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UNIVERSIDADE ESTADUAL PAULISTA
“JÚLIO DE MESQUITA FILHO”
INSTITUTO DE BIOCIÊNCIAS – RIO CLARO

PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS BIOLÓGICAS
(BIOLOGIA CELULAR, MOLECULAR E MICROBIOLOGIA)

SUGARCANE BAGASSE XYLAN ACETYLATION AND ITS EFFECT ON BIOPLASTIC FORMULATION, PROPERTIES AND BIODEGRADATION

JÚLIA RIBEIRO MARTINS

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Dissertação apresentada ao Instituto de Biociências do Campus de Rio Claro, Universidade Estadual Paulista, como parte dos requisitos para obtenção do título de Mestre em Biologia Celular, Molecular e Microbiologia.

Orientador: Prof. Dr. Michel Brienzo

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TÍTULO DA DISSERTAÇÃO: Sugarcane Bagasse Xylan Acetylation and its Effect on Bioplastic Formulation, Properties and Biodegradation

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Prof. Dr. MICHEL BRIENZO (Participaçao Virtual)
Laboratorio de Caracterizacao de Biomassa / Instituto de Pesquisa em Bioenergia IPBEN

Prof. Dr. ADILSON ROBERTO GONÇALVES (Participaçao Virtual)
IPBEN / Instituto de Pesquisa em Bioenergia

Prof. Dr. MARIO GUIMARÃES JUNIOR (Participaçao Virtual)
Departamento de Eletromecânica / Centro Federal de Educação Tecnológica de Minas Gerais

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RESUMO

A aplicação de materiais biodegradáveis renováveis em substituição ao plástico é urgente. Devido ao crescimento da população mundial e ao aumento de seus hábitos de consumo, até 23 milhões de toneladas de resíduos plásticos estão sendo descartados em ambientes naturais, como ecossistemas aquáticos, trazendo danos irreversíveis à vida selvagem. Um biopolímero com potencial para a produção de bioembalagens são as hemiceluloses. No entanto, a molécula de hemicelulose apresenta algumas desvantagens, como baixa resistência térmica, e o bioplástico formado pode apresentar fragilidade e baixa resistência mecânica. Assim, modificações químicas de hemiceluloses podem ser aplicadas para superar tais problemas. A acetilação é um tipo de modificação química comumente aplicada às hemiceluloses e pode melhorar algumas das características do bioplástico. No presente estudo, xilana de cana-de-açúcar foi acetilada aplicando ácido sulfúrico como catalisador, e diferentes condições de reação como teor de ácido sulfúrico e tempo de reação foram testadas. Gras de acetilação baixo (0.45) e médio (0.9) foram alcançados, o que resultou em xilana de cana solúvel em água (como vantagem). A reação de acetilação foi responsável pela hidrólise da xilana devido à presença de ácido sulfúrico, que causou grande perda de massa. Isso pode ser observado principalmente em amostras com alto teor de ácido sulfúrico ou com tempo de reação aumentado. Os bioplásticos foram formados utilizando xilana acetilada com baixo e médio DS e xilana não acetilada, aplicando-se amido como copolímero e glicerol como plastificante. Xilana acetilada em blenda com amido na formação de bioplásticos é aqui relatado pela primeira vez. A água foi utilizada como solvente para a formação do bioplástico e o bioplástico à base de amido, sem adição de xilana, foi utilizado para comparação. A acetilação em graus baixos e médios causou um aumento na resistência mecânica e térmica. A acetilação DS de 0,45 aparentemente não afetou a taxa de desintegração do bioplástico, enquanto o DS médio de 0,9 pode ter sido responsável pela diminuição da atividade microbiana, o que foi atestado em análise de ecotoxicidade. Todas as amostras estudadas apresentam propriedade de barreira ao óleo até 30 dias, uma vantagem para aplicação em embalagens. Os resultados indicam que a acetilação em grau moderado trouxe a vantagem de criar xilana solúvel em água, e foi suficiente para melhorar as propriedades dos bioplásticos.

Palavras-chave: Bioplástico, Bagaço de Cana-de-açúcar, Xilana, Acetilação, Solúvel em Água, Modificação Química

ABSTRACT

The application of renewable biodegradable materials replacing plastic is urgent. Due to world population growth and an increase in its consuming habits, up to 23 million metric tons of plastic wastes are being disposed of in natural environments, such as aquatic ecosystems, bringing irreversible damage to wildlife. A potential biopolymer for biopackaging production is hemicelluloses. However, hemicelluloses molecule presents some disadvantages such as low thermal resistance, and the bioplastic formed may present brittleness and low mechanical strength. Therefore, chemical modifications of hemicelluloses can overcome such issues. Acetylation is a common chemical modification applied to hemicelluloses, and can enhance some of the bioplastic features. In the present study, sugarcane xylan was acetylated applying sulfuric acid as catalyst, and different reaction conditions such as sulfuric acid content and reaction time were tested. Low (0.45) and medium (0.9) acetylation degrees substitution (DS) were achieved, which resulted in water-soluble sugarcane xylan (as an advantage). Acetylation reaction was responsible for xylan hydrolysis due to the presence of sulfuric acid, which caused for high mass loss. This could be seen specially in samples with high sulfuric acid content or with increased reaction time. Bioplastics were formed using acetylated xylan with low and medium DS and non-acetylated xylan, applying starch as copolymer and glycerol as a plasticizer. Acetylated xylan blended with starch in bioplastics formation is here reported for the first time. Water was used as a solvent for bioplastic formation, and starch-based bioplastic, without the addition of xylan was used for comparison. Acetylation in both low and medium degrees caused an increase in mechanical and thermal resistance. Acetylation DS of 0.45 apparently didn’t affect the disintegration rate of the bioplastic, while medium DS of 0.9 may have been responsible for decreasing microbial activity, which was attested in ecotoxicity analysis. All of the samples studied present oil barrier property up to 30 days, an advantage for package application. The results indicate that acetylation in a moderate degree brought the advantage of creating water-soluble xylan, and it was sufficient for enhancing bioplastics properties.

Keywords: Bioplastic, Sugarcane Bagasse, Xylan, Acetylation, Water-soluble, Chemical Modification

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SUMMARY

CHAPTER I: INTRODUCTION AND OBJECTIVES

1. Introduction

The world population is growing significantly, and the current average population increase is estimated at 81 million people per year (WORLDOMETER, 2022). That, associated with its increasing consumption habits, resulted in an increase in the production of plastic materials. It is estimated that 19 to 23 million metric tons of plastic waste entered aquatic ecosystems in 2016, which represents 11 % of plastic waste generated globally in that year (BORRELLE et al., 2020). Synthetic polymers degradation is a slow process, as they are not directly consumed by microorganisms. They are initially degraded by environmental factors, such as light, heat, moisture, and chemical conditions, which rupture the bonds of macromolecules (SINGH et al., 2021; WILKES et al., 2017). In this process, micro and nanoplastics are created, resulting in radical sites, which are essential for the action of microorganisms.

With increasing worldwide concerns over such problematics, much effort has been directed to the application of biopolymers in the production of bioplastics, such as cellulose and hemicelluloses. Hemicelluloses are a group of polysaccharides with highly diversified structures incorporating various sugars, usually presenting an amorphous structure. It accounts for 20 ~ 35 percent of plant biomass and is the second most abundant biopolymer after cellulose (LING et al., 2020). In sugarcane bagasse, xylose content represents up to 80 % of hemicelluloses (ALVES et al., 2021).

Acetyl group is a common substituent found on hemicelluloses in their natural state, usually connected to its backbone or ramification through ester linkages (GILLE; PAULY, 2012). It is thought that hemicelluloses acetylation was obtained through an evolutionary process, adjusting the plant biological functions, such as flexural properties of wood, polysaccharide interaction, plant growth, and stress resistance (GAO et al., 2017; GRANTHAM et al., 2017; JOHNSON et al., 2017; PAULY; RAMÍREZ, 2018; VOGEL et al., 2004; YAN et al., 2018; ZHANG et al., 2017; ZHU et al., 2014). However, for industrial processing, hemicelluloses are deacetylated during separation from other biomass polymers, due to alkaline solubilization frequently applied (PENG et al., 2012). Therefore, there is a great amount of free hydroxyl groups on hemicellulosic backbones, specifically two per xylose unit. The free hydroxyl groups present an opportunity for chemical modifications, which may be used to hinder the molecule drawbacks such as poor solubility in common organic solvents and low thermal stability during sample processing (HUDA et al., 2005; LÖNNBERG et al., 2006). Among the modification strategies are esterification, including acetylation, oleoylation, lauroylation, fluorination, crosslinking, and etherification, including methylation, carboxymethylation, and benzylation (ALEKHINA et al., 2014; MARTINS; ABE; BRIENZO, 2022; PENG; REN; SUN, 2010; REN; SUN; PENG, 2008).

Chemical acetylation is an esterification reaction that substitutes hydroxyl groups in the hemicelluloses backbone with relatively hydrophobic acetyl groups (compared to the hydroxyl groups). Such modification influences the molecule properties, such as hydrophobicity, solubilization in different solvents, and thermal degradation. However, such properties will depend on the degree of acetylation obtained, as acetyl groups will be responsible for impeding hydroxyl groups to create hydrogen bonds with water and spontaneous intra-molecular hydrogen bonding, keeping the xylan chains from aggregating (STEPAN et al., 2013; ZHU et al., 2020). Also, relatively hydrophobic acetyl groups present good affinity with some organic solvents such as chloroform, dimethylsulfoxide, and tetrahydrofuran (SUN; HUGHES, 1999).

Numerous methods for hemicelluloses acetylation have been reported to achieve varying degrees of substitution and controlled hemicelluloses properties (AKKUS; OZKAN; BAKIR, 2018; MORAIS DE CARVALHO et al., 2019; REN; SUN; LIU, 2007; SUN; HUGHES, 1999; YILMAZ-TURAN et al., 2020; ZHU et al., 2020). Hemicelluloses may be acetylated by varying reaction conditions such as the solvents and catalysts applied, as well as reaction time and temperature, which will also influence the molecule degradation in the process. Therefore, this study evaluated the sugarcane bagasse xylan acetylation reaction conditions, applying acetic anhydride as an acetylation agent, and sulfuric acid as a reaction catalyst. The conditions were applied to produce xylan with different acetylation degrees, which were employed in starch/xylan-based bioplastics formulation. Bioplastic properties such as mechanical resistance, thermal degradation, water-solubility, oil barrier, and disintegration were evaluated.

CHAPTER V: GENERAL CONCLUSIONS

The present study aimed to evaluate the influence of reaction conditions on the acetylation degree obtained, as well as the influence of the acetylation degree in the bioplastic formation and properties. It was possible to control xylan degree of acetylation by varying the reaction parameters such as catalyst content and reaction time. Increasing reaction time was responsible for increasing the DS obtained, while the higher sulfuric acid content caused hemicelluloses hydrolysis. Sugarcane bagasse xylan acetylation with DS ranging from 0.42 to 0.91 was achieved and confirmed by FTIR analysis. Acetylated xylan with such DS was water-soluble, which allowed for the application of water as a solvent, and starch and glycerol as copolymer and plasticizer in the bioplastic formation. Both low (0.45) and medium (0.9) acetylation DS showed influence on xylan-based bioplastic properties when compared to non-acetylated xylan and starch-based bioplastics.

In general, the low DS of 0.45 caused an increase in the bioplastics water affinity, while the medium DS of 0.9 has the opposite effect. For instance, low DS bioplastic presented a higher moisture content and water permeability rate when compared to the non-acetylated bioplastic, whereas medium DS bioplastic presented a reduction in both of those properties. This indicates an increase in the hydrophilicity of the low DS bioplastic due to the hindrance of aggregation among xylan chains. However, the low DS applied was not enough to cause an increase in hydrophobicity, which was observed in the bioplastic with medium DS of 0.9, which was indicated by water contact angle analysis.

