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Preparation of Fibres from Urginea indica Kunth (Jangli Pyaz) and it's Microbial Properties

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Abstract

Urginea indica Kunth (Drimia indica), popularly known as Jangli Pyaz, is a rare, endangered, and threatened medicinal plant belonging to the Liliaceae family. It contains nutrients and beneficial compounds for your health. Onions have numerous papules in the bulbs that act as a defensive mechanism in addition to having a strong bitter flavour. Its mystical healing powers include cardiotonic, anti-carcinomic, anti-jaundice, anti-dropsy, anti-asthmatic, anti-epileptic, dermatological, and diuretic properties. It is also an abortifacient and has effects on the menstrual cycle. Insects, fungus, and rodents are all treated with it as a pesticide. There is a glaborous, bulbous plant known as Urginea indic. The Liliaceae family includes several therapeutic herb species. a Kunth in the forests of Maharashtra. Urginea indica Kunth bulb extracts' phytochemical analyses and antioxidant properties were evaluated. Bulbs are abundant in several primary and secondary metabolites, including sugars, alkaloids, vitamin C, vitamin E, flavonoids, phenols, glycosides, and saponins, according to phytochemical screening. An HPTL Catalysis method was developed for Urginea indica Kunth flavonoids' chemical fingerprinting. The method's accuracy, precision, and linearity were verified, and they were contrasted with those of the RP-HPLC-DAD method.

Keywords: *Urginea Indica Kunth, Phytochemicals, Medicinal Plant, Flavonoids*

1. Introduction

Drimia indica, also known as Indian squill, is a medicinal plant native to India, Pakistan, and other parts of Asia. It has been used in traditional medicine for centuries to treat a variety of conditions, including asthma, bronchitis, heart disease, skin conditions, and intestinal worms. Phytochemical studies have shown that D. indica contains a variety of active compounds, including alkaloids, flavonoids, phenols, tannins, steroids, glycosides, quinones, resins, and saponins. These compounds have been shown to possess a wide range of pharmacological activities, including antibacterial, antifungal, laxative, spasmodic, antioxidant, anti-angiogenic, pro-apoptotic, anti-diabetic, anti-cancer, and cardiac effects (Pratyush Kumar Jena et al., 2023)

Medicinal plants have been used for centuries to treat a wide range of diseases. Urginea indica is a medicinal plant that has been shown to have antifungal, antibacterial, and anticancer activities. It is a member of the Hyacinthaceae family and is native to India, Pakistan, and other parts of Asia. The bulb of Urginea indica is the most commonly used part of the plant for medicinal purposes. It contains a variety of phytochemical compounds, including alkaloids, tannins, flavonoids, and phenolic compounds. These compounds have been shown to have a variety of pharmacological activities, including antibacterial, antifungal, laxative, spasmodic, antioxidant, anti-angiogenic, and pro-apoptotic effects. Urginea indica has the potential to be used in the development of new and effective therapies for a variety of diseases, including bacterial infections, cancer, and heart disease. Urginea indica is a medicinal plant that has been used to treat a variety of ailments, including arthritis, inflammatory diseases, and cancer. It is also a potential source of new antimicrobial and anticancer drugs. This study investigated the antibacterial and antifungal activity of Urginea indica extracts against a variety of bacterial and fungal strains. The results showed that the extracts were effective against both gram-positive and gram-negative bacteria, as well as against the fungi. The findings of this study suggest that Urginea indica has the potential to be used in the development of new antimicrobial and anticancer

drugs. The growing problem of antibiotic resistance and the need for new and effective antibacterial therapies. Urginea indica is one of many medicinal plants that are being investigated for their potential to be used in the development of new antibacterial drugs. Despite its wide range of potential therapeutic benefits, D. indica has not been well-studied scientifically. However, more research is needed to fully understand the safety and efficacy of the plant extracts. Present research is for extraction of fibre from Urginea indica Kunth (Sanyogita Shahi and Shirish Kumar Singh,2023), (Sanyogita Shahi and Shirish Kumar Singh, 2022).

