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Research paper

Evaluation of Tensile and Thermal Behavior Analysis of Nano Carbon Fiber Reinforced Polymer Composite

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Abstract

Today a lot of research work is performed throughout the world on the use of natural fibers as a strengthening material introduced in the preparation of various kinds of composites, and also the use of natural fiber/polymer composites in civil and mechanical engineering fields are playing very important role due to its usage of natural resource and its properties. From the current journal, we have recently found NFRPC fibers which are extracted from NFRPC plants by involving hard physical work. In this journal, the tensile components of the six to seven months NFRPCare analyzed through various tests such as FTIR, XRD, SEM, THERMO GRAVIMETRIC ANALYSE and match with other available conventional all-natural fibers, and also examine the chemical qualities of NFRPC. The fiber of NFRPC has a high wax content, so it's easy to bind with materials like resin. SEM analyze also signifies the presence of voids on the interior surface of the fiber material. and the results show that the NFRPC provides good Tensile and Thermal properties.

Keywords: *Inspected, tensile, thermal behavior, analysis, NFRPC.*

1. Introduction

The past research was focused on exploring the antibacterial and preliminary phytochemical properties of NFRPC(W.A.) throughput in vitro approach. Results revealed promising antibacterial activity of the bacteria analyzed. Among these, ethanol and aqueous extracts are found to get a strong inhibitory effect comparing with all the other selections. Which show that the potentiality of the plant extracts for treating various skin and gastrointestinal infections in humans. Result of many water conditions along the tensile properties of kenaf fiber. Result demonstrated that the water absorption pattern of this carnage fiber immersed in sea water showed highest absorption traits in contrast to distilled water and inflammatory solution.

(Radzi, Sapuan et al. 2018) explored the potential outcomes of utilizing kenaf fiber as analyst for memory composites implied for poa psychologistations. The trials were directed on a dark on-plate (BOD) machine having a sparkly stainless-steel counter face at different connected burdens (30 - 60 N) and fiber introductions. Paste wear comes about uncovered that Thermo plastic treated kenaf fiber-fortified polyurethane (T-KFRP) (in AP-O) includes a larger amount of wear protection in correlation with perfect polyurethane (N-PU). SEM perceptions showed distinctive wear systems, for example, fiber separation, setting, delamination, and small scale breaks.

(Sair, Oushabi et al. 2018) checked on the resources of kenaf fiber strengthened composites regarding mechanical properties, warm properties ,notwithstanding water retention properties., besides, the assembling procedure and their specialized issues were tended to. They have examined improvements made in the territory of kenaf fiber strengthened composites. It was uncovered that the work of kenaf strands can create occupations in both urban and rustic areas.

(Ganeshan, Ramshankar et al. 2018) studied the effect of alkali treatment of kenaf fibers and inclusion of LNR (Liquid Natural Rubber) in polyester matrix onto the mechanical properties oa polyester matrixkali treated fibers were also found to provide much better impact and flexural advantages into the composites. Measurement of environmental stress cracking resistance (ESCR) shows that the mix with acidity moderate gets got the fastest diffusion rate, accompanied closely by using base moderate, after which without medium. Equalization of all carnage shows good properties due to impact, flexural, and fracture strength in contrast to the untreated kenaf mix.

(Atiqah, Jawaid et al. 2018) manufactured bio composites from kenaf bast fiber and PLA and concentrated pliable properties and water utilization conduct of bio composites from kenaf bast fiber and PLA. They've endeavored to create thermo formable non woven blend materials containing artificially retted kenaf for car applications.

(Satyanarayana, Flores-Sahagun et al. 2018) examined the impact of ligno cellulosic composites by receptive expulsion handling in which great interfacial grip is created by methods for a blend of fiber adjustment and framework change strategies. Common mechanical assessment is as of now announced. They examined the enhanced grip coming about because of responses and upgraded polar associations at stage limits.

