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Degradation of geotextiles of *Typha latifolia* Linn used in soil bioengineering techniques

Degradação de geotêxteis de *Typha latifolia* Linn utilizados em técnicas de bioengenharia de solos

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Abstract

The use of taboa fibers (*Typha latifolia* Linn), for geotextile manufacturing, was designed to stabilize riverbanks or slopes and to create an ecologically suitable environment for the recovery of vegetation and soil anchoring. The objective of this work was to evaluate the resistance of geotextiles manufactured from taboa fibers submitted to accelerate aging in the laboratory and degradation of these fibers in the field. The geotextile manufacturing was performed with different knots in fibers that had previously undergone different drying processes. To perform the tests in the laboratory, an apparatus that allowed the geotextile to be subjected to premature aging was built, seeking to simulate the environmental conditions. The fibers were exposed to UVB radiation followed by condensation, using also a mechanical cooler, for temperature equalization. The tensile strength tests followed the guidelines observed in the ISO 10319 (1996) and ISO 12236 (1998) Brazilian National Standards. The field trials were conducted by placing samples on a slope on the right bank of the São Francisco river in the municipality of Amparo do São Francisco, Sergipe state, 10°08'20.7''S 36°54'47.0''W, Northeaster Brazil, with 20m^2 area, under local climatic conditions, for further evaluation of their degradation. Since the materials are not homogeneous in their manufacture, non-uniform results occurred when subjected to degradation. This may explain the fact that unexpected increases in stress and strain values were observed. The taboa geotextile showed results of rupture stress and deformation that signals positively for its commercial use, thus confirming its potential for use as part of soil bioengineering techniques.

Keywords: Innovation; Erosion; Bioengineering

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Resumo

O uso das fibras da taboa (*Typha latifolia* Linn), para confecção de geotêxteis, tem sido trabalhada, buscando a estabilização de taludes de rios ou encostas, e assim criando um ambiente ecologicamente favorável para a recuperação da vegetação e a ancoragem do solo. O objetivo deste trabalho foi avaliar a resistência e durabilidade de geotêxteis fabricados com fibras da taboa submetidos ao envelhecimento acelerado em laboratório e degradação dessas fibras em campo. A confecção dos geotêxteis foi realizada com diferentes nós em fibras que passaram previamente por processos de secagem distintos. Para a realização dos testes em laboratório, foi construído aparato que permitiu submeter os corpos de prova ao envelhecimento precoce, buscando simulação das condições ambientais, isto é, as fibras foram expostas à radiação UVB seguida de condensação, utilizando-se também um resfriador mecânico para equalização da temperatura. Os ensaios de resistência à tração seguiram diretrizes observadas nas normas ISO 10319 (1996) e ISO 12236 (1998). Os ensaios de campo foram conduzidos por disposição de amostras em um talude da margem direita do rio São Francisco no município de Amparo do São Francisco-SE, 10°08'20.7''S 36°54'47.0''W, Nordeste do Brazil, com área de 20m^2, submetidas às condições climáticas locais, para posterior avaliação da sua degradação. Uma vez que os materiais não apresentam homogeneidade na sua fabricação, ocorreram resultados não uniformes quando submetidos à degradação. Isso pode explicar o fato de serem observados aumentos inesperados nos valores de tensão e deformação. O geotêxteis de taboa apresentou resultados de tensão de ruptura e deformação que sinaliza positivamente para o seu uso comercial, confirmando, assim, as suas potencialidades para uso como parte das técnicas de bioengenharia de solos.

Palavras-chave: Inovação; Erosão; Bioengenharia

Introduction

The soil bioengineering or biological engineering, which is the combination of techniques that use inert materials (iron, rocks, geotextiles) with living structures (vegetation), have been gaining technical importance and visibility and playing a role in the erosion control on riverbanks and slopes, and associated with works of civil engineer in this area (SANTOS; HOLANDA, 2013).

The use of geotextiles combined with recognized viability technologies offers a great advantage in protecting the soil, mostly recognized as the low cost when compared to other techniques of traditional engineering (FUGGINI *et al.*, 2016). According to Holanda *et al.* (2009) and Broda *et al.* (2018), Geotextiles promote immediate protection against soil erosion, characterized in that programmable degradation as well as they provide speed in the revegetation process, a situation that allows potential reduction of erosion.

The occurrence of low availability of geotextiles made from natural fibers on the market, is restricted to a few species, almost exclusively made from fibers extracted from coconut (*Cocos nucifera* L.) as well, sisal (*Agave sisalana* Perrine) (DESAI and KANT, 2016) and Kenaf (*Hibiscus cannabinus*) (SHIRAZI *et al.* 2019).