2. Materials And Methods

Extraction Of Fibre from Urginea indica Kunth:

The layers of bulb and upper stem are used to prepare fibre. In the apparatus used to harvest U. indica Kunth fibres, the bulb is manually peeled. The bulb, which has been peeled and is light purple to whitish, is wasted. The inner layers are slightly whitish in color. The fibres are more in inner layer as compared to outer one.

Another method of extraction is by Sodium hydroxide. Sodium hydroxide (NaOH) extraction is one of the most extensively used and economical techniques for processing natural fibres. Sodium hydroxide is used to produce a variety of natural plant fibres, including lotus, cotton, hemp, alfalfa, flax, and ramie. Urginea indica Kunth fibres are also degummed with sodium hydroxide. However, sodium hydroxide-extracted Urginea indica Kunth fibres have an excessive amount of non-cellulose components.

3. Results and Discussion

Peeling:

Manual labour is used to conduct the peeling. The stem is divided vertically before being peeled. There are four vertical segments that make up the bulb. Peeler now begins coloring the inner bark of the trunk while peeling off layers of it. The white part after peeling is gathered in a convenient location (Kanika Mishra and Sanyogita Shahi,2023).

Fibre Extracting:

The inner layer of bulb, which has been peeled, is processed via a machine with pressure rollers and a mechanism for separating fibres. Since the white inner pulp has a significant quantity of moisture inside of it, the pulp must be rid of this moisture. Pressure rollers aid in removing moisture from fibres (Tapas Kumar Dandasena et al., 2023), (Kajal et al., 2023).

The purple and whitish purple slices is peeled and then run through the roller nip to remove moisture. Moisture purges like a sugarcane juice press. The peeled slices is fed as long as possible between the rollers nip by the machine operator while holding one end of the peeled slices (Sephali Sinha et al., 2023), (Swayamprabha Pati et al., 2023).

Washing And Sun Drying:

The machine operator manually drew the trunk back once it had been fed into the machine to its maximum length. The mechanism for fibre separation activates when he pulls back the trunk. The fibres immediately split as the operator draws back the trunk. The bottom of the machine is where the pulp produced throughout the operation is collected. The operator now does the identical procedure on the opposite end of the bark (Parinita Tripathy et al.,2023), (Sanyogita Shahi et al., 2022).

Characteristics Of Urginea indica Kunth Fibres:

A natural bast fibre is Urginea indica Kunth fibre. It possesses unique physical, chemical, and many other qualities that make it a high-quality fiber.

- The Urginea indica Kunth fibres resemble bamboo and lotus fibres in appearance.
- Its fibres may be spun more easily than bamboo fibre.
- The peak tensile strength of Urginea indica Kunth fiber is lower than than banana, lotus and bamboo fibres.
- The fibres from Urginea indica Kunth have a good sheen, much as silk. The method used to remove and spin the fibres affects how shiny they are.
- The Urginea indica Kunth fibers have weak elongation properties.

- The Urginea indica Kunth fibre is denser than cotton fibre means its specific gravity is higher than cotton fibre.
- It has low moisture absorption capabilities. It swiftly releases moisture as well as quickly absorbs it.
- It may be considered as an eco-friendly fibre because it is biodegradable and has no adverse effects on the environment.
- Like Banana fibres, Urginea indica Kunth fibres may be spun in a variety of ways. It may be spun using the ring frame, open-end, worsted, and wet spinning processes.

4. Conclusion

Urginea indica Kunth is a plant that produces dense, glossy fibres with low absorbance. These fibres are used to make clothing for tents, curtains, and other dress materials that protect people from microbes and insects. The fibres repel microbes and insects, making them ideal for use in areas where these pests are prevalent.

References:

1. Abbas, S., Bashir, S., Khan, A., Mehmood, M.H., Gilani, A.H. (2012). Gastrointestinal stimulant effect of Urginea indica Kunth.and involvement of muscarinic receptors. Phytother Res.26: 704-08.
2. Alexandre Gomes., Takanori Matsuo., Koichi Goda., JunjiOhgi., Compo: Part A. 38 (2007) 1820.
3. Alongi J, Carletto RA, Di Blasio A, et al. Intrinsic intumescent-like flame retardant properties of DNA-treated cotton fabrics. Carbohydr Polym 2013; 96: 296–304.
4. Amasta, S.P. The Useful Plants of India, 1st ed.; CSIR: New Delhi, India, 1986.
5. Arokiyaraj S, Perinbam K, Agastian P, Mohan Kumar R. Phytochemical analysis and antibacterial activity of Vitex agnus-castus. Int J Green Pharm. 2009; 3: 162–164.
6. Arpitha G.R., Sanjay M.R., Yogesha B., Adv. Engg. Appd. Sci: An Inter. J. 4(4) (2014) 47.
7. Asl, M. N. & Hosseinzadeh, H. (2008) Review of pharmacological effects of Glycyrrhiza sp. and its bioactive compounds. Phytotherapy Research, 22: 709–724.
8. Avinash R. Pai., Ramanand N. Jagtap., J. Mater. Environ. Sci. 6(4) (2015) 917.
9. Banso, A.,Adeyemo, S.O. (2007). Evalution of antibacterial Properties of tannis isolated from Dichrostachyescinerea Afr. Biotechnol. 6:1785-7.
10. Baquar, S.R. (1989). Medicinal and poisonous plants of Pakistan. Karachi, Printas, p 458.
11. Bashir, S., Abbas, S., Khan, A., Gilani, A. H. (2013). Studies on bronchodilator and cardiac stimulant activities of Urginea indica.Bangladesh Journal of Pharmacology, 8(3), 249-254.
12. Benkeblia, N. (2004). Antimicrobial activity of essential oil extracts of various Onions (Allium cepa) and Garlic (Allium sativum) lebensm- WISS- U- Technol. 373.
13. Bennet, R.N. and Wallsgrove, R.M. (1994) Secondary metabolism in plant defense mechanisms. New Phytol. 127: 617–633.
14. Blanchard EJ, Graves EE, Salame PA. Flame resistant cotton/polyester carpet materials. J Fire Sci 2000; 18: 151–164.
15. Boopalan M., Niranjanaa M., Umapathy M.J., Compo: Part B. 51 (2013) 57.
16. Brand-Williams W.,Cuvelier M.E. and Berset C.(1995)." Use of free radical method to evaluate antioxidant activity", LebensmittelWissenschaft and Tecnologie; 28 (1) : 25-30.
17. Brodnitz MH, Pascale JV. (1971).Thiopropanal Soxide: A lachrymatory [sic] factor in onions. JAgric Food Chem; 19: 269– 72.
18. Chittoor, M.S.; Binny, A.J.R.; Yadlapalli, S.K.; Cheruku, A.; Dandu, C.; Nimmanapalli, Y. Anthelmintic and antimicrobial studies of Drimia indica (Roxb.) Jessop. bulb aqueous extracts. J. Pharm. Res. 2012, 5, 3677–3686.
19. Davoodi M.M., Sapuan S.M., Ahmad D., Aidy Ali, Khalina A., Mehdi Jonoobi, Mater. Design. 31 (2010) 4932.
20. De Luca, V. and St Pierre, B. (2000) The cell and developmental biology of alkaloid biosynthesis. Trends Plant Sci. 5: 168–173.
21. Deepak A.V., Bharathi P. Salimath, 2006, Antiangiogenic and proapoptotic activity of a novel glycoprotein from U. indica is mediated by NF-kB and Caspase activated DNase in ascites tumor model. Pages 297–307.
22. Deepak, A.V.; Thippeswamy, G.; Shivakameshwari, M.N.; Salimath, B.P. Isolation and characterization of a 29-kDa glycoprotein with antifungal activity from bulbs of Urginea indica. Biochem. Biophys. Res. Commun. 2003, 311, 735–742.
23. Deshmukh, T., Yadav, B.V., Badole, S.L., Bodhankar, S.L., Dhaneshwer,S.R.(2008).Antihyperglycaemic activity of alcoholic extract of Aerva lantana (L.) A. L. Juss Ex J. A. Sehultes leaves in alloxan induced diabetic mice. J. Appl.Biomed,6 : 81-87.
24. Dhananjay Pandey, Ashwini Kumar Gupta May – Jun 2014; Article No. 47, Int. J. Pharm. Sci. Rev. Res., 26(2): 273-281 ISSN 0976 – 044X.