(Yusra, Juahir et al. 2018) studied the effect of freeze on kenaf fiber grade. They ran detailed evaluation on fiber processing and chemical composition. Frost-damaged kenaf with bacterial expansion has been decorticated by hand and then divided into six segments (26.88 cm each) from the bottom to tip of the stem and then retted liberally or bacterially from the lab. Fiber characteristics was contrasted between 2 process and six locations.

(De Assis, Reisinger et al. 2018) compared about the hypothetical and trial tractable properties of kenaf fiber bundle. Both test and hypothetical outcomes exhibit that the rigidity of the kenaf fiber bundle increments with expanding the strain rate though pliable modulus stay unaltered on account of progress in strain rate.

(Siakeng, Jawaid et al. 2017) compared about the hypothetical and trial tractable properties of kenaf fiber bundle. Both test and hypothetical outcomes exhibit that the rigidity of the kenaf fiber bundle increments with expanding the strain rate though pliable modulus stay unaltered on account of progress in strain rate.

(Sulaiman, Cieh et al. 2017) inquired about the electrical segments of wood flour/kenaf-pp blend. The exploration uncovered that the promotion of long kenaf fiber as fortification with wood flour-pp mix has expanded the rigidity and modulus fairly.

(Ayadi, Hanana et al. 2017) contemplated the pliable properties of kenaf strands for basic utilize. The examination demonstrates that the alkalization builds the properties of this fiber.

(Nazir, Abdullah et al. 2017) contemplated the paper making properties of dyed pop AQ kenaf bark and heart mash. They found that the bark filaments are long, firm and thin giving great balance, light radiating and mellow holding. The point was to look at the mechanical parts of short kenaf bast and central element fortified unsaturated polyester composites with fluctuating fiber percent i.e. 0 %, 5 %, 10 %, 20 %, 30 % and 40 %. The outcomes likewise demonstrated that the ideal fiber content for achieving greatest rigidity for both bast and central element composites were 20 %wt.

(Yamoum and Magaraphan 2017) examined the impact of refining on substantial and electro-dynamic characteristics of various cellulosic filaments and found that beating builds the surface control, particular surface zone and certain volume of strands, however didn't adjust the Whole fiber content.

(Shanks 2017) studied the mechanical operation of banana/sisal reinforced polyester composites. Properties of the fibers were ascertained.Tensile properties of these composites as a function of fiber concentration and fiber makeup and layering routines were ascertained.

(Sajna, Mohanty et al. 2017) The displayed the FTIR impact of silane treated banana (SiB) and Closite 30B (C30B) nanoclay on the warm harmony and fire retardancy of PLA was contemplated. Isoconversional motor investigation utilizing Friedman and Flynn-Wall-Ozawa methodology and examination in light of parameters in the maximal corruption speed (Kissinger framework) were utilized to comprehend the warm debasement energy from the bio nano composites.

(Subramanya, Satyanarayana et al. 2017) Recognizing the need for components of the plant fibers for their usage within polymeric composites and also non-availability of information on tensile, renewable, along with also other components of banana components of Karnataka (India), a study had been performed together with the objective of discovering some of those properties. This specific post introduces determination of structural aspects of the fibers by Fourier transform infra red (FTIR) spectroscopy and xray diffraction (XRD) techniques; accessing stress-strain curves and electrical attributes by tensile screening; ultimately, thermal possessions by differential scanning calorimetry and thermogravimetric analysis.

(Bakri, Jayamani et al. 2017) FTIR spectrum of banana fibers demonstrated aromatic character, while XRD results indicated that the fiber to get chiefly the cellulose that I structure and crystallinity indicator of 52%. Information of fiber samples were demonstrated by thermal studies. Stress-strain curves of banana fibers indicated their fragile temperament with moderate worth of tensile energy, but low percentage elongation. Weibull analysis of received electrical strength values showed version of "feature power" worth out of 3800 MPa in 99% dependability to 22,700 MPa using 0.01% reliability. Morphology studies demonstrated the range of flaws across the length of the fiber, whereas fractured surface exhibited flat surface with naturally-occurring cracks certainly suggesting brittle temperament of the fiber.