Acetylation in both low and medium degrees caused an increase in the bioplastics Young's modulus up to 100 times higher when compared to non-acetylated xylan bioplastic. All of the bioplastics studied present oil barrier property, an advantage for package application. Although acetylation is known to hinder polymer biodegradation, the low DS applied in the present study of 0.45 apparently was sufficient to impede the bioplastics disintegration in soil. However, the medium DS of 0.9 may have hindered microbial activity, which caused lower alterations in the soil and, therefore, presented reduced ecotoxicity when compared to other bioplastics in the present work.

The results indicated that acetylation shows potential for enhancing bioplastics properties for packaging material, especially by the increase in mechanical and thermal resistance, and water barrier properties. Polymers chemical modifications have shown to be a great tool in order to enhance biomaterials properties, while still applying renewable sources as feedstocks. Such researches are detrimental to gradually reducing the application of traditional petroleum-based plastics in society. Therefore, reducing environmental damage, such as threatening wildlife, spreading toxins, and contributing to global warming. Some examples of renewable polymers developed through research and produced and distributed on an industrial scale are cellulose acetate, polylactic acid, starch thermoplastics, and, more recently, ethylene derived from sugarcane, among others. Therefore, the investigation of increasing the application of renewable materials in a wider variety of fields is one of the main tools for a more sustainable society.

REFERENCES

ABE, M. M. et al. Advantages and disadvantages of bioplastics production from starch and lignocellulosic components. **Polymers**, v. 13, n. 15, 1 ago. 2021.

ABE, M. M. et al. Production and assessment of the biodegradation and ecotoxicity of xylan- and starch-based bioplastics. **Chemosphere**, v. 287, 1 jan. 2022.

ABE, M. M.; BRANCIFORTI, M. C.; BRIENZO, M. Biodegradation of hemicellulose-cellulose-starch-based bioplastics and microbial polyesters. **Recycling**, v. 6, n. 1, p. 22, 2021.

ABUSHAMMALA, H.; KROSSING, I.; LABORIE, M. P. Ionic liquid-mediated technology to produce cellulose nanocrystals directly from wood. **Carbohydrate Polymers**, v. 134, p. 609–616, 24 ago. 2015.

ABUSHAMMALA, H.; MAO, J. A Review on the Partial and Complete Dissolution and Fractionation of Wood and Lignocelluloses Using Imidazolium Ionic Liquids. **Polymers**, v. 12, n. 1, p. 195, 11 jan. 2020.

AKKUS, M.; OZKAN, N.; BAKIR, U. Efficient Acetylation of Xylans by Exploiting the Potassium Acetate Formed During the Alkaline Extraction. **Journal of Polymers and the Environment**, v. 26, n. 8, p. 3397–3403, 1 ago. 2018.

ALEKHINA, M. et al. Carboxymethylation of alkali extracted xylan for preparation of bio-based packaging films. **Carbohydrate Polymers**, v. 100, p. 89–96, 2014.

ALVES, R. C. et al. Sieving process selects sugarcane bagasse with lower recalcitrance to xylan solubilization. **Journal of Chemical Technology and Biotechnology**, v. 96, n. 2, p. 327–334, 1 fev. 2021.

AMARASEKARA, A. S. Ionic Liquids in Biomass Processing. **Israel Journal of Chemistry**, v. 59, n. 9, p. 789–802, 1 set. 2019.

AMSBURY, S. et al. Stomatal Function Requires Pectin De-methyl-esterification of the Guard Cell Wall. **Current Biology**, v. 26, n. 21, p. 2899–2906, 7 nov. 2016.

ANDREWARTHA, K. A.; PHILLIPS, D. R.; STONE, B. A. Solution Properties of Wheat-Flour Arabinoxylans and Enzymically Modified Arabinoxylans. **Carbohydrate Research**, v. 77, n. 1, p. 191–204, 1979.

ANTONIOU, E. et al. Solvent effects on polysaccharide conformation. **Carbohydrate Polymers**, v. 79, n. 2, p. 380–390, 20 jan. 2010.

ANTONIOU, J. et al. Physicochemical and thermomechanical characterization of tara gum edible films: Effect of polyols as plasticizers. **Carbohydrate Polymers**, v. 111, p. 359–365, 13 out. 2014.

ASTM E96/E96M. ASTM E96 / E96M - 05 Standard Test Methods for Water Vapor Transmission of Materials. 2010.

ASTM F119-82. ASTM F119-82 - Standard Test Method for Rate of Grease Penetration of Flexible Barrier Materials (Rapid Method). 2008.

AVRAM, A. M. et al. Nanofiltration membranes for ionic liquid recovery. **Separation Science and Technology (Philadelphia)**, v. 52, n. 13, p. 2098–2107, 2 set. 2017.

AYOUB, A. et al. Development of an acetylation reaction of switchgrass hemicellulose in ionic liquid without catalyst. **Industrial Crops and Products**, v. 44, p. 306–314, jan. 2013.

AZEREDO, H. M. C. et al. Wheat straw hemicellulose films as affected by citric acid. **Food Hydrocolloids**, v. 50, p. 1–6, 1 ago. 2015.

BACETE, L. et al. Plant cell wall-mediated immunity: cell wall changes trigger disease resistance responses. **Plant Journal**, v. 93, n. 4, p. 614–636, 1 fev. 2018.

BAIG, K. S.; WU, J.; TURCOTTE, G. Future prospects of delignification pretreatments for the lignocellulosic materials to produce second generation bioethanol. **International Journal of Energy Research**, 2019.

BALESTRI, E. et al. Phytotoxicity assessment of conventional and biodegradable plastic bags using seed germination test. **Ecological Indicators**, v. 102, p. 569–580, 1 jul. 2019.

BARTHEL, S.; HEINZE, T. Acylation and carbanilation of cellulose in ionic liquids. **Green Chemistry**, v. 8, n. 3, p. 301–306, 2 mar. 2006.

BARTLEWICZ, O. et al. Heterogeneous catalysis with the participation of ionic liquids. **Catalysts**, v. 10, n. 11, p. 1–16, 1 nov. 2020.

BARTZ, J. et al. Acetylation of barnyardgrass starch with acetic anhydride under iodine catalysis. **Food Chemistry**, v. 178, p. 236–242, 1 jul. 2015.

BELLISSENT-FUNEL, M. C.; NASR, S.; BOSIO, L. X-ray and neutron scattering studies of the temperature and pressure dependence of the structure of liquid formamide. **Journal of Chemical Physics**, v. 106, n. 19, p. 7913–7919, 15 maio 1997.

BELMOKADDEM, F. Z. et al. Green synthesis of xylan hemicellulose esters. **Carbohydrate Research**, v. 346, n. 18, p. 2896–2904, 27 dez. 2011.

BERLIOZ, S. et al. Gas-phase surface esterification of cellulose microfibrils and whiskers. **Biomacromolecules**, v. 10, n. 8, p. 2144–2151, 10 ago. 2009.

BERTOTI, A. R.; LUPORINI, S.; ESPERIDIÃO, M. C. A. Effects of acetylation in vapor phase and mercerization on the properties of sugarcane fibers. **Carbohydrate Polymers**, v. 77, n. 1, p. 20–24, 22 maio 2009.

BERTUZZI, M. A.; ARMADA, M.; GOTTIFREDI, J. C. Physicochemical characterization of starch based films. **Journal of Food Engineering**, v. 82, n. 1, p. 17–25, 1 set. 2007.

BHASKARUNI, S. V. H. S. et al. A review on multi-component green synthesis of N-containing heterocycles using mixed oxides as heterogeneous catalysts. **Arabian Journal of Chemistry**, v. 13, n. 1, p. 1142–1178, 1 jan. 2020.

BHUNIA, K. et al. Migration of chemical compounds from packaging polymers during microwave, conventional heat treatment, and storage. **Comprehensive Reviews in Food Science and Food Safety**, v. 12, n. 5, p. 523–545, set. 2013.

BI, R. et al. The degree of acetylation affects the microbial degradability of mannans. **Polymer Degradation and Stability**, v. 133, p. 36–46, 1 nov. 2016.

BIELY, P. Microbial carbohydrate esterases deacetylating plant polysaccharides. **Biotechnology Advances**, v. 30, n. 6, p. 1575–1588, nov. 2012.

BIERMANN, C. J. Hydrolysis and Other Cleavages of Glycosidic Linkages in Polysaccharides. **Advances in Carbohydrate Chemistry and Biochemistry**, v. 46, p. 251–271, 1988.

BILO, F. et al. A sustainable bioplastic obtained from rice straw. **Journal of Cleaner Production**, v. 200, p. 357–368, 1 nov. 2018.

BISCHOFF, V. et al. TRICHOME BIREFRINGENCE and its homolog AT5G01360 encode plant-specific DUF231 proteins required for cellulose biosynthesis in arabidopsis. **Plant Physiology**, v. 153, n. 2, p. 590–602, jun. 2010.

BISSETT, F. et al. Isolation, Purification, and Characterization of a Complex Heteroxylan from Industrial Wheat Bran. **J. Agric. Food Chem. J. Agric. Food Chem**, v. 30, n. 3, p. 488–495, 1982.

BORDALLO, H. N. et al. Quasi-elastic neutron scattering study of dimethyl-sulfoxide-water mixtures: Probing molecular mobility in a nonideal solution. **Journal of Chemical Physics**, v. 121, n. 24, p. 12457–12464, 22 dez. 2004.

BORRELLE, S. B. et al. Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. **Science**, v. 369, n. 6510, p. 1515–1518, 2020.

BRENNAN, T. C. R. et al. Recovery of sugars from ionic liquid biomass liquor by solvent extraction. **Bioenergy Research**, v. 3, n. 2, p. 123–133, 2010.

BRIENZO, M. et al. Sugarcane bagasse hemicellulose properties, extraction technologies and xylooligosaccharides production. **Food waste: practices, management and challenges**, p. 155–188, 2016.

BRIENZO, M.; SIQUEIRA, A. F.; MILAGRES, A. M. F. Search for optimum conditions of sugarcane bagasse hemicellulose extraction. **Biochemical Engineering Journal**, v. 46, n. 2, p. 199–204, 1 out. 2009.

BUCHANAN, C. M. et al. Preparation and characterization of arabinoxylan esters and arabinoxylan ester/cellulose ester polymer blends. **Carbohydrate Polymers**, v. 52, p. 345–357, 2003.

BURANOV, A. U.; MAZZA, G. Extraction and characterization of hemicelluloses from flax shives by different methods. **Carbohydrate Polymers**, v. 79, n. 1, p. 17–25, 5 jan. 2010.

BUSSE-WICHER, M. et al. The pattern of xylan acetylation suggests xylan may interact with cellulose microfibrils as a twofold helical screw in the secondary plant cell wall of Arabidopsis thaliana. **Plant Journal**, v. 79, n. 3, p. 492–506, 2014.

BUSSE-WICHER, M. et al. Evolution of xylan substitution patterns in gymnosperms and angiosperms: Implications for xylan interaction with cellulose. **Plant Physiology**, v. 171, n. 4, p. 2418–2431, 1 ago. 2016.

CANDIDO, J. P. et al. Detoxification of sugarcane bagasse hydrolysate with different adsorbents to improve the fermentative process. **World Journal of Microbiology and Biotechnology**, v. 36, n. 3, 1 mar. 2020.

CAO, L. et al. An edible oil packaging film with improved barrier properties and heat sealability from cassia gum incorporating carboxylated cellulose nano crystal whisker. **Food Hydrocolloids**, v. 98, p. 105251, 1 jan. 2020.

CARDINAUD, C.; TRESSAUD, A. Surface Modification of Inorganic Materials by Fluorination Treatments. Em: **Advanced Inorganic Fluorides**. [s.l.] Elsevier, 2000. p. 437–492.

CASTRO-AGUIRRE, E. et al. Insights on the aerobic biodegradation of polymers by analysis of evolved carbon dioxide in simulated composting conditions. **Polymer Degradation and Stability**, v. 137, p. 251–271, 1 mar. 2017.

