Book of

The First Scientific Conference of the Faculty of Sciences

"Environmental Pollution and Challenges of Environmental Sustainability"

(Reconciliation with the Environment)

Sirte, October, 14, 2025

Edited by:
Prof. Abdussalam Salhin Mohamed.
Prof. Hisain Masoud Abomadina.
Dr. Ashraf Mustafa Abusenaina.
Dr. Fathia Abdulljawad Mosa

Publications of Research and Consultation Center– Sirte University
First Edition 2025

Types of Article Open Access

The First Scientific Conference of The Faculty of Science – Sirte University "Environmental Pollution and the Challenges of Environmental Sustainability"

EPESC October 14, 2025

Part One: Dedicated to papers submitted in the English language

Libyan Agency for the International Standard Book Number (ISBN)
📘 **ISBN 978-9959-891-67-9**

Conference Committees

Higher Committee

Prof. Dr. Sulayman M. Alshatir	University President
Prof. Dr. Eltayeb M. Elgobbi	University Vice President
Dr. Ashraf M. Abusenaina	Dean of the Faculty

Scientific Committee

Prof. Dr. Abdussalam Salhin Mohamed	Faculty of Science / Sirte University	Head
Prof. Dr. Hamid M. Younis Ahmed	Faculty of Science / Sirte University	Member
Prof. Dr. Ramadan Abdel-Mawla Al-Hindawi	Faculty of Science / Omar Al-Mukhtar	Member
Prof. Dr. Tahani Younis Omar	Faculty of Science / Sirte University	Member
Dr. Fathia A. Mosa	Faculty of Science / Sirte University	Member

---

Preparatory Committee

Ms. Zainab Ragab Al-Fitouri	Head
Mr. Ali M. Naji	Member
Mr. Ali A. Alghazali	Member
Dr. Souad A. Abumaryam	Member
Abdulhalim M. Alshatir	Member
Khaled J. Amhalhal	Member
Sofian S. Alshaali	Member
Ali M. Almaedani	Member
Yousuf M. Alkirrami	Member

 ISBN 978-9959-891-67-9

Editorial Team:

Contact Email: epesc@su.edu.ly
Conference Website:
https://su.edu.ly/research/index.php/conferences/science/sc1

Contents

The First Scientific Conference of the Faculty of Science – Sirte University
Environmental Pollution and Challenges of Environmental Sustainability (EPESC),
Oct. 14, 2025

The Potential of Using Wild Giant Common Reed Plant (*Phragmites australis*) as a Source for Biodegradable Plastic

Seham Abdulsalam Misbah[1] and Abdulsalam Salhin M. Ali[2]*

[1]*Libyan Academy for Postgraduate Studies, Ajdabiya, Libya.*

[2] *Chemistry Department, Sirte University, Sirte, Libya.*

Corresponding Author Email: *salam_salhin@su.edu.ly*

Article History:

Received: 08 April 2025

Revised: 13 June 2025

Published: 15 November 2025

Keywords:

Biodegradable; Bioplastic; Cellulose; Common reed; Green synthesis.

Abstract: The importance of this research lies in reducing the damage caused by wild plants, such as the common reed, to other plants and soil, as well as exploring their potential as environmentally friendly biomaterials. In this study, a simple method was employed to extract cellulose from the stems and leaves of the wild plant. The yield of cellulose was 41.4% from the stems and 26% from the leaves. Subsequently, bioplastic was produced from the extracted cellulose. FTIR analysis characterized the production of the bioplastic film, confirming the presence of specific functional groups. Additionally, the solubility of the films was tested, demonstrating their stability in most organic solvents. The degradation test indicated that these bioplastic films are soluble in soil. Finally, the degree of anisotropy of the bioplastic film was determined using DSC analysis, which yielded a value of 253 °C.

Introduction

Petroleum-based plastics have become an integral part of modern life due to their versatility and widespread use in items such as packaging, kitchenware, toys, furniture, and construction materials (Haslam, 1972). Their popularity is largely attributed to their low cost, light weight, durability, and chemical stability. However, these same properties have led to persistent environmental challenges, as conventional plastics degrade very slowly, often persisting in ecosystems for decades (Vymazal, 2011). Despite the global production of plastic exceeding 34 million tons annually, a mere 7%

is recycled, while the majority ends up in landfills, oceans, and other natural environments (Sushmitha et al., 2016). Furthermore, the incineration of plastic waste releases greenhouse gases such as carbon dioxide and methane, exacerbating climate change (IPCC, 2010). Beyond environmental impacts, plastic pollution has been linked to human health issues, including endocrine disruption and hormonal imbalances (Mathieu-Denoncourt et al., 2015).