2. Fabrication and Methods

In the last two decades, there has been an impressive enhance in the use of natural fibers such as fiber extraction from NFRPC indica, pineapple and banana for making a new environment friendly and biodegradable composite materials (somehow these composites are called ‘‘Green Composites’’). Recent studies in natural fiber composites offer significant improvement in materials from renewable sources with enhanced support for global sustainability. These natural fiber composites possess high/ moderate strength, thermal stability when they are recyclable, but the problems of using pure biodegradable polymers are their lower strength and transition temperature.

NFRPC

NFRPC [Nano fiber reinforced polymer composite] (Figure. 1. a) are prepared from the stems of water hycinth plant. The entire plant is cultivated of an amount of (25 kg) from the Kavery River coral land, Erode District, Tamilnadu, India. After the areca nut, Hen feather cultivation of the entire plant, leaves and are removed from the plant by using a knife. Then the stems of the NFRPC are washed with pure water and allowed to dry at room temperature in an open space for one week to eliminate the moisture content. Then the dried water hyacinth stems are taken into the flour mill hopper and ground by the flour mill grinder with different grid size blades to change the long strand stems into desirable grain sizes powder form with the processing time of one hour. In order to reduce the grain size of the water hyacinth stems powder the grinding process is repeated until reach the fine grain size particles. Finally the desired grain size water hyacinth stems powders are made with the flour mill grinder.

Polypropylene

Polypropylene (Figure.1.b) is a thermoplastic "expansion polymer" produced using the blend of propylene monomers. It is utilized as a part of an assortment of uses to incorporate bundling for buyer items, plastic parts for different enterprises including the car business, exceptional gadgets like living pivots, and materials. Today it is a standout amongst the most usually created plastics on the planet. Polypropylene is utilized as a part of both family unit and mechanical applications. Its one of a kind properties and capacity to adjust to different manufacture procedures influence it to emerge as an important material for an extensive variety of employments. Another precious trademark is the polypropylene's capacity to work as both a plastic material and as a fiber. Polypropylene's one of a kind capacity to be produced through various strategies and into various applications implied it soon began to challenge a significant number of the more established elective materials, strikingly in the bundling, fiber, and infusion forming ventures. Its development has been supported throughout the years and it remains a noteworthy player in the plastic business around the world.

(a) (b)

Fig. 1: Fabrication of NFRPC [a] to powder with polypropylene [b] particles

3. Methods

Tensile Methods

Thus tensile tests for CISF were conducted with the help of UTM INSTRON 5500R as per the ASTM D 3822-07 standard. Tests were conducted refer table 1 at various gauge lengths of S1-10, S2-20, S3-30, and S4-40 mm with four samples for each gauge length. The test was conducted at an ambient temperature of ∼28 ◦C and relative humidity of ∼65% and also constant crosshead speed of 0.1 mm/min was used.

Table 1: Mechanical properties of NFRPC fiber

Samples	Tensile strength (MPa)		Young's modulus(GPA)	Strain to Failure %	Cross sectional area (mm^2)
Sample -1	2450	± 756	59	3.85± 2.69	0.4942± 0.1869
Sample -2	2973	± 851	62	5.57± 2.96	0.4862± 0.1781
Sample-3	3703	± 1163	89	7.89± 2.89	0.4859± 0.1578
Sample -4	3653	± 1113	88	5.46± 1.14	0.4629± 0.1595