CHADNI, M. et al. Steam explosion process for the selective extraction of hemicelluloses polymers from spruce sawdust. **Industrial Crops and Products**, v. 141, p. 111757, 1 dez. 2019.

CHADNI, M. et al. Elaboration of hemicellulose-based films: Impact of the extraction process from spruce wood on the film properties. **Carbohydrate Research**, v. 497, p. 108111, 1 nov. 2020.

CHANG, Y.; LV, Y. Structure, functionality, and digestibility of acetylated hulless barley starch. **International Journal of Food Properties**, v. 20, n. 8, p. 1818–1828, 3 ago. 2017.

CHEN, P. et al. Homogeneous acetylation of hemicelluloses from soy sauce residue in imidazolium-based ionic liquid. **Journal of Material Cycles and Waste Management**, v. 17, n. 3, p. 574–582, 23 jul. 2015.

CHEN, Y. et al. Superhydrophobic Modification on Starch Film Using PDMS and Ball-Milled MMT Coating. **ACS Sustainable Chemistry and Engineering**, v. 8, n. 28, p. 10423–10430, 20 jul. 2020.

CHI, H. et al. Effect of acetylation on the properties of corn starch. **Food Chemistry**, v. 106, n. 3, p. 923–928, 1 fev. 2008.

CHIYANZY, I. et al. Spent coffee ground mass solubilisation by steam explosion and enzymatic hydrolysis. **Journal of Chemical Technology and Biotechnology**, v. 90, n. 3, p. 449–458, 1 mar. 2015.

CHOI, I. et al. Physicochemical properties and solubility of sweet potato starch-based edible films. **Food Packaging and Shelf Life**, v. 33, p. 100867, 1 set. 2022.

CHRISTOPHER, L. Adding Value Prior to Pulping: Bioproducts from Hemicellulose. Em: **Global Perspectives on Sustainable Forest Management**. London: [s.n.]. p. 225–246.

CHRISTOV, L. P.; ALEXANDER, B. P. Esterases of xylan-degrading microorganisms: Production, properties, and significance. **Enzyme Microb. Technol.**, v. 15, p. 460–475, 1993.

COLUSSI, R. et al. Acetylated rice starches films with different levels of amylose: Mechanical, water vapor barrier, thermal, and biodegradability properties. **Food Chemistry**, v. 221, p. 1614–1620, 15 abr. 2017.

DA COSTA LOPES, A. M.; ŁUKASIK, R. M. Separation and Recovery of a Hemicellulose-Derived Sugar Produced from the Hydrolysis of Biomass by an Acidic Ionic Liquid. **ChemSusChem**, v. 11, n. 6, p. 1099–1107, 22 mar. 2018.

DAVIS, T. L. Paul schutzenberger. **Journal of Chemical Education**, v. 6, n. 9, p. 1415–1424, 1929.

DE CARVALHO, D. M. et al. Isolation and characterization of acetylated glucuronoarabinoxylan from sugarcane bagasse and straw. **Carbohydrate Polymers**, v. 156, p. 223–234, 20 jan. 2017.

DE FIGUEIREDO, F. C. et al. Chemical input reduction in the arabinoxylan and lignocellulose alkaline extraction and xylooligosaccharides production. **Bioresource Technology**, v. 228, p. 164–170, 2017.

DE FREITAS, C.; CARMONA, E.; BRIENZO, M. Xylooligosaccharides production process from lignocellulosic biomass and bioactive effects. **Bioactive Carbohydrates and Dietary Fibre**, v. 18, p. 100184, 1 abr. 2019.

DE LUCENA, C. A. A. et al. Desenvolvimento de biofilmes à base de xilana e xilana/gelatina para produção de embalagens biodegradáveis. **Polimeros**, v. 27, p. 35–41, 2017.

DE RYCKE, N.; COUTY, F.; DAVID, O. R. P. Increasing the reactivity of nitrogen catalysts. **Chemistry - A European Journal**, v. 17, n. 46, p. 12852–12871, 11 nov. 2011.

DEVI, R. S. et al. The Role of Microbes in Plastic Degradation. Em: **Environmental Waste Management**. [s.l: s.n.]. p. 341–370.

DEWHIRST, R. A.; MORTIMER, J. C.; JARDINE, K. J. Do Cell Wall Esters Facilitate Forest Response to Climate? **Trends in Plant Science**, v. 25, n. 8, p. 729–732, 1 ago. 2020.

DIALLO, B. et al. Biomass yield, chemical composition and theoretical ethanol yield for different genotypes of energy sorghum cultivated on marginal land in China. **Industrial Crops and Products**, v. 137, p. 221–230, 1 out. 2019.

DIEDERICKS, D.; VAN RENSBURG, E.; GÖRGENS, J. F. Enhancing sugar recovery from sugarcane bagasse by kinetic analysis of a two-step dilute acid pretreatment process. **Biomass and Bioenergy**, v. 57, p. 149–160, out. 2013.

DOCHERTY, K. M.; HEBBELER, S. Z.; KULPA, C. F. An assessment of ionic liquid mutagenicity using the Ames Test. **Green Chemistry**, v. 8, n. 6, p. 560–567, 5 jun. 2006.

DOCHERTY, K. M.; KULPA, C. F. Toxicity and antimicrobial activity of imidazolium and pyridinium ionic liquids. **Green Chemistry**, v. 7, n. 4, p. 185–189, 2005.

DONG, C. et al. Dual-frequency ultrasound combined with alkali pretreatment of corn stalk for enhanced biogas production. **Renewable Energy**, v. 127, p. 444–451, 1 nov. 2018.

DOTAN, A. Biobased Thermosets. **Handbook of Thermoset Plastics**, p. 577–622, 1 jan. 2014.

DUPONT, A. L. Cellulose in lithium chloride/N,N-dimethylacetamide, optimisation of a dissolution method using paper substrates and stability of the solutions. **Polymer**, v. 44, n. 15, p. 4117–4126, 27 jun. 2003.

DUTRA, E. D. et al. Alkaline hydrogen peroxide pretreatment of lignocellulosic biomass: status and perspectives. **Biomass Conversion and Biorefinery (Internet)**, v. 8, n. 1, p. 225–234, 1 mar. 2018.

EBRINGEROVÁ, A.; HROMÁDKOVÁ, Z. Xylans of Industrial and Biomedical Importance. **Biotechnology and Genetic Engineering Reviews**, v. 16, n. 1, p. 325–346, 1 abr. 1999.

EGÜÉS, I. et al. Corncob arabinoxylan for new materials. **Carbohydrate Polymers**, v. 102, n. 1, p. 12–20, 15 fev. 2014.

EL-KAFRAWY, A. Investigation of the Cellulose/LiCl/ Dimethylacetamide and Cellulose/LiC1/N-Methyl-2-Pyrrolidinone Solutions by 13C NMR Spectroscopy. **Journal of Applied Polymer Science**, v. 27, n. 7, p. 2435–2443, 1982.

ENDO, T. et al. Efficient recovery of ionic liquid by electrodialysis in the acid hydrolysis process. **Separation Science and Technology (Philadelphia)**, v. 52, n. 7, p. 1240–1245, 3 maio 2017.

ESCARNOT, E.; AGUEDO, M.; PAQUOT, M. Enzymatic hydrolysis of arabinoxylans from spelt bran and hull. **Journal of Cereal Science**, v. 55, n. 2, p. 243–253, mar. 2012.

ESPIRITO SANTO, M. et al. Structural and compositional changes in sugarcane bagasse subjected to hydrothermal and organosolv pretreatments and their impacts on enzymatic hydrolysis. **Industrial Crops and Products**, v. 113, p. 64–74, 1 mar. 2018.

FAKHOURI, M. F. et al. Filmes e coberturas comestíveis compostas à base de amidos nativos e gelatina na conservação e aceitação sensorial de uvas Crimson. 2007. **Ciência e Tecnologia de Alimentos**, v. 27, n. 2, p. 369–375, 2007.

FANG, J. M. et al. Esterification of wheat straw hemicelluloses in the N,N-dimethylformamide/lithium chloride homogeneous system. **Journal of Applied Polymer Science**, v. 74, n. 9, p. 2301–2311, nov. 1999.

FANG, J. M. et al. Acetylation of wheat straw hemicellulose B in a new non-aqueous swelling system. **Carbohydrate Polymers**, v. 41, p. 379–387, 2000.

FANG, J. M. et al. Preparation and characterisation of methylated hemicelluloses from wheat straw. **Carbohydrate Polymers**, v. 47, n. 3, p. 285–293, 15 fev. 2002.

FARHAT, W. et al. A Review of Water-Resistant Hemicellulose-Based Materials: Processing and Applications. **ChemSusChem**, v. 10, n. 2, p. 305–323, 20 jan. 2017.

FARINA, V. High-turnover palladium catalysts in cross-coupling and Heck chemistry: A critical overview. **Advanced Synthesis and Catalysis**, v. 346, n. 13–15, p. 1553–1582, dez. 2004.

FERNANDES, É. S. et al. Minor Biomass Particle Size for an Efficient Cellulose Accessibility and Enzymatic Hydrolysis. **ChemistrySelect**, v. 5, n. 25, p. 7627–7631, 7 jul. 2020.

FERNÁNDEZ-BOLANOS, J. et al. Steam-explosion of olive stones: hemicellulose solubilization and enhancement of enzymatic hydrolysis of cellulose. **Bioresource Technology**, v. 79, p. 53–61, 2001.

FERRER, A.; PAL, L.; HUBBE, M. Nanocellulose in packaging: Advances in barrier layer technologies. **Industrial Crops and Products**, v. 95, p. 574–582, 1 jan. 2017.

FORSAN, C. F. et al. Xylooligosaccharide production from sugarcane bagasse and leaf using Aspergillus versicolor endoxylanase and diluted acid. **Biomass Conversion and Biorefinery**, 2021.

FORTUNATI, E. et al. Effects of modified cellulose nanocrystals on the barrier and migration properties of PLA nano-biocomposites. **Carbohydrate Polymers**, v. 90, n. 2, p. 948–956, 1 out. 2012.

FRADE, R. F. M.; AFONSO, C. A. M. Impact of ionic liquids in environment and humans: An overview. **Human and Experimental Toxicology**, v. 29, n. 12, p. 1038–1054, 2010.

FRISONI, G. et al. Natural cellulose fibers: Heterogeneous acetylation kinetics and biodegradation behavior. **Biomacromolecules**, v. 2, n. 2, p. 476–482, 2001.

FUNDADOR, N. G. V. et al. Acetylation and characterization of xylan from hardwood kraft pulp. **Carbohydrate Polymers**, v. 87, n. 1, p. 170–176, 4 jan. 2012.

GALLINA, G. et al. Hydrothermal extraction of hemicellulose: from lab to pilot scale. **Bioresource Technology**, v. 247, p. 980–991, 1 jan. 2018.

GAO, Y. et al. Two trichome birefringence-like proteins mediate xylan acetylation, which is essential for leaf blight resistance in rice. **Plant Physiology**, v. 173, n. 1, p. 470–481, 1 jan. 2017.

GAVRIIL, G.; KANAVOURAS, A.; COUTELIERIS, F. A. Food-packaging migration models: A critical discussion. **Critical Reviews in Food Science and Nutrition**, v. 58, n. 13, p. 2262–2272, 2 set. 2018.

GE, S. et al. Hemicellulose structural changes during steam pretreatment and biogradation of Lentinus edodes. **Arabian Journal of Chemistry**, v. 11, n. 6, p. 771–781, 1 set. 2018.

GENDRE, D. et al. Trans-Golgi network localized ECHIDNA/Ypt interacting protein complex is required for the secretion of cell wall polysaccharides in Arabidopsis. **Plant Cell**, v. 25, n. 7, p. 2633–2646, jul. 2013.

GENG, W. et al. Effect of delignification on hemicellulose extraction from switchgrass, poplar, and pine and its effect on enzymatic convertibility of cellulose-rich residues. **BioResources**, v. 13, n. 3, p. 4946–4963, 2019.