Vegetable fibers for the production of geotextile have a potential use because they have a combination of good mechanical and environmental properties (KUMAR; DAS, 2018) simple technical requirements for its adoption, combined with good adaptation to the landscape and environmental features. It is also important the previous investigation of the durability of these materials in trials conducted in the laboratory or in the field, necessary to better understand their properties in order to succeed in the slope stabilizations and in the recovery of vegetation that promote the soil anchorage. Along with the study on the durability of the material in the field, it is possible to predict its efficiency and the proper planning and prediction on the functionality of soil bioengineering work and its effectiveness in stabilizing slopes.

The durability or geotextile resistance should be understood as the property that ensures optimal performance and integrity of the material over a period of time of exposure to environmental agents where installed (KUMAR; DAS, 2018). Physical agents that act on the geotextile installed on the river bank, are the river discharge, variation of the water level, temperature, relative humidity, rainfall, radiation, wind, atmospheric pressure, etc. (DIAS FILHO *et al.*, 2016).

The geotextiles manufactured from braided of natural fibers require field or laboratory testing to determine their resistance in order to understand the behavior of their degradation. Simulating in laboratory the effects of weathering occurring in the natural environment and also adding intensity in its effects bring new information on the predictability of that material behavior by accelerating its degradation (METHACANON *et al*., 2010).

Because it is a recent approach on this subject, methods of manufacturing geotextiles, using natural fibers are still lacking, i.e., there is no specific technical standards that direct such tests (JEON, 2016). The taboa fiber is used mostly as raw material for making handicrafts (mats, bags, chairs, flooring, etc.), making the activity an important source of supplementary income for traditional communities as artisans in riparian areas (CARVALHO, 2018). Taboa, tropical plant very common in estuaries and poorly drained soils, has unisexual flowers on declining ears, found at the edge of rivers and lakes, in large quantities, forming what is called "Taboal", growing up to four meters high (BEZERRA, 2006).

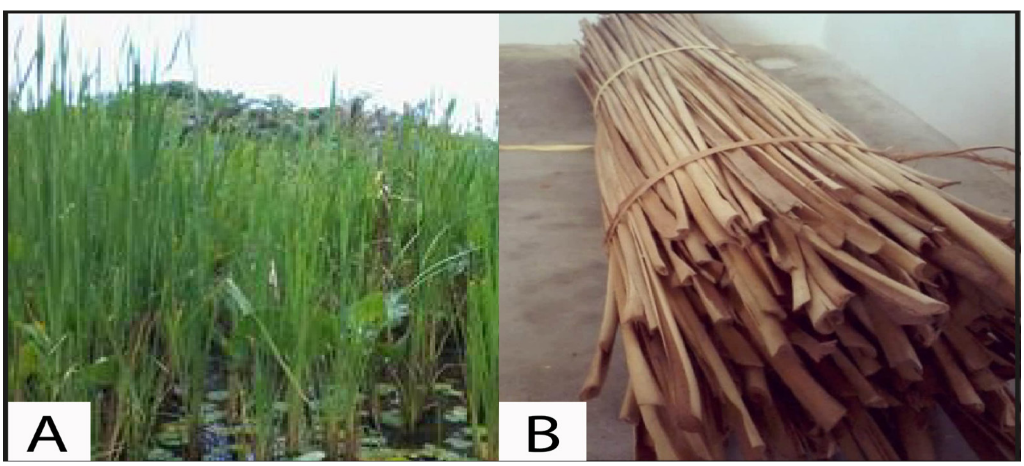
There is an urgent demand for research on new plant fibers applied to the production of geotextiles with high efficiency and durability as well as proven protective action and soil cover, from renewable sources and low cost, to compose soil bioengineering techniques (EMBRAPA, 2014), as well as instruments that make possible the measurement of its strength, considering the possibility of operating materials from fibers of native species, with availability for sustainable use. The sustainable extraction of plant fibers, combined with studies related to the production of geotextiles, as well as improvements in the technical apparatus for aging or degradation, is presented as a technological innovation that comes with great contribution in the studies about erosion control and natural resource conservation on riverbanks or slopes (SAHA *et al.*, 2012). The objective of this work was to evaluate the resistance of geotextiles manufactured from taboa fibers submitted to accelerate aging in the laboratory and the degradation of these fibers in the field.