Surface Study's Of Fiber

By studying the compound structure of these fibers, Fourier Transform Infra Red (FTIR) spectra of the fibers were first got with a Bruker Alpha FTIR spectrometer with standard KBR sample for calibration. And one more process in X-ray diffraction (XRD) analysis has been carried out to learn that the crystallographic Treatment and also to NFRPC of these selected fibers. With this particular purpose, Model Bruker standard code D8 series Diffractometer with CuKα radiation (λ = 1.5406 Å) with Ni filter, operating at 40 KV and 30 MA was used. where the studied the literature **(Tibolla, Pelissari et al. 2018)** formation Powdered banana fiber was retained in a sample holder and found at an continuous mode in The FT-IR are used to figure out the presence of free functional groups in CISF. To get FTIR spectra we utilised Perkin-Elmer Spectrum RXI Fourier Transform Infrared Spectrometer, and also the analysis performed CISF in KBr matrix using a scan rate of 35 scan per minute at an answer of two c.m-1 in wave number location amongst 4oo c.m-1 and 4000 c.m-1 By using both mortar and pestle, KBr powder, the more chopped fiber sample had been inoculated to fine powder. For that listing of FTIR spectra the specimen is prepared by Appling strain. The angel assortment of 10°-eighty° using a scanning speed 20°/min. Powder variant of the sample helped to obtain the best random distribution from the fibers to directly estimate the crystallinity indicator (CI). Following **(Bakri, Jayamani et al. 2017)** to find out the CI of the fiber, 1st the area underneath the peaks (shaded location) along with the complete area from the obtained XRD spectrum were ascertained using Solid Edge CAD software. Afterward, CI (in percentage) was accessed using the formulation as follows:

$$\frac{\textit{Area of cristaline fraction}}{\textit{Area of fiber fraction} + \textit{Area of Amorphous fraction}} \; x\, 100 \;=\; \textit{Crstality}\,\% \qquad \textbf{[1]}$$

Sem Test

The fiber damage under varies reinforced combination determined it. A number of the fibers were sheared and becomes more loose. So the area of damage and also the fiber stripping was conspicuous and fiber pull out wasn't noticed. This effect indicates that there's just a great interaction between fiber and matrix. Fig indicates the worn outermost layer of 40 % fat percent composite under-20 N load. That isn't any sign of plastic deformation along with adherence but also the worn outermost layer of the composite was seen as an furrows. This indicates the implemented load has been NFRPC by fiber and thus the usage immunity has been greatly improved as a result of the reinforcement. Statistics 6.7-6.9 indicates the worn area of 40% weight fraction composite under 10 N loading. The splitting of fibers is clearly observable which Ends in maximum wear of the mix polymer composites.**(Orue, Eceiza et al. 2018)**

Thermo Gravimetric Analysis

This is studies only for the specific fibers were examined in Thermogravimetric analysis [TGA] and differential scanning calorimeter [DSC] .TGA was performed with highly information gathering from thermal stability and conductivity of the present natural fibers , however varies calorimetric studies were good agreement done in thermal end points like transition of glass ,entropy and specific thermal conductivity and etc., The agricultural scenario of the shimadze model equipment examined the some of grams as follows in this standard and specific conditions **(Thermo Gravimetric Analysis, SDT Q600 V20.9, BUILD 20)** is used for thermal behavior of CISF, we used the TGA analysis were carried out in nitrogen atmosphere at a flow rate of 20 ml/min to avoid oxidation effects. 10 mg of CISFs were crushed and kept in alumina crucible to avoid the temperature variations measured by the thermocouple. The heating range is starting from 250Cup to10000C with the heating rate of 100C/min.

4. Result and Discussion

Tensile Test

Tensile testing has been carried out after ASTM D 3822 using UTM INSTRON 5500R equipment having a crosshead speed of 250 mm/min in an temperatures of 32°C and relative humidity 65 percent ± 5%. The above gauge amount of this fiber was chosen for the following reason: Considering the principal benefit of NFRPC investigation is that the ability to supply reasonably correct breakdown analysis and failure predictions with extremely compact samples and this version is directly centered on the failure of a chain in the weakest connection controls rupture and generally seems to function as well adapted to spell out a series of ballistic test results carried out in one gauge duration .Even the stress-strain curves of fibers were first captured during the test, which were used to calculate tensile properties (Young's modulus-YM, final tensile strength-UTS and percent elongation) of their fiber.