GENG, W. et al. Carboxymethylation of hemicellulose isolated from poplar (Populus grandidentata) and its potential in water-soluble oxygen barrier films. **Cellulose**, v. 27, n. 6, p. 3359–3377, 1 abr. 2020.

GIBEAUT, D. M. et al. Changes in cell wall polysaccharides in developing barley (Hordeum vulgare) coleoptiles. **Planta**, v. 221, n. 5, p. 729–738, jul. 2005.

GILLE, S. et al. O-acetylation of Arabidopsis hemicellulose xyloglucan requires AXY4 or AXY4L, proteins with a TBL an DUF231 domain. **Plant Cell**, v. 23, n. 11, p. 4041–4053, nov. 2011.

GILLE, S.; PAULY, M. O-acetylation of plant cell wall polysaccharides. **Frontiers in Plant Science**, v. 3, n. 12, 31 jan. 2012.

GLASSER, W. G. et al. Comparative Enzyme Biodegradability of Xylan, Cellulose, and Starch Derivatives†. **Biotechnology Progress**, v. 11, n. 5, p. 552–557, 1995.

GOLDBERG, E. D. Plasticizing the seafloor: An overview. **Environmental Technology (United Kingdom)**, v. 18, n. 2, p. 195–201, 1 fev. 1997.

GOLDMANN, W. M. et al. Formic acid aided hot water extraction of hemicellulose from European silver birch (Betula pendula) sawdust. **Bioresource Technology**, v. 232, p. 176–182, 2017.

GORDOBIL, O. et al. Xylan-cellulose films: Improvement of hydrophobicity, thermal and mechanical properties. **Carbohydrate Polymers**, v. 112, p. 56–62, 4 nov. 2014.

GOUNGA, M. E.; XU, S. Y.; WANG, Z. Whey protein isolate-based edible films as affected by protein concentration, glycerol ratio and pullulan addition in film formation. **Journal of Food Engineering**, v. 83, n. 4, p. 521–530, dez. 2007.

GRANTHAM, N. J. et al. An even pattern of xylan substitution is critical for interaction with cellulose in plant cell walls. **Nature Plants**, v. 3, n. 11, p. 859–865, 1 nov. 2017.

GRÖNDAHL, M.; ERIKSSON, L.; GATENHOLM, P. Material properties of plasticized hardwood xylans for potential application as oxygen barrier films. **Biomacromolecules**, v. 5, n. 4, p. 1528–1535, jul. 2004.

GRÖNDAHL, M.; GUSTAFSSON, A.; GATENHOLM, P. Gas-Phase Surface Fluorination of Arabinoxylan Films. **Macromolecules**, v. 39, n. 7, p. 2718–2721, 4 abr. 2006.

GRÖNDAHL, M.; TELEMAN, A.; GATENHOLM, P. Effect of acetylation on the material properties of glucuronoxylan from aspen wood. **Carbohydrate Polymers**, v. 52, n. 4, p. 359–366, 1 jun. 2003.

GROUS, W. R.; CONVERSE, A. O.; GRETHLEIN, H. E. Effect of steam explosion pretreatment on pore size and enzymatic hydrolysis of poplar. **Enzyme and Microbial Technology**, v. 8, n. 5, p. 274–280, 1986.

GU, X.; YANG, C. Q. FTIR Spectroscopy Study of the Formation of Cyclic Anhydride Intermediates of Polycarboxylic Acids Catalyzed by Sodium Hypophosphite. **Textile Research Journal**, v. 70, n. 1, p. 64–70, 2000.

GUILBERTT, S.; GONTARDS, N.; CUQS, B. Technology and Applications of Edible Protective Films. **Packaging Technology and Science**, v. 8, p. 339–346, 1995.

GURAGAIN, Y. N. et al. Novel Biomass Pretreatment Using Alkaline Organic Solvents: A Green Approach for Biomass Fractionation and 2,3-Butanediol Production. **Bioenergy Research**, v. 9, n. 2, p. 643–655, 1 jun. 2016.

HAKALA, T. K.; LIITIÄ, T.; SUURNÄKKI, A. Enzyme-aided alkaline extraction of oligosaccharides and polymeric xylan from hardwood kraft pulp. **Carbohydrate Polymers**, v. 93, n. 1, p. 102–108, 1 mar. 2013.

HANSEN, N. M. L.; PLACKETT, D. Sustainable films and coatings from hemicelluloses: A review. **Biomacromolecules**, v. 9, n. 6, p. 1493–1505, 2008.

HAQ, M. A.; HASNAIN, A.; AZAM, M. Characterization of edible gum cordia film: Effects of plasticizers. **LWT - Food Science and Technology**, v. 55, n. 1, p. 163–169, jan. 2014.

HARTMAN, J. et al. Oxygen barrier materials from renewable sources: Material properties of softwood hemicellulose-based films. **Journal of Applied Polymer Science**, v. 100, n. 4, p. 2985–2991, 15 maio 2006.

HEIKKINEN, S. L. et al. Specific enzymatic tailoring of wheat arabinoxylan reveals the role of substitution on xylan film properties. **Carbohydrate Polymers**, v. 92, n. 1, p. 733–740, 30 jan. 2013.

HEINZE, T. New ionic polymers by cellulose functionalization. **Macromol Chem Phys**, n. 199, p. 2341–2364, 1998.

HEINZE, T.; SCHWIKAL, K.; BARTHEL, S. Ionic liquids as reaction medium in cellulose functionalization. **Macromolecular Bioscience**, v. 5, n. 6, p. 520–525, 24 jun. 2005.

HERNADI, A. Hydrolysis of cellulose cross-linked with N-methylol compounds. **Cell Chem Technol**, v. 33, p. 381–390, 2000.

HERNÁNDEZ-BELTRÁN, J. U.; HERNÁNDEZ-ESCOTO, H. Enzymatic hydrolysis of biomass at high-solids loadings through fed-batch operation. **Biomass and Bioenergy**, v. 119, p. 191–197, 1 dez. 2018.

HETTRICH, K. et al. Derivatization and characterization of xylan from oat spelts. **Macromolecular Symposia**, v. 232, p. 37–48, 1 dez. 2005.

HIMMEL, M. E. et al. Biomass recalcitrance: Engineering plants and enzymes for biofuels production. **Science**, v. 315, n. 5813, p. 804–807, 9 fev. 2007.

HO, B. K.; CHIN, S. F.; PANG, S. C. pH-responsive carboxylic cellulose acetate nanoparticles for controlled release of penicillin G. **Journal of Science: Advanced Materials and Devices**, v. 5, n. 2, p. 224–232, 1 jun. 2020.

HOFLE, G.; STEGLICH, W.; VORBRUGGEN, H. 4-Dialkylaminopyridines as Highly Active Acylation Catalysts. **Angew. Chem. Int. Ed English**, v. 17, n. 7, p. 569–583, 1978.

HÖIJE, A. et al. Isolation and characterization of physicochemical and material properties of arabinoxylans from barley husks. **Carbohydrate Polymers**, v. 61, n. 3, p. 266–275, 29 ago. 2005.

HOSPIDO, A.; RODRÍGUEZ, H. Life Cycle Assessment (LCA) of Ionic Liquids. Em: **Encyclopedia of Ionic Liquids**. Singapore: Springer Singapore, 2019. p. 1–9.

HU, F.; JUNG, S.; RAGAUSKAS, A. Pseudo-lignin formation and its impact on enzymatic hydrolysis. **Bioresource Technology**, v. 117, p. 7–12, ago. 2012.

HU, L. et al. Effect of ionic liquid pretreatment on the physicochemical properties of hemicellulose from bamboo. **Journal of Molecular Structure**, v. 1210, 15 jun. 2020.

HUANG, L. et al. Gelation behavior of native and acetylated konjac glucomannan. **Biomacromolecules**, v. 3, n. 6, p. 1296–1303, nov. 2002.

HUDA, M. S. et al. A study on biocomposites from recycled newspaper fiber and poly(lactic acid). **Industrial and Engineering Chemistry Research**, v. 44, n. 15, p. 5593–5601, 20 jul. 2005.

HUDDLESTON, J. G. et al. Characterization and comparison of hydrophilic and hydrophobic room temperature ionic liquids incorporating the imidazolium cation. **Green Chemistry**, v. 3, n. 4, p. 156–164, 2001.

IBN YAICH, A.; EDLUND, U.; ALBERTSSON, A. C. Transfer of Biomatrix/Wood Cell Interactions to Hemicellulose-Based Materials to Control Water Interaction. **Chemical Reviews**, v. 117, n. 12, p. 8177–8207, 28 jun. 2017.

IFUKU, S. et al. Surface modification of bacterial cellulose nanofibers for property enhancement of optically transparent composites: Dependence on acetyl-group DS. **Biomacromolecules**, v. 8, n. 6, p. 1973–1978, jun. 2007.

IFUKU, S. et al. Acetylation of chitin nanofibers and their transparent nanocomposite films. **Biomacromolecules**, v. 11, n. 5, p. 1326–1330, 10 maio 2010.

JAAFAR, Z. et al. Meaning of xylan acetylation on xylan-cellulose interactions: A quartz crystal microbalance with dissipation (QCM-D) and molecular dynamic study. **Carbohydrate Polymers**, v. 226, p. 115315, 15 dez. 2019.

JANUSZ, G. et al. Lignin degradation: Microorganisms, enzymes involved, genomes analysis and evolution. **FEMS Microbiology Reviews**, v. 41, n. 6, p. 941–962, 1 nov. 2017.

JENSEN, J. K. et al. Identification of an algal xylan synthase indicates that there is functional orthology between algal and plant cell wall biosynthesis. **New Phytologist**, v. 218, n. 3, p. 1049–1060, 1 maio 2018.

JIA, Z. et al. NMR characterization of endogenously O-acetylated oligosaccharides isolated from tomato (Lycopersicon esculentum) xyloglucan. **Carbohydrate Research**, v. 340, n. 11, p. 1818–1825, 15 ago. 2005.

JIANG, W. et al. Effect of acetylation/deacetylation on enzymatic hydrolysis of corn stalk. **Biomass and Bioenergy**, v. 71, p. 294–298, 1 dez. 2014.

JIN, X. et al. Promoting the material properties of xylan-type hemicelluloses from the extraction step. **Carbohydrate Polymers**, v. 215, p. 235–245, 1 jul. 2019.

JO, A. R. et al. Preparation of slowly digestible sweet potato Daeyumi starch by dual enzyme modification. **Carbohydrate Polymers**, v. 143, p. 164–171, 5 jun. 2016.

JOHNSON, A. M. et al. Natural acetylation impacts carbohydrate recovery during deconstruction of Populus trichocarpa wood. **Biotechnology for Biofuels**, v. 10, n. 1, p. 1–12, 23 fev. 2017.

JOHNSON, K. E. Acids and Bases in Ionic Liquids. Em: **Green Industrial Applications of Ionic Liquids**. [s.l: s.n.]. v. 1p. 419–437.

JUNLI, R. et al. Novel hydrophobic hemicelluloses: Synthesis and characteristic. **Carbohydrate Polymers**, v. 89, n. 1, p. 152–157, 5 jun. 2012.

KABEL, M. A. et al. Structural differences of xylans affect their interaction with cellulose. **Carbohydrate Polymers**, v. 69, n. 1, p. 94–105, 1 maio 2007.

KABIR, M. M. et al. Effects of chemical treatments on hemp fibre structure. **Applied Surface Science**, v. 276, p. 13–23, 1 jul. 2013.

KANG, X. et al. Lignin-polysaccharide interactions in plant secondary cell walls revealed by solid-state NMR. **Nature Communications**, v. 10, n. 1, 1 dez. 2019.

KAPU, N. S.; TRAJANO, H. L. Review of hemicellulose hydrolysis in softwoods and bamboo. **Biofuels, Bioproducts and Biorefining**, v. 8, n. 6, p. 857–870, 1 nov. 2014.