25. Dixon, R.A, Chris J. Lamb, Sameer Masoud, Vincent J.H. Sewalt, Nancy L. Paiva. et al. (1996) Metabolic engineering: prospects for crop improvement through the genetic manipulation of phenylpropanoid biosynthesis and defense responses – a review. Gene, 179: 61–71.
26. Ganan. P., Zuluaga., R., Velez., J.M., Mondragon, I. 2004. Biological Natural Retting for determining the Hierarchical Structuration of Banana Fibers. Macromol Biosci. 20:49(10) 978-983.
27. Ghazala Akhtara, Arham Shabbir, Urginea indica attenuated rheumatoid arthritis and inflammatory paw edema in diverse animal models of acute and chronic inflammation, Journal of Ethnopharmacology, Journal of Ethnopharmacology, volume 238, 28 June 2019, 111864.
28. Gong Y, Han GT, Zhang YM, Zhang JF, Jiang W, PanY. 2015 Research on the degradation performance of the lotus nanofibers-alginate porous materials.Polym. Degrad.Stab. 118,104–110.
29. Gong Y, Han GT, Zhang YM, Zhang JF, Jiang W, PanY. 2015 Research on the degradation performance of the lotus nanofibers-alginate porous materials.Polym. Degrad.Stab. 118,104–110.
30. Horrocks AR. Flame retardant challenges for textiles and fibres: New chemistry versus innovatory solutions. Polym Degrad Stab 2011; 96: 377–392.
31. Horrocks AR. Flame-retardant finishing of textiles. Color Technol 1986; 16: 62–101.
32. Ibrahim NA, Abdel-Aziz MS, Eid BM, et al. Biosynthesis, optimization and potential textile application of fungal cellulases/xylanase multifunctional enzyme preparation from Penicillium sp. SAF6. Biocatal Biotransform 2016; 34: 128–136.
33. Ibrahim NA, Eid BM, El-Zairy ER. Antibacterial functionalization of reactive-cellulosic prints via inclusion of bioactive Neem oil/βCD complex. Carbohydr Polym 2011; 86: 1313–1319.
34. Ibrahim NA, El-Badry K, Eid BM, et al. A new approach for biofinishing of cellulose- containing fabrics using acid cellulases. Carbohydr Polym 2011; 83: 116–121.
35. Ibrahim NA, El-Zairy EMR, Eid BM. Eco-friendly modification and antibacterial functionalization of viscose fabric. J Text Inst 2016, pp. 1–6.
36. Ibrahim NA, Khalil HM, El-Zairy EMR, et al. Smart options for simultaneous functionalization and pigment coloration of cellulosic/wool blends. Carbohydrate Polymer 2013; 96: 200–210.
37. Jena, B., Singh, S. S., Behera, S. K., Mishra, S., Chakrabortty, S., Meher, D. & Mishra, A. (2023). To decipher the phytochemical agent and mechanism for Urginea indica mediated green synthesis of Ag nanoparticles and investigation of its antibacterial activity against Methicillin-resistant Staphylococcus aureus. Environmental Research, 216, 114700.