Material and methods

Geotextiles used in this work were manufactured from taboa fibers (*Typha latifolia* Linn.), a very common plant in the lowlands of the lower São Francisco River, state of Sergipe, that the also known as cattail local riverine communities regularly use in the manufacture of various utensils or crafts such as baskets, mats, bags, woven sandals among others (Figure 1A and B).

Figure 1 – Appearance of taboa plant (A) and the fibers collected for preparation of geotextiles (B)

Figura 1 – Aspecto da planta de tabôa (A) e das fibras coletadas para confecção dos Geotêxteis (B)

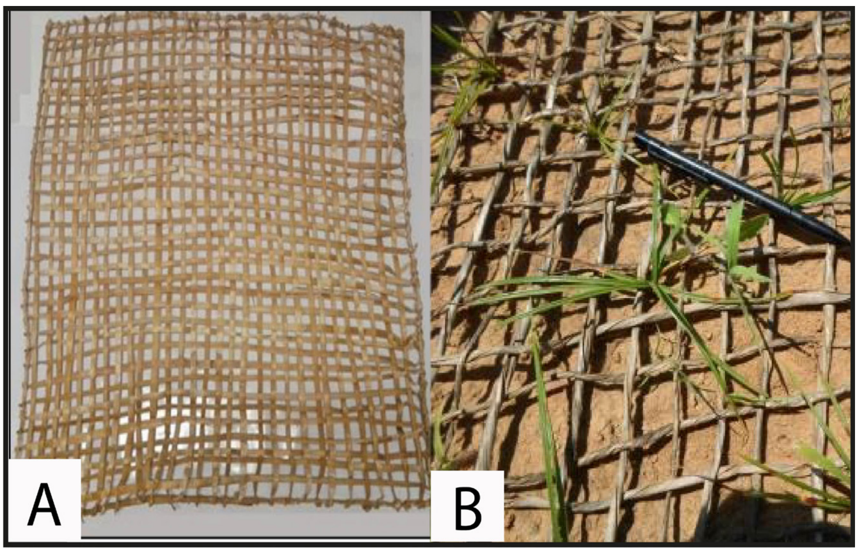


Source: Authors (2016)

The taboa fibers were studied for geotextile manufacturing processes, observing the twisted, the texture of the material, thickness, strength and durability. The fibers were collected with the aid of sickles and applying post-harvest processing techniques, consisting in cutting the stems without the use of plant roots (TEIXEIRA; FERNANDES, 2011) The straw plants went through a one-week drying period and manually the larger and smaller wires were separated, and selected by the length. The manufacture of geotextiles was conducted with a technique using different nodes and different moisture reduction treatments. After the fiber preparations and the manufacture of the geotextile, accelerated aging tests were performed to check the degradation in the laboratory and in the field, to get aging effects, or the impact of exposure to environmental factors related to tensile strength and also its durability (Figure 2A and B).

Figure 2 – Appearance of geotextile made from taboa fiber (A) and geotextile in the field tests (B)

Figura 2 – Aspecto do Geotêxtil confeccionado com fibra de Tabôa (A) e geotêxtil em campo submetido aos fatores climáticos (B)



Source: Authors (2016)

The samples were subjected to continuous leaching, saturation drying and ventilation-condensation-ventilation, common procedures used for the evaluation of geo-synthetics or polypropylene fabrics, common in civil construction, and which were the starting point for the evaluation of geotextile resources manufactured from vegetable fibers. Saturation and drying tests attempt to reproduce, in the laboratory, the change in material caused by variations in humidity (water level) and temperature of the material in the field. For the specific case of geotextiles, the saturation and drying cycles were performed by submerging the samples in distilled water at an ambient temperature of 21°C, with subsequent drying in an oven at 100°C. It should be noted that this test procedure is generally used for rocky materials. The samples were subjected to cycles with 2 hours of immersion in distilled water, followed by 2 hours of drying in an oven. Two hours of submersion or drying guarantee saturation or drying for geotextiles. Samples remained submerged in distilled water, at room temperature.

The equipment used for continuous leaching tests was the Soxhlet extractor, which allows to subject the samples of the material under controlled temperature variation, precipitation and fluctuating level of the leaching solution. The conventional apparatus comprises mantle heater, balloon extractor tube and condenser tube (PINTO, 2006).

Accelerated aging of the geotextile

The accelerated aging test promoted the acceleration of the mechanisms responsible for the degradation of fibers from a built equipment which simulated the field's environmental conditions, in predetermined cycles. This aging or degradation chamber was built in the Laboratório de Erosão e Sedimentação (LABES), at Universidade Federal de Sergipe (UFS), based in an equipment currently used for geo-synthetics previously tested by Silveira (2009). A registered background related to technological development and innovation on this subject is in the first experiments or tests conducted with the use of available geotextiles in the market, made from coconut fibers and sisal fibers, provided by manufacturers .