KARTHA, K. P. R. Iodine, a novel catalyst in carbohydrate reactions. **Pergamon Journals Ltd.**, v. 27, n. 29, p. 3415–3416, 1986.

KATAOKA, L. F. DE M. S.; HIDALGO FALLA, M. D. P.; LUZ, S. M. DA. The Influence of Potassium Hydroxide Concentration and Reaction Time on the Extraction Cellulosic Jute Fibers. **Journal of Natural Fibers**, 2021.

KAUSHIK, N.; KUMAR, K.; KUMAR, S. Potential of Jatropha curcas for Biofuels. **Journal of Biobased Materials and Bioenergy**, v. 1, n. 3, p. 301–314, 4 maio 2008.

KHALILZADEH, M. A.; SADEGHIFAR, H.; VENDITTI, R. Natural Clinoptilolite/KOH: An Efficient Heterogeneous Catalyst for Carboxymethylation of Hemicellulose. **Industrial & Engineering Chemistry Research**, v. 58, n. 27, p. 11680–11688, 10 jul. 2019.

KOCH, K. et al. Material properties and molecular aspects of highly acetylated starch-based films. **Journal of Renewable Materials**, v. 2, n. 2, p. 134–144, 1 maio 2014.

KÖHLER, S. et al. Interactions of ionic liquids with polysaccharides 1. Unexpected acetylation of cellulose with 1-ethyl-3-methylimidazolium acetate. **Macromolecular Rapid Communications**, v. 28, n. 24, p. 2311–2317, 14 dez. 2007.

KÖHNKE, T.; ÖSTLUND, Å.; BRELID, H. Adsorption of arabinoxylan on cellulosic surfaces: Influence of degree of substitution and substitution pattern on adsorption characteristics. **Biomacromolecules**, v. 12, n. 7, p. 2633–2641, 11 jul. 2011.

KONDURI, M. K. R.; FATEHI, P. Synthesis and characterization of carboxymethylated xylan and its application as a dispersant. **Carbohydrate Polymers**, v. 146, p. 26–35, 1 ago. 2016.

KONG, W. et al. Hemicellulose-Based Hydrogels and Their Potential Application. Em: **Polymer gels**. Singapore: Springer Singapore, 2018. p. 87–127.

KONG, Y. et al. Galactose-depleted xyloglucan is dysfunctional and leads to dwarfism in arabidopsis. **Plant Physiology**, v. 167, n. 4, p. 1296–1306, 1 abr. 2015.

KONIECZNY, J.; LOOS, K. Facile Esterification of Degraded and Non-Degraded Starch. **Macromolecular Chemistry and Physics**, v. 219, n. 18, p. 1800231, 1 set. 2018.

KRINGSTAD, K. P.; LINDSTROM, K. Spent liquors from pulp bleaching. **Critical Review**, v. 18, n. 8, p. 236–248, 1984.

LACROIX, C. et al. Functional galactomannan platform from convenient esterification in imidazolium-based ionic liquids. **Polymer Chemistry**, v. 3, n. 2, p. 538–546, fev. 2012.

LAMONT, B. B. Seed/cotyledon size and nutrient content play a major role in early performance of species on nutrient-poor soils. **New Phytol**, v. 137, p. 665–672, 1997.

LAURE, S. et al. Assessment of an Organosolv lignocellulose biorefinery concept based on a material flow analysis of a pilot plant. **Cellulose Chemistry and Technology**, v. 48, n. 9, p. 793–798, 2014.

LEE, C. et al. The Four Arabidopsis REDUCED WALL ACETYLATION Genes are expressed in secondary wall-containing cells and required for the acetylation of Xylan. **Plant and Cell Physiology**, v. 52, n. 8, p. 1289–1301, ago. 2011.

LEMOS, P. V. F. et al. The important role of crystallinity and amylose ratio in thermal stability of starches. **Journal of Thermal Analysis and Calorimetry**, v. 131, n. 3, p. 2555–2567, 1 mar. 2018.

LI, W. et al. Rapid dissolution of lignocellulosic biomass in ionic liquids using temperatures above the glass transition of lignin. **Green Chemistry**, v. 13, n. 8, p. 2038–2047, 8 jan. 2011.

LI, Z.; PAN, X. Strategies to modify physicochemical properties of hemicelluloses from biorefinery and paper industry for packaging material. **Reviews in Environmental Science and Biotechnology**, v. 17, n. 1, p. 47–69, 1 mar. 2018.

LING, Z. et al. Conformational analysis of xylobiose by DFT quantum mechanics. **Cellulose**, v. 27, n. 3, p. 1207–1224, 1 fev. 2020.

LIPSCOMB, G. et al. **Ionic liquid recovery and purification in biomass treatment processes**. , 2012.

LITVINENKO, V. I.; AMANMURADOV, K.; ABUBAKIROV, N. K. Glycosides of Vaccaria segetalis. **Chemistry of Natural Compounds 1968 3:3**, v. 3, n. 3, p. 131–134, 1 maio 1967.

LIU, L. et al. A Xyloglucan Backbone 6-O-Acetyltransferase from Brachypodium distachyon Modulates Xyloglucan Xylosylation. **Molecular plant**, v. 9, n. 4, p. 615–617, 4 abr. 2016.

LIU, X. et al. Thermal degradation and stability of starch under different processing conditions. **Starch/Staerke**, v. 65, n. 1–2, p. 48–60, jan. 2013.

LIU, X.; LUAN, S.; LI, W. Utilization of waste hemicelluloses lye for superabsorbent hydrogel synthesis. **International Journal of Biological Macromolecules**, v. 132, p. 954–962, 1 jul. 2019.

LIU, Y.; LOTERO, E.; GOODWIN, J. G. Effect of water on sulfuric acid catalyzed esterification. **Journal of Molecular Catalysis A: Chemical**, v. 245, n. 1–2, p. 132–140, 15 fev. 2006.

LODISH, H. et al. Molecular cell biology. Em: **The Dynamic Plant Cell Wall**. [s.l.] W. H. Freeman, 2000. v. Section 22.5.

LÖNNBERG, H. et al. Grafting of cellulose fibers with poly(ε-caprolactone) and poly(L-lactic acid) via ring-opening polymerization. **Biomacromolecules**, v. 7, n. 7, p. 2178–2185, jul. 2006.

LOTERO, E. et al. Synthesis of biodiesel via acid catalysis. **Industrial and Engineering Chemistry Research**, v. 44, n. 14, p. 5353–5363, 6 jul. 2005.

LOUIS, A. C. F.; VENKATACHALAM, S. Energy efficient process for valorization of corn cob as a source for nanocrystalline cellulose and hemicellulose production. **International Journal of Biological Macromolecules**, v. 163, p. 260–269, 15 nov. 2020.

LOURENÇO, A. et al. Lignin composition and structure differs between Xylem, Phloem and phellem in quercus suber L. **Frontiers in Plant Science**, v. 7, p. 1612, 27 out. 2016.

LUCAS, N. et al. Polymer biodegradation: Mechanisms and estimation techniques - A review. **Chemosphere**, v. 73, n. 4, p. 429–442, set. 2008.

LUO, C.; BRINK, D. L.; BLANCH, H. W. Identification of potential fermentation inhibitors in conversion of hybrid poplar hydrolyzate to ethanol. **Biomass and Bioenergy**, v. 22, n. 2, p. 125–138, 2002.

LUZAR, A.; CHANDLER, D. Structure and hydrogen bond dynamics of water-dimethyl sulfoxide mixtures by computer simulations. **The Journal of Chemical Physics**, v. 98, n. 10, p. 8160–8173, 1993.

LYU, G.-J.; WU, S.-B.; LOU, R. Kinetic study of the thermal decomposition of hemicellulose isolated from corn stalk. **BioResources**, v. 5, n. 2, p. 1281–1291, 2010.

MACEDO, J. V. C. et al. Xylan-starch-based bioplastic formulation and xylan influence on the physicochemical and biodegradability properties. **Polymer Bulletin**, 29 ago. 2022.

MANABE, Y. et al. Loss-of-function mutation of REDUCED WALL ACETYLATION2 in Arabidopsis leads to reduced cell wall acetylation and increased resistance to Botrytis cinerea. **Plant Physiology**, v. 155, n. 3, p. 1068–1078, mar. 2011.

MANABE, Y. et al. Reduced wall acetylation proteins play vital and distinct roles in cell wall O-acetylation in Arabidopsis. **Plant Physiology**, v. 163, n. 3, p. 1107–1117, nov. 2013.

MAO, Z.; YANG, C. Q. IR spectroscopy study of cyclic anhydride as intermediate for ester crosslinking of cotton cellulose by polycarboxylic acids. V. Comparison of 1,2,4-butanetricarboxylic acid and 1,2,3-propanetricarboxylic acid. **Journal of Applied Polymer Science**, v. 81, n. 9, p. 2142–2150, 29 ago. 2001.

MARTINS, J. R.; ABE, M. M.; BRIENZO, M. Chemical Modification Strategies for Developing Functionalized Hemicellulose: Advanced Applications of Modified Hemicellulose. **Hemicellulose Biorefinery: A Sustainable Solution for Value Addition to Bio-Based Products and Bioenergy**, v. 1, p. 171–205, 2022.

MAZEAU, K.; CHARLIER, L. The molecular basis of the adsorption of xylans on cellulose surface. **Cellulose**, v. 19, n. 2, p. 337–349, abr. 2012.

MCCORMICK, C. L.; CALLAIS, P. A.; HUTCHINSON, B. H. Solution Studies of Cellulose in Lithium Chloride and N,AT-Dimethylacetamide. **Infrared Spectra of Inorganic Compounds**, v. 18, n. 4, p. 261–272, 1985.

MCKEEN, L. W. Introduction to Plastics and Elastomers. Em: **Chemical Resistance of Thermoplastics**. [s.l.] Elsevier, 2014. p. 21–34.

MEDINA-JARAMILLO, C. et al. Active and smart biodegradable packaging based on starch and natural extracts. **Carbohydrate Polymers**, v. 176, p. 187–194, 15 nov. 2017.

MEDRONHO, B.; LINDMAN, B. Competing forces during cellulose dissolution: From solvents to mechanisms. **Current Opinion in Colloid and Interface Science**, v. 19, n. 1, p. 32–40, 2014.

MELATI, R. B. et al. Key Factors Affecting the Recalcitrance and Conversion Process of Biomass. **Bioenergy Research**, v. 12, n. 1, 15 mar. 2019.

MELATI, R. B. et al. Anatomic influence of sugarcane biomass on xylan solubilization. **Industrial Crops and Products**, v. 164, p. 113357, 1 jun. 2021.

MENDES, F. R. S. et al. Preparation and evaluation of hemicellulose films and their blends. **Food Hydrocolloids**, v. 70, p. 181–190, 1 set. 2017.

MESA, L. et al. The effect of organosolv pretreatment variables on enzymatic hydrolysis of sugarcane bagasse. **Chemical Engineering Journal**, v. 168, n. 3, p. 1157–1162, 15 abr. 2011.

MIHIRETU, G. T.; CHIMPHANGO, A. F.; GÖRGENS, J. F. Steam explosion pre-treatment of alkali-impregnated lignocelluloses for hemicelluloses extraction and improved digestibility. **Bioresource Technology**, v. 294, 1 dez. 2019.

MIKI, K. et al. Methylation-triggered fractionation of lignocellulosic biomass to afford cellulose-, hemicellulose-, and lignin-based functional polymers: Via click chemistry. **Green Chemistry**, v. 22, n. 9, p. 2909–2928, 7 maio 2020.

MIKKONEN, K. S. et al. Effect of polysaccharide structure on mechanical and thermal properties of galactomannan-based films. **Biomacromolecules**, v. 8, n. 10, p. 3198–3205, out. 2007.

MIKKONEN, K. S. et al. Films from glyoxal-crosslinked spruce galactoglucomannans plasticized with sorbitol. **International Journal of Polymer Science**, v. 2012, 2012.