FTIR Analysis

Shown in figure 2 displays the FTIR spectra of the banana fibers used within this study, which appears to be marginally different in character in that documented earlier .past literature Knowing that the principal elements of lignocellulosic fiber like banana fibers would be cellulose-based materials, found FTIR spectra has been credited mainly to these components. As shows contrast of spectral point rankings of this present analysis with all the sooner reports that were published. From the perspective and also the table aforementioned, it is noted you will find four different types of bands that may also be compared with the earlier ones that are reported. All these are rings in 3334.10, 2931.93, 1642.46, 1021.35, 863.18, 580.60, and 512.12 cm−1 respectively . Even the absorptions rings at 3500-3100 cm--inch are assigned to extending vibrations as well as other polymeric institutions of hydroxyl groups. It's recognized that these are commonly found in cellulose, hemicelluloses, and lignin, suggesting a ethereal part of the NFRPC india fibers. These are important because they demonstrate the pseudo-stem banana fibers feature functional groups that allow interactions among metallic ions and the NFRPC fiber. However, the above are different from these celebrated for freshwater banana fibers, " in which C-C of polyunsaturated vibrations at lignin emerged at the area of 1420-1580 cm−1 and C-H symmetric and asymmetric stretching rings at the region of 1800 cm−1 **(Guimarães et al. 2009)**. The feeble wide peaks observed in 782, 720, 501.12, 548, and 534 cm--inch correlated with angular deformations of CH linkages of aromatic groups are likewise marginally different those detected **by (Becker et al. 2013).**

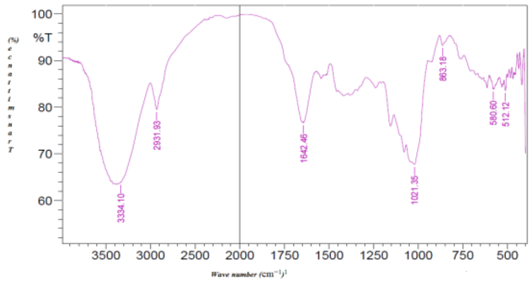

Fig. 2: FTIR analysis spectra graph [NFRPC Fiber]

Thermal Gravimetric Analysis

The above scientific studies of TGA and DSC imply why these fibers demonstrate that a small drop in fever regarding first of the circadian rhythms (akin for the degradation of cellulose and hemicelluloses) than the people with a number of these additional mixed fibers. This may be associated with greater percentage of chains having poorer intermolecular connections (non-crystalline linked area) of NFRPC components, and this can be evident based upon the decrease level of crystallinity of a number of those additional NFRPC fibers.

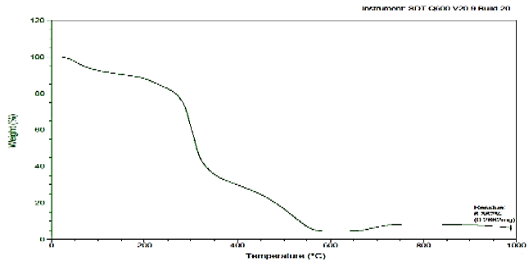

Fig. 3: Thermal gravimetric analysis

SEM/XRD Analysis

Their numbers may vary from fiber to fiber. All these really could possibly be reason for the variation in different potency SEM /XRD values as shown in figure 4. About the opposite side, shattered surface, which is apparently flat, clean, and intracellular fractures clearly signify fragile temperament of the cabbage corroborating behavior of detected stress-strain curves. Furthermore, it is evident that cells found as "holes" in the cross-sections, are non-spherical rather irregular in shape using thick walls. [19][20]

