statistically different mean from the others in the amount of water capture.

Post hoc tests show that the poly-shade mesh had a statistically significant mean water capture difference versus the others. Additionally, the water capture of the mesh coated with epoxy resin and polyester did not show significant differences between the mesh coated with asphalt emulsion, Impercryl and the uncoated fique mesh, and there were no statistically significant differences.

B. Evaluation of fog catchers

The average obtained from the 8 measurements of water capture by the fog catchers installed in the field is shown in Fig. 14.

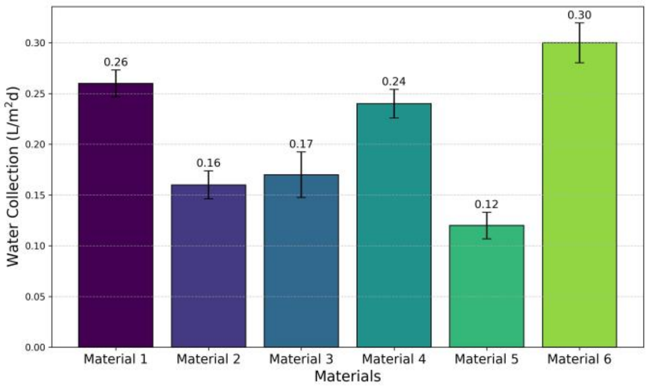

Fig.14. Water capture testing of coated mesh materials in the field.

The highest water capture was obtained in the fog-catcher with the poly-shade mesh, followed by the fog-catcher with fique mesh coated with epoxy resin, which had an increase of 124.4% in water capture with respect to the fog-catcher with the uncoated fique mesh.

The coatings on the fog catchers, with polyester resin, impercryl, asphalt emulsion increased water capture by 105.9%, 41.5%, and 37.2%, respectively, compared to the uncoated fique fiber.

The increase in water capture, as reported by Rajaram et al. [23], is due to the fact that increasing the hydrophobicity of the mesh increases the fog collection efficiency. Despite the increase in water capture with the applied coatings versus natural fiber, the amount collected by the fog catchers is below the common values where these systems are installed which are 0.8 to 10 L/m2d [24].

When the ANOVA test was applied to evaluate significant differences in the field water capture, the values shown in Table VII were obtained.

TABLE VII.
ANOVA TEST WATER CAPTURE IN THE FIELD

Property	Source	Sum of squares	Mean square	FO	P
Water capture in field		0.250	0.050	150	<0.001
	Residuals systems	0.0179	3.32 E-4		

The post hoc tests reflected the same behavior as the laboratory tests, where the polyshade mesh showed a statistically significant difference in water capture versus the others; between the mesh coated with epoxy resin and polyester there are no significant differences and additionally between the meshes coated with asphalt emulsion, Impercryl and the uncoated fique mesh there are no statistically significant differences.

IV. CONCLUSIONS

The mechanical, morphological, and water capture properties of four polymer-coated fique fiber meshes (epoxy, polyester, Impercyrl, and asphalt emulsion) were evaluated and compared to an uncoated fique mesh and an additional poly-shade mesh (Raschel).

An increase in the mechanical properties was evidenced in all the polymer-coated fique meshes, compared to the natural fique mesh system. The best performance was obtained in the epoxy resin coated fique mesh system.

The morphological analysis with scanning electron microscopy allowed observing low adhesion between the fique fiber with the asphalt emulsion and with the impercryl coating. However, with respect to the epoxy and polyester resin, a medium adhesion was observed.

The use of all the polymeric coatings applied to the natural fiber mesh increased the amount of water capture in the laboratory, with the highest increase when using the epoxy resin, compared to the uncoated natural fiber.

Fog catchers were manufactured and installed in the field with fique fiber coated with the polymers, which showed an increase in water capture compared to uncoated natural fique fiber. The results, as in the laboratory, showed that the increase was greater with the epoxy coating.

As the mechanical properties of the materials in this study could be affected by water absorption, further research is needed to evaluate these materials under operational humidity conditions. This will provide more relevant information for practical reuse.

It is important to acknowledge that the application of polymeric coatings not only modifies the hydrophobic behavior of the natural fibers but also alters their surface morphology and increases their mass. This study did not quantify the specific surface area reduction caused by the coatings, which could have an impact on the condensation and water harvesting efficiency. Future studies should address this limitation by evaluating the relationship between surface area loss, added polymer mass, and water collection performance in order to optimize the coating application.

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