MITCHELL, D. et al. Effect of the degree of acetylation on the enzymatic digestion of acetylated xylans. **Journal of Wood Chemistry and Technology**, v. 10, n. 1, p. 111–121, 1 mar. 1990.

MOORE, P. J. et al. Immunogold Localization of Xyloglucan and Rhamnogalacturonan I in the Cell Walls of Suspension-Cultured Sycamore Cells. **Plant Physiol**, v. 82, p. 787–794, 1986.

MORAIS DE CARVALHO, D. M. et al. Improving the thermal stability of different types of xylan by acetylation. **Carbohydrate Polymers**, v. 220, p. 132–140, 15 set. 2019.

MOURA, C. M. DE et al. Evaluation of molar weight and deacetylation degree of chitosan during chitin deacetylation reaction: Used to produce biofilm. **Chemical Engineering and Processing: Process Intensification**, v. 50, n. 4, p. 351–355, abr. 2011.

MOYER, P. et al. Relationship between lignocellulosic biomass dissolution and physicochemical properties of ionic liquids composed of 3-methylimidazolium cations and carboxylate anions. **Physical Chemistry Chemical Physics**, v. 20, n. 4, p. 2508–2516, 2018.

MUGWAGWA, R.; CHIMPHANGO, A. Optimising wheat straw alkali-organosolv pre-treatment to enhance hemicellulose modification and compatibility with reinforcing fillers. **International Journal of Biological Macromolecules**, v. 143, p. 862–872, 15 jan. 2020a.

MUGWAGWA, R.; CHIMPHANGO, A. Enhancing the functional properties of acetylated hemicellulose films for active food packaging using acetylated nanocellulose reinforcement and polycaprolactone coating. **Food Packaging and Shelf Life**, v. 24, p. 100481, 1 jun. 2020b.

MURAD, P. C. et al. Acid-catalyzed esterification of free fatty acids with ethanol: an assessment of acid oil pretreatment, kinetic modeling and simulation. **Reaction Kinetics, Mechanisms and Catalysis**, v. 123, n. 2, p. 505–515, 1 abr. 2018.

NASIR, N. et al. Utilization of empty fruit bunch fibre as potential adsorbent for ammonia nitrogen removal in natural rubber wastewater. **International Journal of Integrated Engineering**, v. 10, n. 8, p. 27–32, 2018.

NEGRO, M. J. et al. Changes in various physical/chemical parameters of Pinus pinaster wood after steam explosion pretreatment. **Biomass and Bioenergy**, v. 25, n. 3, p. 301–308, 2003.

NEMR, A. EL; RAGAB, S.; SIKAILY, A. EL. Rapid synthesis of cellulose triacetate from cotton cellulose and its effect on specific surface area and particle size distribution. **Iranian Polymer Journal (English Edition)**, v. 26, n. 4, p. 261–272, 1 abr. 2017.

NEUMÜLLER, K. G. et al. Positional preferences of acetyl esterases from different CE families towards acetylated 4-O-methyl glucuronic acid-substituted xylo-oligosaccharides. **Biotechnology for Biofuels**, v. 8, n. 1, 22 jan. 2015.

NIEDER-HEITMANN, M. et al. Economic evaluation and comparison of succinic acid and electricity co-production from sugarcane bagasse and trash lignocelluloses in a biorefinery, using different pretreatment methods: dilute acid (H2SO4), alkaline (NaOH), organosolv, ammonia fibre expansion (AFEX^{TM}), steam explosion (STEX), and wet oxidation. **Biofuels, Bioproducts and Biorefining**, v. 14, n. 1, p. 55–77, 1 jan. 2020.

OSTADJOO, S. et al. Effcient enzymatic hydrolysis of biomass hemicellulose in the absence of bulkwater. **Molecules**, v. 24, n. 23, 20 nov. 2019.

PAN, X. et al. Bioconversion of hybrid poplar to ethanol and co-products using an organosolv fractionation process: Optimization of process yields. **Biotechnology and Bioengineering**, v. 94, n. 5, p. 851–861, 5 ago. 2006.

PANDEY, K. K. A Study of Chemical Structure of Soft and Hardwood and Wood Polymers by FTIR Spectroscopy. **J Appl Polym Sci**, v. 71, p. 1969–1975, 1999.

PAPADIMITRIOU, C. A. et al. Evaluation of leaching and ecotoxicological properties of sewage sludge-fly ash mixtures. **Environmental Research**, v. 106, n. 3, p. 340–348, mar. 2008.

PARKER, A. J. Protic-Dipolar Aprotic Solvent Effects on Rates of Bimolecular Reactions. **Chemical Reviews l**, v. 69, n. 1, p. 1–32, 1969.

PARRA, D. F. et al. Mechanical properties and water vapor transmission in some blends of cassava starch edible films. **Carbohydrate Polymers**, v. 58, n. 4, p. 475–481, 7 dez. 2004.

PARTHASARATHI, R. et al. Insights into hydrogen bonding and stacking interactions in cellulose. **Journal of Physical Chemistry A**, v. 115, n. 49, p. 14191–14202, 15 dez. 2011.

PATEL, J. P.; PARSANIA, P. H. Characterization, testing, and reinforcing materials of biodegradable composites. **Biodegradable and Biocompatible Polymer Composites: Processing, Properties and Applications**, p. 55–79, 1 jan. 2017.

PAULY, M. et al. Effects of the mur1 mutation on xyloglucans produced by suspension-cultured Arabidopsis thaliana cells. **Planta**, v. 214, n. 1, p. 67–74, 2001.

PAULY, M.; KEEGSTRA, K. Plant cell wall polymers as precursors for biofuels. **Current Opinion in Plant Biology**, v. 13, n. 3, p. 304–311, 2010.

PAULY, M.; RAMÍREZ, V. New Insights Into Wall Polysaccharide O-Acetylation. **Frontiers in plant science**, v. 9, 21 ago. 2018.

PAWAR, P. M. A. et al. Acetylation of woody lignocellulose: Significance and regulation. **Frontiers in Plant Science**, v. 4, n. MAY, p. 118, 21 maio 2013.

PAWAR, P. M. A. et al. Expression of fungal acetyl xylan esterase in Arabidopsis thaliana improves saccharification of stem lignocellulose. **Plant Biotechnology Journal**, v. 14, n. 1, p. 387–397, 1 jan. 2016.

PAWAR, P. M. A. et al. Downregulation of RWA genes in hybrid aspen affects xylan acetylation and wood saccharification. **New Phytologist**, v. 214, n. 4, p. 1491–1505, 1 jun. 2017.

PENG, F. et al. Rapid homogeneous lauroylation of wheat straw hemicelluloses under mild conditions. **Carbohydrate Research**, v. 343, n. 17, p. 2956–2962, 24 nov. 2008.

PENG, F. et al. Fractional purification and bioconversion of hemicelluloses. **Biotechnology Advances**, v. 30, n. 4, p. 879–903, jul. 2012.

PENG, X. W. et al. Xylan-rich hemicelluloses- graft -acrylic acid ionic hydrogels with rapid responses to pH, salt, and organic solvents. **Journal of Agricultural and Food Chemistry**, v. 59, n. 15, p. 8208–8215, 10 ago. 2011.

PENG, X. W.; REN, J. L.; SUN, R. C. Homogeneous esterification of xylan-rich hemicelluloses with maleic anhydride in ionic liquid. **Biomacromolecules**, v. 11, n. 12, p. 3519–3524, 13 dez. 2010.

PEREIRA, C. S. et al. Effects of Xylan Side-Chain Substitutions on Xylan-Cellulose Interactions and Implications for Thermal Pretreatment of Cellulosic Biomass. **Biomacromolecules**, v. 18, n. 4, p. 1311–1321, 10 abr. 2017.

PERNAK, J.; GOC, I.; MIRSKA, I. Anti-microbial activities of protic ionic liquids with lactate anion. **Green Chemistry**, v. 6, n. 7, p. 323–329, 2004.

PERNAK, J.; SOBASZKIEWICZ, K.; MIRSKA, I. Anti-microbial activities of ionic liquids. **Green Chemistry**, v. 5, n. 1, p. 52–56, 2003.

PETRUŠ, L.; GRAY, D. G.; BEMILLER, J. N. Homogeneous alkylation of cellulose in lithium chloride/dimethyl sulfoxide solvent with dimsyl sodium activation. A proposal for the mechanism of cellulose dissolution in LiC1/MezSO. **Carbohydrate Research**, v. 268, p. 319–323, 1995.

PETZOLD, K. et al. Synthesis and characterization of methyl xylan. **Carbohydrate Polymers**, v. 74, n. 3, p. 327–332, 4 nov. 2008.

PETZOLD, K.; SCHWIKAL, K.; HEINZE, T. Carboxymethyl xylan-synthesis and detailed structure characterization. **Carbohydrate Polymers**, v. 64, n. 2, p. 292–298, 11 maio 2006.

PETZOLD-WELCKE, K. et al. Xylan derivatives and their application potential - Mini-review of own results. **Carbohydrate Polymers**, v. 100, p. 80–88, 2014.

PLASTICSEUROPE. Plastics - the Facts 2019. **Plastics Shape the Future**, p. 1–42, 2020.

PLECHKOVA, N. V.; SEDDON, K. R. Applications of ionic liquids in the chemical industry. **Chemical Society Reviews**, v. 37, n. 1, p. 123–150, 2008.

POLETTO, M. Thermal degradation and morphological aspects of four wood species used in lumber industry. **Revista Árvore**, v. 40, n. 5, p. 941–948, 2016.

POURCHEZ, J. et al. Alkaline stability of cellulose ethers and impact of their degradation products on cement hydration. **Cement and Concrete Research**, v. 36, n. 7, p. 1252–1256, jul. 2006.

POURYA, M.; ABDOLNABI, H.; SOLTANI, S. B. Mechanistic study of the wettability alteration induced by preformed particle gel (PPG) in carbonate reservoirs. **Journal of Molecular Liquids**, v. 328, n. 4, p. 115422, 2021.

PRETTI, C. et al. Acute toxicity of ionic liquids to the zebrafish (Danio rerio). **Green Chemistry**, v. 8, n. 3, p. 238–240, 2 mar. 2006.

PUCHART, V. et al. Positional specificity of Flavobacterium johnsoniae acetylxylan esterase and acetyl group migration on xylan main chain. **Carbohydrate Polymers**, v. 232, p. 115783, 15 mar. 2020.

PUHOVSKI, Y. P.; RODE, B. M. Structure and dynamics of liquid formamide. **Chemical Physics**, v. 190, p. 61–82, 1995.

QI, G. et al. Improvement and Characterization in Enzymatic Hydrolysis of Regenerated Wheat Straw Dissolved by LiCl/DMAc Solvent System. **Applied Biochemistry and Biotechnology**, v. 181, n. 1, p. 177–191, 1 jan. 2017.

RAYAMAJHI, V.; DHAKAL, D.; SOHNG, J. K. Functional Characterization of NgnL, an Alpha/beta-hydrolase Enzyme Involved in Biosynthesis of Acetylated Nodusmicin. **Biotechnology and Bioprocess Engineering**, v. 25, n. 3, p. 414–420, 1 jun. 2020.

REICHARDT, C.; WELTON, T. Solute-Solvent Interactions. Em: **Solvents and solvent effects in organic chemistry**. 4th. ed. [s.l: s.n.]. v. 692p. 7–52.

RÉMOND, C. et al. Combination of ammonia and xylanase pretreatments: Impact on enzymatic xylan and cellulose recovery from wheat straw. **Bioresource Technology**, v. 101, n. 17, p. 6712–6717, 2010.

REN, J. L. et al. Acetylation of wheat straw hemicelluloses in ionic liquid using iodine as a catalyst. **Carbohydrate Polymers**, v. 70, n. 4, p. 406–414, 1 nov. 2007.