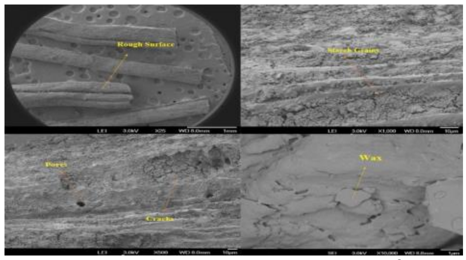

Fig. 4: Scanning electron microscope (SEM) of NFRPC

Predicated on the characterization of NFRPC composites analyzed Inside table as refer **SEM** analysis were analysis 2 theta process as refer the table 2. This fraction function, especially the thermal behavior components, it may be anticipated these fibers will be exceptionally Helpful in several programs from the industrial industry, particularly in the Evolution of micro composites was documented everywhere.[21]

Table 2: Sem Analysis 2 Theta Analysis Values in %

2-Theta °	Angstrom Count	%	
27.217	3.27389	155	100.0
80.449	1.19281	114	73.9

5. Conclusion

1. Mainly focused in FTIR spectrum of Nano carbon fibers reinforced polymer composite indicates the Nano carbon fibers reinforced polymer composite reveal aromatic character indicating the fiber to become lignocellulosic using all the presence of cellulose, hemicelluloses, and lignin. Further comparison to spectral point positions of the present study with all the earlier published reports indicates you will find little gaps at the field of assorted bands. For example, the preceeding differs from the ones observed for NFRPC - sample -3 , " in which C-I of polyunsaturated vibrations in lignin emerged from the region of evaluation states that threepeat 3334.10−1belongs into the carboxylic acid O-H because of the existence of cellulose was analyzed it.
2. Morphology reports revealed the number of defects over the length of the fiber, while fractured surface shown flat surface having naturally-occurring cracks clearly signaling brittle nature of this fiber.
3. Even the minorpeak reveals significantly less percentage content of hemicellulose, and it is advantageous,as higher material may affect the mechanical components of CISFs.this affirms the equilibrium of the CISF materials throughout the process of polymerization. Thus the features of the CISF as well as the examined results say the prospect of using this fiber for growing the fiber fortify polymer combination.
4. Outcomes are shown by test for CSIF. The tensile strength and the youthful modulus are present to be 3653±11 at 13 Mpa along with 8 8±3-7 Gpa. Stress-strain curve of NFRPC indicated fragile nature of the fibers using mild values of tensile energy, but low-percentage elongation.
5. All these merits of mechanical components can be present to be lower compared to the range of the value noted for CNFRPC worldwide focused specimen diameter 9 to 23 µm indicating that the fibers used within this analysis tend to be thicker compared others.
6. XRD results indicated that the fiber to get mainly the cellulose I structure and CI of about 52%, becoming more than that of first time documented CI value for its NFRPC fibers (27 percent).
7. Normal NFRPC fibers analyzed had been discovered density and also higher quantity of cellulose up content to 70.35% and density was discovered 10.04 %.
8. DSC and TGA of NFRPC fiber shown that the thermal-degradation details of NFRPC fiber samples and also their thermal equilibrium.

References

[1] Atiqah A, Jawaid M, Sapuan S, Ishak M & Alothman OY, "Thermal properties of sugar palm/glass fiber reinforced thermoplastic polyurethane hybrid composites", Composite Structures, (2018).

[2] Ayadi R, Hanana M, Mzid R, Hamrouni L, Khouja ML & Salhi Hanachi A, "Hibiscus cannabinus L.–Kenaf: A Review Paper", Journal of Natural Fibers, Vol.14, No.4,(2017), pp.466-484.

[3] Bakri MKB, Jayamani E & Hamdan S, "Processing and Characterization of Banana Fiber/Epoxy Composites: Effect of Alkaline Treatment", Materials Today: Proceedings, Vol.4, No.2, (2017), pp.2871-2878.

[4] De Assis T, Reisinger LW, Pal L, Pawlak J, Jameel H & Gonzalez RW, "Understanding the Effect of Machine Technology and Cellulosic Fibers on Tissue Properties–A Review", Bio Resources, Vol.13, No.2,(2018).

[5] Ganeshan P, Ramshankar P, Raja K, Vijayanand G, Kumar SS & Prabu B, "Mechanical Properties of Madar/Bauhinia Racemosa Hybrid Composites", TAGA JOURNAL, (2018).