It was possible to build a simple unit, even unpatented yet, to test the acceleration and the degradation of these materials in laboratory conditions, with innovations in the apparatus previously built. Some parameters were observed for the construction of this apparatus, such as type of lamp to be used as a radiation source as well as the arrangement where the material to be subjected to testing should be placed. The choice of the right lamp was made according to the type of radiation to be simulated in order to promote the geotextile degradation. The operation of the geotextile accelerated aging equipment was made in accordance in accordance with the methodology explained by Saron and Leite (2001), who used to test a material made with carbon fiber, a UVB radiation followed by condensation (cycles), also using a cooler to cool the temperature.

Q-Lab-US model UVB-313 lamps that emit UVB radiation were used, occupying the position of magnetic spectrum of 290-320 nanometers. These have a power of 40 W, and are electrically equivalent to a fluorescent lamp with length 1.20 m and diameter 2.54 cm. According to Koerner (2012), the UVB radiation in the natural environment is partially absorbed by the ozone layer but has great potential of damage. The UVA ultraviolet rays cause some damage in the polymers; UVB ultraviolet rays cause severe damage to the polymers and UVC ultraviolet rays, as mentioned, do not reach the earth's surface (BALOGH *et al.*, 2011).

Degradation and Aging Tests of Geotextiles

According to Balogh *et al.* (2011), the degradation was conducted associated with aging of geotextiles in the laboratory using test samples prepared with dimensions of 20 cm width and 50 cm in length, obtained in a longitudinal direction of manufactured geotextile. Among the total quantity of tested samples, five were kept intact, which acted as blank samples, without any degradation procedure.

The samples were placed under condensation cycles, radiation, and ventilation, to simulate a field environment, however in an accelerated manner. The used protocol recommends to submit the samples to 4 hours of ultraviolet radiation at a 50°C followed by 4 hours of condensation at 50°C with a cooling time of 10 minutes, in a cycle of 8 hours, repeating 3 cycles per day (BALOGH *et al.*, 2011). Saturation and drying tests were performed, with the samples subjected to cycles of two hours of saturation and two hours of oven drying. This material was immersed in distilled water for about twelve hours at room temperature and then subjected to oven drying at the temperature of 100°C. Thus, the assay of saturation and drying played an accelerated way in the effects of moisture and variations in the temperature occurring in field environment.

Samples were taken from the simulated box after being subjected to programmed degradation times (Table 1). The amount of samples, size and number of hours of exposure of the used materials in this work were established according Balogh *et al.*(2011). Once there are no specifications on the quantity of lamps for the geotextiles from natural fibers, we assume that two lamps were enough for this experiment, adopted from other scientific cited works. The reports from the stated literature, performed experiments with only synthetic fibers and conducted them with two blocks, each consisting of four lamps (SILVA; AZEVEDO, 2016). Is important to mention that, in the execution of the test with natural fibers, a smaller number of lamps was used, which is the half the number that is normally used in assays with synthetic fibers, due to the low resistance of natural fibers.

Table 1 – Levels of degradation of geotextile samples in laboratory conditions

Tabela 1 – Níveis dos parâmetros adotados para os Tratamentos das amostras de geotêxteis, em condições de laboratório

Degradation levels (hours)	1st Level	2nd Level	3rd Level	4th Level
	120	240	480	1000
Nº. samples	5	5	5	5
Time (Days)	10	20	42	84

Source: Authors(2016)

In order to test the degradation under field conditions, the samples were placed on a slope of the right bank of São Francisco River in its lower course, located in the municipality of Amparo São Francisco, SE state, with geographic coordinates 36°50'25.335''W and 10°13'34,081''S. The selected area has been tested with soil bioengineering techniques for slope stabilization, which evaluated the effect of degradation of environmental factors of the studied material. The used geotextile covered the slope in an area of 20 m^2, according to the standard procedure with this material in the field. Five samples were collected in the programed time, occurring in the central part of the slope, through six months.

Considering that the degree of geotextile degradation in the field condition is influenced by the exposure to the solar radiation angle, samples were placed in accordance with the slope angle, kept in total contact to the soil. During the geotextile field exposure, climate variables such as temperature, relative humidity, wind, precipitation and solar radiation were raised.