REN, J. L. et al. Studies of the Lauroylation of Wheat Straw Hemicelluloses under Heating. **Journal of Agricultural and Food Chemistry**, v. 56, n. 4, p. 1251–1258, 27 fev. 2008.

REN, J. L.; SUN, R. C.; LIU, C. F. Etherification of hemicelluloses from sugarcane bagasse. **Journal of Applied Polymer Science**, v. 105, n. 6, p. 3301–3308, 15 set. 2007.

REN, J. L.; SUN, R. C.; PENG, F. Carboxymethylation of hemicelluloses isolated from sugarcane bagasse. **Polymer Degradation and Stability**, v. 93, n. 4, p. 786–793, abr. 2008.

RENARD, C. M. G. C.; JARVIS, M. C. Acetylation and methylation of homogalacturonans 1: Optimisation of the reaction and characterisation of the products. **Carbohydrate Polymers**, v. 39, n. 3, p. 201–207, 1 jun. 1999.

RINDLAV, Å.; HULLEMAN, S. H. D.; GATENHOLM, P. Formation of starch films with varying crystallinity. **Carbohydrate Polymers**, v. 34, n. 1–2, p. 25–30, 5 dez. 1997.

RIVARD, C. et al. Starch esters as biodegradable plastics: Effects of ester group chain length and degree of substitution on anaerobic biodegradation. **Enzyme and Microbial Technology**, v. 17, n. 9, p. 848–852, 1 set. 1995.

ROGERS, R. D.; SEDDON, K. R. Ionic Liquids - Solvents of the Future? **Science**, v. 302, n. 5646, p. 792–793, 31 out. 2003.

ROJAS, O. J. **Cellulose Chemistry and Properties: Fibers, Nanocelluloses and Advanced Materials**. 1. ed. Raleigh: Springer, 2016. v. 271p. 1–52

ROMBOUTS, F. M.; THIBAULT, J.-F. Enzymic and Chemical Degradation and The Fine Structure of Pectins from Sugar-Beet Pulp. **Carbohydrate Research**, v. 154, p. 189–203, 1986.

RUIZ, H. A. et al. Biorefinery valorization of autohydrolysis wheat straw hemicellulose to be applied in a polymer-blend film. **Carbohydrate Polymers**, v. 92, n. 2, p. 2154–2162, 15 fev. 2013.

RYAN, P. G. The Incidence and Characteristics of Plastic Particles Ingested by Seabirds. **Marine Environmental Research**, v. 23, p. 175–206, 1987.

SAIKIA, C. N. et al. Esterification of high a-cellulose extracted from Hibiscus cannabinus L. **Industrial Crops and Products**, v. 4, p. 233–239, 1995.

SALAM, A. et al. Incorporation of carboxyl groups into xylan for improved absorbency. **Cellulose**, v. 18, n. 4, p. 1033–1041, ago. 2011.

SANCHES SILVA, A. et al. Kinetic migration studies from packaging films into meat products. **Meat Science**, v. 77, n. 2, p. 238–245, out. 2007.

SÁNCHEZ-BASTARDO, N.; ROMERO, A.; ALONSO, E. Extraction of arabinoxylans from wheat bran using hydrothermal processes assisted by heterogeneous catalysts. **Carbohydrate Polymers**, v. 160, p. 143–152, 15 mar. 2017.

SANNIGRAHI, P. et al. Pseudo-lignin and pretreatment chemistry. **Energy and Environmental Science**, v. 4, n. 4, p. 1306–1310, abr. 2011.

SANTOS, C. C. et al. Elephant grass leaves have lower recalcitrance to acid pretreatment than stems, with higher potential for ethanol production. **Industrial Crops and Products**, v. 111, p. 193–200, 1 jan. 2018.

SANZ, R. et al. Brønsted acid catalyzed propargylation of 1,3-dicarbonyl derivatives. Synthesis of tetrasubstituted furans. **Organic Letters**, v. 9, n. 4, p. 727–730, 15 fev. 2007.

SATRIA, H. et al. Efficient Hydrolysis of Polysaccharides in Bagasse by in Situ Synthesis of an Acidic Ionic Liquid after Pretreatment. **ACS Sustainable Chemistry and Engineering**, v. 5, n. 1, p. 708–713, 3 jan. 2017.

SAXENA, A.; RAGAUSKAS, A. J. Water transmission barrier properties of biodegradable films based on cellulosic whiskers and xylan. **Carbohydrate Polymers**, v. 78, n. 2, p. 357–360, 5 set. 2009.

SCHEIBLE, W. R.; PAULY, M. Glycosyltransferases and cell wall biosynthesis: Novel players and insights. **Current Opinion in Plant Biology**, v. 7, n. 3, p. 285–295, jun. 2004.

SCHMATZ, A. A.; TYHODA, L.; BRIENZO, M. Sugarcane biomass conversion influenced by lignin. **Biofuels, Bioproducts and Biorefining**, v. 14, n. 2, p. 469–480, 1 mar. 2020.

SCHMIDT, V. C. R. et al. Effect of the degree of acetylation, plasticizer concentration and relative humidity on cassava starch films properties. **Food Science and Technology**, v. 39, n. 2, p. 491–499, 1 abr. 2019.

SCHULTINK, A. et al. The role of the plant-specific altered xyloglucan9 protein in arabidopsis cell wall polysaccharide o-acetylation. **Plant Physiology**, v. 167, n. 4, p. 1271–1283, 1 abr. 2015.

SEDDON, K. R. Review Ionic Liquids for Clean Technology. **J. Chem. T ech. Biotechnol**, v. 68, p. 351–356, 1997.

SERESHTI, H.; MOHAMMADI-ROUSHANDEH, J. Chemical Modification Of Beech Wood. **Iran Polym J**, v. 12, n. 1, p. 15–20, 1 jan. 2003.

SHAH, T. A.; ULLAH, R. Pretreatment of wheat straw with ligninolytic fungi for increased biogas productivity. **International Journal of Environmental Science and Technology**, v. 16, n. 11, p. 7497–7508, 1 nov. 2019.

SHAMSHINA, J. L.; ZAVGORODNYA, O.; ROGERS, R. D. Ionic liquids. Em: **Encyclopedia of Analytical Science**. [s.l.] Elsevier, 2019. p. 218–225.

SHAO, H. et al. Facile and green preparation of hemicellulose-based film with elevated hydrophobicity: Via cross-linking with citric acid. **RSC Advances**, v. 9, n. 5, p. 2395–2401, 2019.

SHAO, H. et al. Barrier film of etherified hemicellulose from single-step synthesis. **Polymers**, v. 12, n. 10, 1 out. 2020.

SHIMIZU, F. L. et al. Acid, alkali and peroxide pretreatments increase the cellulose accessibility and glucose yield of banana pseudostem. **Industrial Crops and Products**, v. 115, p. 62–68, 1 maio 2018.

SHIMIZU, F. L. et al. Minimum Lignin and Xylan Removal to Improve Cellulose Accessibility. **Bioenergy Research**, v. 13, n. 3, p. 775–785, 1 set. 2020.

SIGMA-ALDRICH. **Ionic liquids | Sigma-Aldrich**. Disponível em: <https://www.sigmaaldrich.com/BR/pt/search/ionic-liquids?focus=products&page=1&perPage=30&sort=relevance&term=ionic%20liquids&type=product_name>. Acesso em: 11 jul. 2021.

SIMMONS, T. J. et al. Folding of xylan onto cellulose fibrils in plant cell walls revealed by solid-state NMR. **Nature Communications**, v. 7, 21 dez. 2016.

SINGH, G. et al. Role of Microbes in Plastic Degradation. p. 281–299, 2021.

SINGH, S. K.; SAVOY, A. W. Ionic liquids synthesis and applications: An overview. **Journal of Molecular Liquids**, v. 297, p. 112038, 1 jan. 2020.

SJÖSTRÖM, E. Chapter 5 - EXTRACTIVES BT - Wood Chemistry (Second Edition). **Wood Chemistry (Second Edition)**, p. 90–108, 1993.

SPORCK, D. et al. Xylan extraction from pretreated sugarcane bagasse using alkaline and enzymatic approaches. **Biotechnology for Biofuels**, v. 10, n. 1, 2017.

STEPAN, A. M. et al. Arabinose content of arabinoxylans contributes to flexibility of acetylated arabinoxylan films. **Journal of Applied Polymer Science**, v. 125, n. 3, p. 2348–2355, 5 ago. 2012.

STEPAN, A. M. et al. Fast and highly efficient acetylation of xylans in ionic liquid systems. **Cellulose**, v. 20, n. 6, p. 2813–2824, dez. 2013.

STEPNOWSKI, P.; MROZIK, W.; NICHTHAUSER, J. Adsorption of alkylimidazolium and alkylpyridinium ionic liquids onto natural soils. **Environmental Science and Technology**, v. 41, n. 2, p. 511–516, 15 jan. 2007.

STOFFEL, R. B. et al. Hemicellulose extraction from slash pine sawdust by steam explosion with sulfuric acid. **Biomass and Bioenergy**, v. 107, p. 93–101, 2017.

STOFFEL, W.; CHU, F.; AHRENS, E. H. Analysis of Long-Chain Fatty Acids by Gas-Liquid Chromatography. **Anal. Chem.**, v. 30, n. 5, p. 127–135, 1958.

STRANNE, M. et al. TBL10 is required for O-acetylation of pectic rhamnogalacturonan-I in Arabidopsis thaliana. **Plant Journal**, v. 96, n. 4, p. 772–785, 1 nov. 2018.

STRIEGEL, A. M. Theory and applications of DMAC/LICL in the analysis of polysaccharides. **Carbohydrate Polymers**, v. 34, p. 267–214, 1997.

SUN, B. et al. Acetylation of Plantation Softwood Without Catalysts or Solvents. **Wood Res**, v. 64, n. 5, p. 799–810, 2019.

SUN, R. et al. **Acetylation of wheat straw hemicelluloses in N,N-dimethylacetamide/LiCl solvent systemIndustrial Crops and Products**. [s.l: s.n.]. Disponível em: <www.elsevier.com>.

SUN, R. C. et al. Esterification of hemicelluloses from poplar chips in homogeneous solution of N,N-dimethylformamide/lithium chloride. **Journal of Wood Chemistry and Technology**, v. 19, n. 4, p. 287–306, 1999b.

SUN, R. C.; HUGHES, S. **Fractional isolation and physico-chemical characterization of alkali-soluble polysaccharides from sugar beet pulpCarbohydrate Polymers**. [s.l: s.n.].

SUN, R.; LAWTHER, J. M.; BANKS, W. B. Fractional and structural characterization of wheat straw hemicelluloses. **Carbohydrate Polymers**, v. 29, p. 325–358, 1996.

SUN, X. F.; SUN, R. C.; SUN, J. X. Oleoylation of sugarcane bagasse hemicelluloses using N-bromosuccinimide as a catalyst. **Journal of the Science of Food and Agriculture**, v. 84, n. 8, p. 800–810, jun. 2004.

SURIYATEM, R.; AURAS, R. A.; RACHTANAPUN, P. Improvement of mechanical properties and thermal stability of biodegradable rice starch–based films blended with carboxymethyl chitosan. **Industrial Crops and Products**, v. 122, p. 37–48, 15 out. 2018.

SURYANTO, H. et al. Influence of Nanoclay on Thermal Decomposition of Biocomposite Matrix Starch/Carrageenan Blend. **IOP Conference Series Materials Science and Engineering**, v. 494, 2019.

SWATLOSKI, R. P. et al. Dissolution of cellulose with ionic liquids. **Journal of the American Chemical Society**, v. 124, n. 18, p. 4974–4975, 8 maio 2002.

TALIA, R. et al. A new birch xylan derivative by aqueous benzylation. **Uniwersytet śląski**, p. 403–406, 2010.

TELEMAN, A. et al. Characterization of acetylated 4-O-methylglucuronoxylan isolated from aspen employing 1 H and 13 C NMR spectroscopy. **Carbohydrate Research**, v. 329, p. 807–815, 2000.