[6] Nazir MS, Abdullah MA & Raza MR, "Polypropylene Composite with Oil Palm Fibers: Method Development, Properties and Applications", Polypropylene-Based Biocomposites and Bionanocomposites, (2017).

[7] Orue A, Eceiza A & Arbelaiz A, "Pretreatments of Natural Fibers for Polymer Composite Materials", Lignocellulosic Composite Materials, Springer, (2018), pp.137-175.

[8] Radzi A, Sapuan S, Jawaid M & Mansor M, "Mechanical and Thermal Performances of Roselle Fiber-Reinforced Thermoplastic Polyurethane Composites", Polymer-Plastics Technology and Engineering, Vol.57, No.7,(2018), pp.601-608.

[9] Sair S, Oushabi A, Kammouni A, Tanane O, Abboud Y & El Bouari A, "Mechanical and thermal conductivity properties of hemp fiber reinforced polyurethane composites", Case Studies in Construction Materials, Vol.8, (2018), pp.203-212.

[10] Sajna V, Mohanty S & Nayak SK, "Influence of nanoclay and graft copolymer on the thermal and flammability properties of poly (lactic acid)/banana fiber biocomposites", Journal of Vinyl and Additive Technology, Vol.23, (2017).

[11] Satyanarayana KG, Flores-Sahagun TH & Bowman P, "Lignocellulosic Materials of Brazil—Their Characterization and Applications in Polymer Composites and Art Works", Lignocellulosic Composite Materials, (2018), pp.1-96.

[12] Shanks R, Recycled synthetic polymer fibers in composites. Green Composites (Second Edition), Elsevier, (2017), pp.73-93.

[13] Siakeng R, Jawaid M, Ariffin H, Sapuan S, Asim M & Saba N, "Natural fiber reinforced polylactic acid composites: A review." Polymer Composites, (2018).

[14] Subramanya R, Satyanarayana KG & Shetty Pilar B, "Evaluation of Structural, Tensile and Thermal Properties of Banana Fibers", Journal of Natural Fibers, Vol.14, No.4,(2017), pp.485-497.

[15] Sulaiman S, Cieh NL, Mokhtar MN, Naim MN & Kamal SMM, "Covalent immobilization of cyclodextrin glucanotransferase on kenaf cellulose nanofiber and its application in ultrafiltration membrane system", Process Biochemistry, Vol.55, (2017), pp.85-95.

[16] Tibolla H, Pelissari FM, Martins JT, Vicente A & Menegalli FC, "Cellulose nanofibers produced from banana peel by chemical and mechanical treatments: Characterization and cytotoxicity assessment", Food Hydrocolloids, Vol.75, (2018), pp.192-201.

[17] Yamoum C & Magaraphan R, "Effect of peanut shell content on mechanical, thermal, and biodegradable properties of peanut shell/polylactic acid biocomposites", Polymer Composites, Vol.38, No.4, (2017), pp.682-690.

[18] Yusra AI, Juahir H, Firdaus NNA, Bhat A, Endut A, Khalil HA & Adiana G, "controlling of green nanocellulose fiber properties produced by chemo-mechanical treatment process via sem, tem, afm and image analyzer characterization", journal of fundamental and applied sciences, Vol.10,(2018),pp.1-17.

[19] G, Abikhanova, A Ahmetbekova, E Bayat, A Donbaeva, G Burkitbay (2018). International motifs and plots in the Kazakh epics in China (on the materials of the Kazakh epics in China), Opción, Año 33, No. 85. 20-43.

[20] Akhpanov, S. Sabitov, R. Shaykhadenov (2018). Criminal pre-trial proceedings in the Republic of Kazakhstan: Trend of the institutional transformations. Opción, Año 33. 107-125.

[21] G Cely Galindo (2017) Del Prometeo griego al de la era-biós de la tecnociencia. Reflexiones bioéticas Opción, Año 33, No. 82 (2017):114-133