The intact samples (blank samples), aged by field and laboratory treatments were then subjected to mechanical tests. For the tensile strength test, no confined bodies of evidence were cut in the field, in accordance with ISO 10319 (1996), in the dimensions of 20 cm width and 30 cm length also subjected to static puncture tests (CBR tests), according to that described in ISO 12236 (1998).

For conducting tensile tests intact sample were taken, the ones which have not undergone any kind of degradation by the presented processes, and geotextiles samples which have undergone degradation in the field as well as the samples which have went through acceleration processes in the laboratory degradation. The samples after the drying processes were subjected to mechanical tests in order to test their resistances as shown in Table 2.

The geotextile resistance tensile strength tests were conducted by an electro-mechanical machine Instron model 3367 to 5 kN load cell and measurement error less than 1%, carried out at "Laboratório de Engenharia de Materiais" of "Universidade Federal de Sergipe" - UFS. In each of the collected samples in order to perform the tests, four strips were removed from the geotextile and tested to tensile strength. The spacing of the machine claws was of 150 mm, where was applied a preload of 1.0 kN at a constant charge speed of 10 $mm.minute^{-1}$ (PINTO, 2006).

After the tensile strength test, the pull strength values were obtained, related to their displacement up to the break. Together with the data of the displacement until the break the geotextile material deformation was determined by the following Equation (1):

$$\alpha f = \frac{Ff}{Ws} \quad (1)$$

in which: αf is the tensile strength in N / m; Ff is the maximum force per unit width N of the sample to cause a sample rupture, as read directly from the instrument; WS is the sample width in meters.

The deformation of the individual samples was calculated using Equation (2). Expressed as percentage increase in length based on the LVDT readings as follows:

$$\varepsilon p = \frac{\Delta L}{Lg} x100 \tag{2}$$

in which: εp deformation "ε" in %; ΔL is the variation of length of a null force corresponding to the force measured in mm; Lg is the initial nominal gauge length in mm.

Along with the tests load curves versus deformation ε were generated, and calculated tensile strength at break (αmax) and Deformation (ε).

Table 2 – Program of mechanical tests of the samples under different types and levels of degradation

Tabela 2 – Programa de ensaios mecânicos, parâmetros avaliados nas amostras submetidas aos diferentes tipos e níveis de degradação

Essays	Type of degradation (%)	Degradation level				
		0	**1**	**2**	**3**	**4th**
Tensile strength Non-Confined	Intact	(5)				
	Natural (days)		90	180		-
			(5)	(5)		-
	Humidity cycles (hours)		100	200	360	720
			(5)	(5)	(5)	(5)
	C UV-B (hrs)		240	480	1000	2000
			(5)	(5)	(5)	(5)
	Intact	(5)				
	Natural (days)		90	180		-
			(5)	(5)		-
Static puncture resistance	Humidity cycles (hours)		100	200	360	720
			(5)	(5)	(5)	(5)
	Continuous leaching (hours)		200			
			(5)			
	C UV-B (hrs)		240	480	1000	2000
			(5)	(5)	(5)	(5)

Source: Adapted from Pinto (2006)

Where: (5) Number of samples for each test.

Statistical analysis

The results of the evaluated parameters were subjected to a normal distribution Shapiro-Wilk test at 5% of significance level, which indicated that the data did not follow a normal distribution, and then tested to ANOVA and Kruskal-Wallis tests and Hochberg tests of the 5% significance to compare the averages and between ranks, all with the IBM-SPSS (IBM CORPORATION, 2017) aid.