TEODORO, A. P. et al. Cassava starch films containing acetylated starch nanoparticles as reinforcement: Physical and mechanical characterization. **Carbohydrate Polymers**, v. 126, p. 9–16, 1 ago. 2015.

THARANATHAN, R. N. Biodegradable films and composite coatings: Past, present and future. **Trends in Food Science and Technology**, v. 14, n. 3, p. 71–78, 1 mar. 2003.

THE EUROPEAN COMMISSION. Comission Regulation (EU) No 10/2011. . 2011.

THOMPSON, G. et al. The treatment of pulp and paper mill effluent: a review. **Bioresource Technology**, v. 77, p. 275–286, 2001.

THUY PHAM, T. P.; CHO, C. W.; YUN, Y. S. Environmental fate and toxicity of ionic liquids: A review. **Water Research**, v. 44, n. 2, p. 352–372, 2010.

TING, W. J. et al. An enzymatic/acid-catalyzed hybrid process for biodiesel production from soybean oil. **Journal of the Chinese Institute of Chemical Engineers**, v. 39, n. 3, p. 203–210, 2008.

TRESSAUD, A. et al. Modification of surface properties of carbon-based and polymeric materials through fluorination routes: From fundamental research to industrial applications. **Journal of Fluorine Chemistry**, v. 128, n. 4, p. 378–391, 2007.

TSAPEKOS, P.; KOUGIAS, P. G.; ANGELIDAKI, I. Anaerobic Mono- and Co-digestion of Mechanically Pretreated Meadow Grass for Biogas Production. **Energy and Fuels**, v. 29, n. 7, p. 4005–4010, 16 jul. 2015.

TSERKI, V. et al. Novel biodegradable composites based on treated lignocellulosic waste flour as filler. Part I. Surface chemical modification and characterization of waste flour.

Composites Part A: Applied Science and Manufacturing, v. 36, n. 7, p. 965–974, jul. 2005.

TSERKI, V.; MATZINOS, P.; PANAYIOTOU, C. Novel biodegradable composites based on treated lignocellulosic waste flour as filler. Part II. Development of biodegradable composites using treated and compatibilized waste flour. **Composites Part A: Applied Science and Manufacturing**, v. 37, n. 9, p. 1231–1238, set. 2006.

URBANOWICZ, B. R. et al. Two Arabidopsis proteins synthesize acetylated xylan in vitro. **Plant Journal**, v. 80, n. 2, p. 197–206, 2014.

VAN LEEUWEN, P. W. N. M. Introduction. Em: **Homogeneous Catalysis**. Dordrecht: Kluwer Academic Publishers, 2004. p. 1–28.

VILA, C.; SANTOS, V.; PARAJÓ, J. C. Simulation of an organosolv pulping process: Generalized material balances and design calculations. **Industrial and Engineering Chemistry Research**, v. 42, n. 2, p. 349–356, 2003.

VOGEL, J. P. et al. Mutations in PMR5 result in powdery mildew resistance and altered cell wall composition. **Plant Journal**, v. 40, n. 6, p. 968–978, dez. 2004.

WANG, H.; GURAU, G.; ROGERS, R. D. Ionic liquid processing of cellulose. **Chemical Society Reviews**, v. 41, n. 4, p. 1519–1537, 30 jan. 2012.

WANG, H. T. et al. Structural and thermal characterization of lauroylated hemicelluloses synthesized in an ionic liquid. **Polymer Degradation and Stability**, v. 97, n. 11, p. 2323–2330, 1 nov. 2012.

WANG, J. et al. Concentration of ionic liquids by nanofiltration for recycling: Filtration behavior and modeling. **Separation and Purification Technology**, v. 165, p. 18–26, 13 jun. 2016.

WELLS, A. S.; COOMBE, V. T. On the freshwater ecotoxicity and biodegradation properties of some common ionic liquids. **Organic Process Research and Development**, v. 10, n. 4, p. 794–798, jul. 2006.

WERNER, K.; POMMER, L.; BROSTRÖM, M. Thermal decomposition of hemicelluloses. **Journal of Analytical and Applied Pyrolysis**, v. 110, n. 1, p. 130–137, 2014.

WILKES, R. et al. Degradation and metabolism of synthetic plastics and associated products by Pseudomonas sp.: capabilities and challenges. **Journal of Applied Microbiology**, v. 123, n. 3, p. 582–593, 1 set. 2017.

WOODWARD, I. et al. Super-hydrophobic Surfaces Produced by Plasma Fluorination of Polybutadiene Films. **Langmuir**, v. 19, n. 8, p. 3432–3438, 15 abr. 2003.

WORLDOMETER. **Current World Population**. Disponível em: <https://www.worldometers.info/world-population/>. Acesso em: 2 fev. 2022.

WU, J. et al. Homogeneous acetylation of cellulose in a new ionic liquid. **Biomacromolecules**, v. 5, n. 2, p. 266–268, mar. 2004.

XIANG, Z. et al. Film-forming polymers from distillers' grains: Structural and material properties. **Industrial Crops and Products**, v. 59, p. 282–289, 2014.

XIANG, Z. et al. Water cast film formability of sugarcane bagasse xylans favored by side groups. **Cellulose**, v. 27, n. 13, p. 7307–7320, 1 set. 2020.

XIE, W. H. et al. Enhanced enzymatic digestibility of sugarcane bagasse pretreated by ionic liquids. **Journal of Biobased Materials and Bioenergy**, v. 9, n. 5, p. 493–501, 1 out. 2015.

XING, S.; POIRIER, Y. The protein acetylome and the regulation of metabolism. **Trends in Plant Science**, v. 17, n. 7, p. 423–430, jul. 2012.

XIONG, G.; CHENG, K.; PAULY, M. Xylan O-acetylation impacts xylem development and enzymatic recalcitrance as indicated by the arabidopsis mutant tbl29. **Molecular Plant**, v. 6, n. 4, p. 1373–1375, 2013.

XU, F. et al. Rapid esterification of wheat straw hemicelluloses induced by microwave irradiation. **Carbohydrate Polymers**, v. 73, n. 4, p. 612–620, 5 set. 2008.

XU, J. et al. Mild and efficient extraction of hardwood hemicellulose using recyclable formic acid/water binary solvent. **Bioresource Technology**, v. 254, p. 353–356, 1 abr. 2018.

XU, J. et al. Plasticized hemicelluloses/chitosan-based edible films reinforced by cellulose nanofiber with enhanced mechanical properties. **Carbohydrate Polymers**, v. 224, p. 5164, 15 nov. 2019.

YADOLLAHI, R. et al. How properties of cellulose acetate films are affected by conditions of iodine-catalyzed acetylation and type of pulp. **Cellulose**, v. 26, n. 10, p. 6119–6132, 15 jul. 2019.

YAN, J. et al. Increased drought tolerance in plants engineered for low lignin and low xylan content. **Biotechnology for Biofuels**, v. 11, n. 195, 18 jul. 2018.

YANG, T. et al. Effects of changes in biopolymer composition on moisture in acetylated wood. **Forests**, v. 11, n. 719, 1 jul. 2020.

YANG, Y. C. et al. Fabrication of antimicrobial composite films based on xylan from pulping process for food packaging. **International Journal of Biological Macromolecules**, v. 134, p. 122–130, 1 ago. 2019.

YEDRO, F. M. et al. Chemical composition and extraction kinetics of Holm oak (Quercus ilex) hemicelluloses using subcritical water. **Journal of Supercritical Fluids**, v. 129, p. 56–62, 1 nov. 2017.

YILMAZ-TURAN, S. et al. Bio-based films from wheat bran feruloylated arabinoxylan: Effect of extraction technique, acetylation and feruloylation. **Carbohydrate Polymers**, v. 250, p. 116916, 15 dez. 2020.

YUAN, Y. et al. Roles of Arabidopsis TBL34 and TBL35 in xylan acetylation and plant growth. **Plant Science**, v. 243, p. 120–130, 1 fev. 2016.

ZEMPLÉN, G.; GERECS, A.; HADÁCSY, I. Über die Verseifung acetylierter Kohlenhydrate. **Berichte der deutschen chemischen Gesellschaft (A and B Series)**, v. 69, n. 8, p. 1827–1829, 5 ago. 1936.

ZENG, Z. et al. Recent Developments on the Mechanism and Kinetics of Esterification Reaction Promoted by Various Catalysts. Em: **Chemical Kinects**. [s.l: s.n.]. p. 255–285.

ZHANG, B. et al. Control of secondary cell wall patterning involves xylan deacetylation by a GDSL esterase. **Nature Plants**, v. 3, p. 170017, 3 mar. 2017.

ZHANG, H. et al. 1-allyl-3-methylimidazolium chloride room temperature ionic liquid: A new and powerful nonderivatizing solvent for cellulose. **Macromolecules**, v. 38, n. 20, p. 8272–8277, 4 out. 2005.

ZHANG, H.; FU, S.; CHEN, Y. Basic understanding of the color distinction of lignin and the proper selection of lignin in color-depended utilizations. **International Journal of Biological Macromolecules**, v. 147, p. 607–615, 15 mar. 2020.

ZHANG, L. et al. Arabinosyl deacetylase modulates the arabinoxylan acetylation profile and secondary wall formation. **Plant Cell**, v. 31, n. 5, p. 1113–1126, 1 maio 2019.

ZHANG, L.; XUE, W.; GU, L. Modification of hyperbranched hemicellulose polymer and its application in adsorbing acid dyes. **Cellulose 2019 26:9**, v. 26, n. 9, p. 5583–5601, 11 maio 2019.

ZHANG, R.; WANG, X.; CHENG, M. Preparation and characterization of potato starch film with various size of Nano-SiO2. **Polymers**, v. 10, n. 10, 2018.

ZHAO, X. B.; WANG, L.; LIU, D. H. Peracetic acid pretreatment of sugarcane bagasse for enzymatic hydrolysis: A continued work. **Journal of Chemical Technology and Biotechnology**, v. 83, n. 6, p. 950–956, jun. 2008.

ZHAO, Y. et al. Hemicellulose-based film: Potential green films for food packaging. **Polymers**, v. 12, n. 8, p. 1775, 1 ago. 2020.

ZHONG, R.; CUI, D.; YE, Z. Members of the DUF231 family are O-acetyltransferases catalyzing 2-O-and 3-O-acetylation of mannan Running title: Mannan O-acetyltransferases. **Plant and Cell Physiology**, v. 59, n. 11, p. 2339–2349, 2018a.

ZHONG, R.; CUI, D.; YE, Z. H. Regiospecific acetylation of xylan is mediated by a group of DUF231-containing O-acetyltransferases. **Plant and Cell Physiology**, v. 58, n. 12, p. 2126–2138, 1 dez. 2017.

ZHONG, R.; CUI, D.; YE, Z. H. A group of Populus trichocarpa DUF231 proteins exhibit differential Oacetyltransferase activities toward xylan. **PLoS ONE**, v. 13, n. 4, 1 abr. 2018b.

ZHONG, R.; CUI, D.; YE, Z. H. Xyloglucan O-acetyltransferases from Arabidopsis thaliana and Populus trichocarpa catalyze acetylation of fucosylated galactose residues on xyloglucan side chains. **Planta**, v. 248, n. 5, p. 1159–1171, 1 nov. 2018c.

ZHU, R. et al. Valorization of industrial xylan-rich hemicelluloses into water-soluble derivatives by in-situ acetylation in EmimAc ionic liquid. **International Journal of Biological Macromolecules**, v. 163, p. 457–463, 15 nov. 2020.

ZHU, X. F. et al. Trichome birefringence-Like27. Affects aluminum sensitivity by modulating the 0-Acetylation of xyloglucan and aluminum-binding capacity in arabidopsis. **Plant Physiology**, v. 166, n. 1, p. 181–189, 1 set. 2014.

ZWECKMAIR, T. et al. A novel method to analyze the degree of acetylation in biopolymers. **Journal of Chromatography A**, v. 1372, p. 212–220, 12 dez. 2014.