38. Junmoni Nath, Studies On The Numerous Medicinal Utilities Of The Plant Urginea Indica: A Comprehensive Overview, Sep 2020 Department of Pharmaceutics, Girijananda Chowdhury Institute of Pharmaceutical Sciences, Azara, Guwahati 781017.
39. K. Jankeaw, U. Bupachat, V. Simachaya, Environment Issues in Pollution, Thailand Ministry of Education: Bangkok, 35-36, 1992.
40. K. Morimoto, Natural Dyes, Appropriate Technology Association: Bangkok, 2-11, 1985.
41. Kajal, Sephali Sinha, Swayamprabha Pati, Sanyogita Shahi, Medicinal Value of Chiraita: A Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
42. Kanika Mishra, Sanyogita Shahi, Medicinal Value of Calotropis procera (apple of Sodam): A Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
43. Leonard Y. Mwaikambo., Elias T.N. Bisanda., Poly. Test. 18 (1999) 198.
44. M.N. Shiva Kameshwari, (2013) International Journal Of Pharmacy & Life Sciences Chemical constituents of wild onion Urginea indica Kunth Liliaceae Department of Botany, Bangalore University, Bangalore, (Karnataka) - India, CODEN (USA): IJPLCP.
45. Mahato, Dipa Sahu, Abhiseka Prasad, Sharma H. P., Int. J. of Pharm. & Life Sci. (IJPLS), Vol. 4, Issue 2: February: 2013, 2414-2420, https://nopr.niscpr.res.in/handle/123456789/45048 :Oct-2018, 783-788
46. Manganyi, M.C.; Tlatsana, G.S.; Mokoroane, G.T.; Senna, K.P.; Mohaswa, J.F.; Ntsayagae, K.; Fri, J.; Ateba, C.N. Bulbous Plants Drimia: "A Thin Line between Poisonous and Healing Compounds" with Biological Activities. Pharmaceutics 2021, 13, 1385. https://doi.org/10.3390/ pharmaceutics13091385
47. Manning, J.C.; Goldblatt, P.; Fay, M.F. A revised generic synopsis of Hyacintheaceae in sub-Saharan Africa, based on molecular evidence, including new combinations and the new tribe Pseudoprospereae. Edinb. J. Bot. 2004, 60, 533–568.
48. Mishra S., Mohanty A.K., Drzal L.T., Misra M., Parija S., Nayak S.K., Tripathy S.S., Compo. Sci. Tech. 63 (2003) 1385.
49. Munikenche Gowda T., Naidu A.C.B., Rajput Chhaya, Compo: Part A. 30 (1999) 284
50. Myint, T., San, D. K. N., Phyo, U. A. (2018). Lotus Fiber Value Chain in Myanmar.
51. P. Rodphothong, U. Paradee (Pitimaneeyakul), Dyes and Environment. Proceedings of the Environmental Engineering Association of Thailand, Pitsanulok, Thailand, March 7-9, 2007.
52. Pandey, D.; Gupta, A.K. Antimicrobial activity and phytochemical analysis of Urginea indica from Bastar district of Chhattisgarh. Int. J. Pharm. Sci. Rev. Res. 2014, 26, 273–281.
53. Parinita Tripathy, Pratyush Kumar Jena, Tapas Kumar Dandasena, Sanyogita Shahi, Medicinal Value about Thikur: Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
54. Paul Wambua., Jan Ivens., IgnaasVerpoest., Compo. Sci. Tech. 63 (2003) 1264.