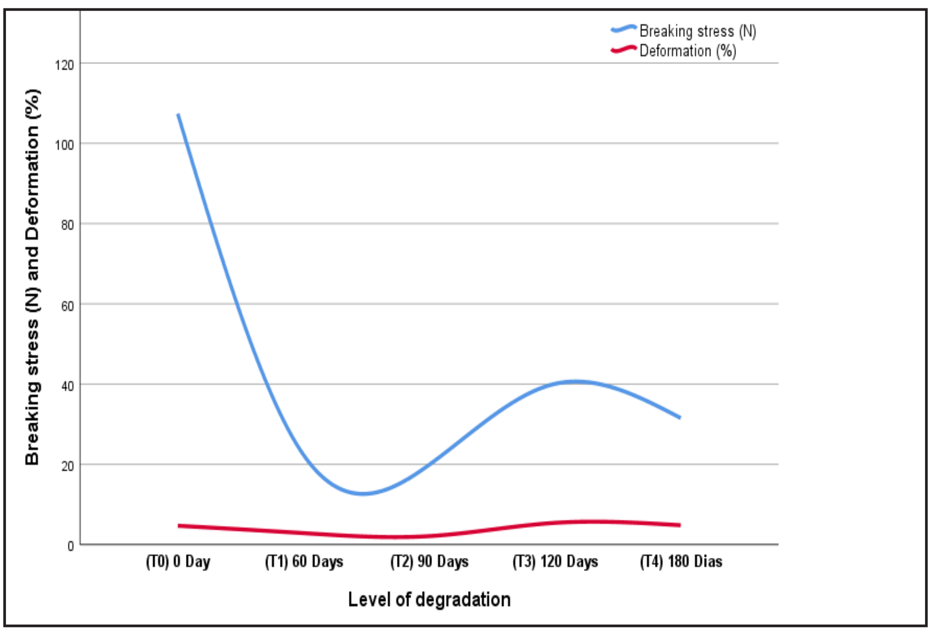
Results and discussion

In the sample analysis submitted to different levels of degradation, a progressive decrease trend in the resistance to tensile strength was observed related to the progress in the aging process. Indeed, the obtained values are the results of applying axial tensile tests generated in the blank samples and in the degraded ones in an accelerated rate (Figure 3). Cicek (2019), working with fiberglass geosynthetic, crumb rubber and tire strips, observed values of resistance to tensile strength close to 150N when tested, not reinforced and not degraded treatments, showing that the manufactured geotextile with taboa reaches the deformity values close to the ones with synthetics materials.

The effect of resistance to accelerated deformities proved to be more evident when analyzing the blank samples - T0/4.57% compared to degraded samples in the period of 180 days - T4/3.62%, representing a decrease of approximately 0.95%.

Figure 3 – Percentage of stress and deformation at different levels of degradation by Condensation and radiation exposure of cattail (taboa) geotextile

Figura 3 – Porcentagem de tensão e deformação nos diferentes níveis de degradação por Condensação e exposição à radiação do geotêxtil de taboa



Source: Authors (2020)

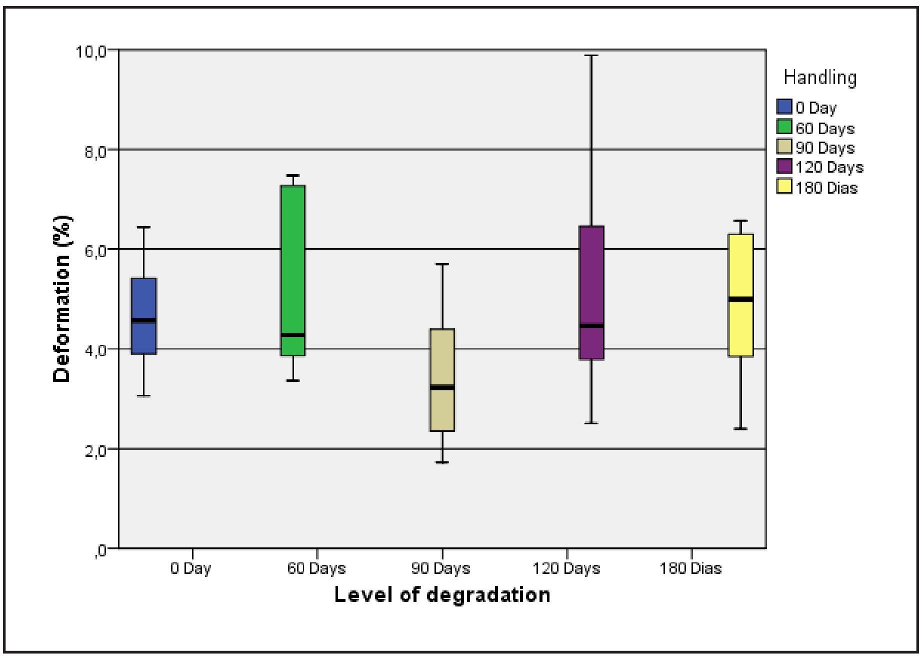
There was a decrease of about 58.83% of T0 to T2 and it returned to near the value T0 from the treatment T3/31,78N (Figure 4) but when analyzed in the average rank, through Simes-

Hochberg method, there was no statistical difference between treatments in different sampling times. This reduction in resistance seems to be a result of UV radiation, probably the same behavior found in the results of (CARNEIRO, ALMEIDA and LOPES, 2019) which induced the application of UV rays in the laboratory using polypropylene geo-grids during 42 days. This effect may be due to a significant acceleration of the fibers oxidation resulting in a drop in its resistance. Fibers from taboa plant, are very much suitable to the occurrence of oxidative actions on both pH different levels (GHOSH *et al.*, 2019) and under UV radiation incidence (Carneiro *et al.*, 2019). Currently studies have declined the production of compounds that prevent such degrading agents (MIDHA; JOSHI; SURESH KUMAR, 2017; THAKUR *et al.*, 2019).

The involved mechanism decrease in the mechanical resistance with aging, allowed a perception of slight decays in the values, although not statistically different, in all tested levels (Figure 4), even though we found a strong deviation of the quartiles data in 120 days sampling.

Figure 4 – Variation of geotextile deformation of taboa exposed to different levels of degradation agents

Figura 4 – Variação da deformação do geotêxtil de taboa exposto aos diferentes níveis dos agentes de degradação



Source: Authors (2020)

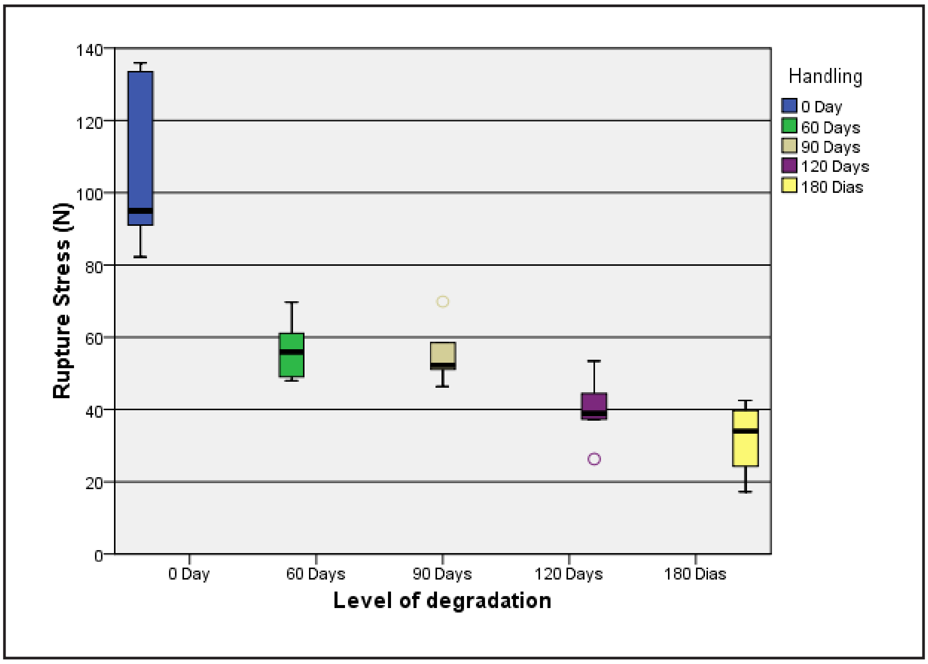
Analyzing the statistical medians related to tension strength in T0/95,03N, T2 and T3 treatments, a numerical difference when compared to T1 treatment at 60 days, 120 days and also in a 180-day sampling time (T3 and T4) (Figure 5) was noticed, although there was no statistical difference among them. This can be related to the degradation process in all treatments, except as a blank sample, which was not submitted to any degradation procedure.

The elevated values of interquartile range for deformation analyses of the tested samples indicated low homogeneity of the tested and braided geotextile, which was not uniform, with different strips thickness. For the rupture resistance the interquartile range presented high levels in the early days of the experiment (T1) regulating over the sampling time (Figure 5).

It was recorded a rainfall period over the collection of the samples in the treatments T3 and T4, which caused a remarkable increase in the soil moisture, thus bringing an extra humidity to the geotextile. The lack of difference in the deformation resistance among the samples in the mentioned treatments might be the moisture absorption by the fibers. It is known that the physical and mechanical properties of natural fibers are affected by environmental changes, represented by temperature and air humidity, harvest time, and the fiber separation process (GHAVAMI; TOLEDO FILHO; BARBOSA, 1999). The fiber moisture might an increase on the flexibility, as demonstrated by Shirazi *et al.*(2019) working with geotextiles by kenaf (*Hibiscus cannabinus*) under different humidities.