55. Pothan, L.A., Potschke, P.,Habler, P. 2005. The static and Dynamic Mechanical Properties of Banana and Glass Fiber Woven Fabric-Reinforced Polyester Composite. Journal of Composite Material. 39:11. 1007-1025.
56. Pothan. L.A., Jayamol, G., Sabu, T. 2002. Effect of Fiber Surface Treatments on the Fiber- matrix Interaction inBanana Fiber Reinforced Polyester Composites. Composite Interfaces. 9:4. 335-353.
57. Pratyush Kumar Jena, Parinita Tripathy, Tapas Kumar Dandasena, Sanyogita Shahi, Medicinal Value of Star anise: Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
58. PTRI. 2005. Banana. Development of the Technology on Processing Banana Fibers as and Investment Opportunity. Indigenous Fibers for Textile Application. Textile Development. 4(2005). Philippines Textile Research Institute.
59. Ramanaiah K., Ratna Prasad A.V., Hema Chandra Reddy K., J. Mater. Environ. Sci. 3 (3) (2012) 378.
60. Saleeby, Murab M. Abaca (Manila Hemp) in the Philippines (Musa Textilis). Manila: Bureau of Printing, 1919. 1-15.
61. Samanta A.K. and Bhattacharya K. Simultaneous dyeing and fire-retardant finishing of jute fabric using an acid dye and selective FR finishing chemicals. Text Light Ind Sci Technol 2015.
62. Sanjay Jagtapa, Rajendra Satputeb , R. M. Mulan Online International Interdisciplinary Research Journal, {Bi-Monthly}, ISSN 2249-9598, Volume-IV, May 2014 Special Issue , 170-186
63. Sanjay M.R., Arpitha G.R., Yogesha B., Mater. Today: Procee. 2 (2015) 2967.
64. Sanyogita Shahi, Megha Turkane, Shirish Kumar Singh, Medicinal Uses of Asafoetida and Piper Nigrum: A Review, European Chemical Bulletin, Volume 12, Special Issue 3, 2023, ISSN No. 2063-5346.
65. Sanyogita Shahi, Shirish Kumar Singh, A Study of Mechanical Left Ventricular Assist Devices (LVADs) to regenerate heart functionality, European Journal of Molecular & Clinical Medicine, Vol. 09, Issue 08, 2022, ISSN No. 2515-8260.
66. Sanyogita Shahi, Shirish Kumar Singh, Medicinal Plants in Chhattisgarh State, Journal of Pharmaceutical Negative Reports, Vol. 13, Special Issue 5, 2022, ISSN No. 2229-7723.
67. Sanyogita Shahi, Shirish Kumar Singh, Medicinal Uses of Momordica charantia L. (Karela), European Chemical Bulletin, Volume 12, Special Issue 3, 2023, ISSN No. 2063-5346.
68. Sanyogita Shahi, Shirish Kumar Singh, Mohammad Chand Jamali, Exploring The Massive Amounts of Biological Data and Its Role in Treating Patients, International Journal of Medical Sciences, Vol. 2, Issue 1, 2022, ISSN No. 2815-0562.
69. Sanyogita Shahi, Shirish Kumar Singh, Mohammad Chand Jamali, The Importance of Bioinformatics in the field of Biomedical Science, International Journal of Bioinformatics, Vol. 1, Issue 1, 2022, ISSN No. 2961-3523.
70. Sarasini, F. and Fiore, V. (2018). A systematic literature review on less common natural fibres and their biocomposites. Journal of cleaner production, 195, 240-267.
71. Saravanan D, Lakshmi SN, Raja KS, et al. Biopolishing of cotton fabric with fungal cellulase and its effect on the morphology of cotton fibres. Indian J Fibre Text Res 2013; 38: 156–160.
72. Sephali Sinha, Swayamprabha Pati, Kajal, Sanyogita Shahi, Medicinal Value of Cinnamon: Literary Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
73. Shenoy, S.R., Kameshwari, M.N., Swaminathan, S., Gupta, M.N. Major antifungal activity from the bulbs of Indian squill Urginea indica is a chitinase. Biotechnol. Prog. 2006, 22, 631–637.
74. Singh V.K., Gope P.C., Chauhan Sakshi., Bisht Deepak Singh., J. Mater. Environ. Sci. 3 (1) (2012) 194.
75. Sonali Aswal, Ankit Kumar, Ruchi Badoni Semwal, Ashutosh Chauhan, Abhimanyu Kumar, Jörg Lehmann and Deepak Kumar Semwal. (2019) Medicina, Drimia indica: A Plant Used in Traditional Medicine and Its Potential for Clinical Uses.
76. Sreekala M.S., Jayamol George., Kumaran M.G., Sabu Thomas., Compo. Sci. Tech. 62 (2002) 353.
77. Stannard, J. Squill in ancient and medieval materia medica, with special reference to its employment for dropsy. Bull. N. Y. Acad. Med. 1974, 50, 684–713.
78. Sudaldeep Sahoo, Sanyogita Shahi, Bioactive Carbohydrates: Review, 2021, Natural Volatiles and Essential Oils, Vol. 8, Issue 6, ISSN No. 2148-9637.
79. Swayamprabha Pati, Sephali Sinha, Kajal, Sanyogita Shahi, Medicinal Value of Clove: Review, European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
80. Tapas Kumar Dandasena, Parinita Tripathy, Pratyush Kumar Jena, Sanyogita Shahi, Medicinal Value Consider Piper cubeb (Kabab chini), European Chemical Bulletin, Volume 12, Special Issue 1(Part B), 2023, ISSN No. 2063-5346.
81. The Plant List. Version 1.1. Available online: http://www.theplantlist.org/ (accessed on 1 January 2013).
82. Velmurugan R., Manikandan V., Compo: Part A. 38 (2007) 2216–2226.
83. Wu M, Shuai H, Cheng Q, Jiang L. 2014 Bioinspired green composite lotus fibers. Angew.Chem.Int.Ed.53, 3358–3361. (doi:10.1002/anie.201310656)
84. Yongli Zhang., Yan Li., Hao Ma., Tao Yu., Compo. Sci. Tech. 88 (2013) 177.