Figure 5 – Variation of tensile strength supported by geotextile according to different treatments

Figura 5 – Variação da força de tensão de ruptura suportada pelo geotêxtil, em função dos diferentes tratamentos adotados



Source: Authors (2020)

The results of Araújo-Filho, Holanda and Andrade (2013) evaluating coconut fiber (400 Fibrax BF) geotextile, tension strength results for the non-degraded material and degraded ones at 60 and 90 days, of 0.31 and 0.13 (kN / m^2) and to deformation of 21.78% and 15.64%, respectively. These findings are close to what was found in this work, showing that the taboa was recorded fiber has good resistance to rupture, showing a strong potential to use in soil bioengineering works.

The geotextile subjected to condensation test and radiation exposure in the laboratory showed tensile strength results with higher average values when compared to the natural degradation assay (Table 3). It has been slowly degraded, but without any statistical difference, even though it seems to indicate that the cited treatments acted weakly when compared to the field conditions.

No statistical differences were verified for deformation treatment between the saturation and drying tests, however for the tension strength a reduction 42.44% has occurred until reaching 120 days of testing (Table 3). This decrease in tension strength over the time for taboa fibers agrees with the findings of Sumi, Unnikrishnan and Mathew (2018) working with coconut fibers. The lower resistance in T1 treatment may be explained by the variation in the fibers strips thickness used in the tensile test.

Silveira (2009) working with coconut fiber geotextile shows that the variation in thickness of the fibers strips, leads to a higher coefficient of variation and, therefore, an unexpected change occurs in the results. This variation may also have occurred with taboa fibers, explaining the resistance increased in radiation exposure (drying).

Table 3 – Tensile strength and deformation of fibers of taboa geotextiles subjected to drying and saturation procedure

Tabela 3 – Resistência à Tração e Deformação das fibras dos geotêxteis de Tabôa submetidas ao ensaio de secagem e saturação

	Level of degradation (days)	Tension strength		Deformation (%)	
		Medians	Rank*	Medians	Rank*
Drying	Not degraded (T0)	95.03	19.6 a	4.57	15.0 a
	60 days (T1)	92.67	16.0 a	3.13	11.2 a
	90 days (T2)	81.79	10.6 a	5.41	11.8 b
	120 days (T3)	64.73	7.0 a	3.68	13.4 b
	180 days (T4)	81.66	11.8 a	3.62	13.6 a
Saturation	Not degraded (T0)	95.03	19.02 a	4.57	13.6 a
	60 days (T1)	72.84	9.8 a	4.57	13.1 a
	90 days (T2)	86.05	12.4 a	4.74	12.8 a
	120 days (T3)	84.70	11.8 ab	3.72	13.6 a
	180 days (T4)	79.01	1.8 a	4.67	11.9 a

Source: Authors(2020)

Where: (*) Multiple Comparisons by Simes-Hochberg method. (**) Ranks followed by the same letter do not differ statistically, uppercase in the column and lowercase in the row. Simes-Hochberg method at 5% probability.

Evaluating the change of the deformation, moisture appears to leave the fibers less rigid, thereby leaving it with a greater deformation capacity, with a slight increase in tensile strength probably by accelerating the decomposition of the vegetable fiber. The geotextile with taboa fiber showed only a decrease in the deformation after 90 days of exposure in the field, but remained with the same characteristics until 180 days of exposure in the field.

Together with the deformation results obtained in this study, it is possible to show how the geotextile can change size (stretch) to rupture. It is noted that the geotextile degradation data in all tests do not differ in the level of deformation, i.e., despite losing tensile strength, the taboa fiber does not lose its elasticity easily.

It was visually noticed a possible microbiological degradation effect on the field identified by change in the colors of the geotextile through browning. There are various fungi and bacteria which are present within or on the surface of geotextiles. Matheus (2002) studying geosynthetics observed that there are no changes in behavior before and after the exposure of this material to the presence of bacteria or fungi. Very few is known about the contribution of microorganisms to the degradation of the geotextiles manufactured with natural fibers under field conditions, once the sources of degradation are unknown, and can be diverse, and so are their ways of degradation.

Conclusions

The resistance to rupture of taboa fibers geotextile did not appear to be strongly influenced by the variation all over the sampling time.

The moisture has promoted a decrease in the hardness of the fiber, thereby taking to a greater deformation capacity, with a slight increase in tensile strength.

The aging chamber induces significant damage to the geotextile fibers formed by taboa by induction caused by ultraviolet radiation, leading to deterioration of the composition according to the exposure time, markedly after 6 months of use.

Compared to commercial synthetic geotextiles subjected to the same experimental conditions, the taboa geotextile obtained favorable results related to tension strength and deformation, thus confirming its potential for using it in soil bioengineering works.

The production of geotextiles using taboa fibers brings new possibilities to the market, that goes beyond the use of coconut and sisal fibers.

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