In response to the escalating problem of plastic waste, biotechnological advancements have introduced alternative solutions, among which bioplastics stand out for their renewability and biodegradability (Barcelos et al., 2018). Unlike traditional plastics, bioplastics are derived from biological feedstocks, making them more compatible with natural degradation processes and less harmful to ecosystems. Some forms of bioplastics can even be composted into soil, enhancing fertility while reducing greenhouse gas emissions (Reddy et al., 2013). Bioplastics are broadly defined as materials that are either biodegradable, bio-based, or both (European Bioplastics, 2023). The raw materials for bioplastics are typically categorized into first-generation (e.g., food crops like corn and sugarcane) and second-generation sources (e.g., agricultural residues, non-food biomass, and organic waste), which offer more sustainable options without affecting food security (Yasser, 2022). Among the various forms of bioplastics, those based on cellulose have garnered attention for their mechanical stability and renewability. In such formulations, cellulose fibers are often incorporated with starch to enhance strength and structural integrity (Avérous & Pollet, 2014). Cellulose, a major component of lignocellulosic biomass, is a linear polysaccharide composed of β-1,4-linked D-glucose units and serves as a fundamental structural material in plant cell walls (Salameh, 2009). One promising and underutilized source of cellulose is the common reed *(Phragmites australis).*

Phragmites australis, commonly known as the common reed, is a perennial wetland grass from the Poaceae family that thrives in diverse habitats, including salt marshes, estuaries, riverbanks, and lake shores (Haslam, 1972). Known for its resilience, this species exhibits a broad ecological tolerance supported by significant phenotypic plasticity and genetic diversity. It is particularly adept at colonizing alkaline and brackish environments. Owing to its adaptability, *P. australis* is frequently used in phytoremediation to remove nutrients, heavy metals, and micropollutants from wastewater—often outperforming other aquatic plants in pollutant uptake (Vymazal, 2011). Morphologically, it grows up to 6 meters tall, with stem diameters ranging between 0.5 to 1.5 cm. Its leaves vary in width from 1 to 5 cm and can reach lengths of up to 60 cm. The plant spreads efficiently through an extensive root system and scaly rhizomes, often forming dense, monotypic stands (Mauchamp et al., 2001).In this study, the cellulose extracted from Phragmites australis is utilized as a key component in the preparation of biodegradable plastic, aiming to develop a sustainable alternative to conventional plastic materials.

Experimental

Materials and Methods

Materials

The studied plant was collected from the Abu Hadi area in the city of Sirte in the northern part of Libya. Methanol (MeOH), ethanol (EtOH), potassium hydroxide (KOH), sodium hydroxide (NaOH), hypochlorite (NaClO), starch, glycerin, and citric acid were used as received from supplier without further purifications.

Methods

Processing of raw material

The leaves and stems (the target parts studied) were first separated and then cut into small pieces. Each sample was washed well with distilled water, dried, ground, and then sieved at a size of 0.7 microns.

Extraction of cellulose

Firstly, the waxy material is removed using a hot mixture (1:1) of ethanol and methanol under reflux for 3 hours at 60°C with continuous stirring. The solid residue is then filtered and washed. Secondly, the product is treated with a base, either sodium hydroxide or potassium hydroxide (5-12.5%), to remove lignin for 2 hours at 60°C. This step is repeated until a clear filtrate is obtained. The sample is then thoroughly washed with distilled water to eliminate any base residues. Finally, the solid residue is bleached using sodium hypochlorite (2.5%) for 2 hours at 90°C, followed by thorough washing to obtain pure cellulose (Kumar & Sharmal, 2017; Sun et al., 2000).

Synthesis of Bioplastic

Bioplastic was prepared by dissolving 2.5 g of starch in 20 ml of distilled water and heating the mixture for 30 minutes at 60°C. While stirring continuously, 0.1 g of cellulose was added to a round-bottomed flask, followed by the addition of 10 ml of 5% citric acid and 2 ml of glycerin. The mixture was stirred at a temperature of 110-130°C until it reached a viscous. Finally, it was poured onto glass plates and allowed to dry. The process is illustrated in Figure 1.

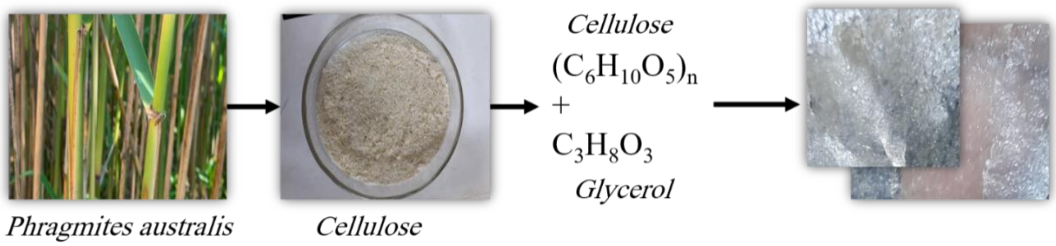


Figure 1: Synthesis of bioplastic from common reed (*Phragmites austuralis*) cellulose

Study of the properties of prepared bioplastics

Solubility test

A dissolution test of the prepared bioplastic was conducted to verify its stability. Samples were cut into small pieces weighing 1 g and placed in different test tubes, each containing 20 ml of different solvents: acetone, acetic acid, ethyl alcohol, sodium hydroxide (NaOH) (1 N), hydrogen chloride (HCl) (1 N), and ammonia (NH_3) at room temperature.

Degradation test

To check the bioplastic decomposition, samples containing different amounts of cellulose (0.1 to 0.5) were buried in soil. A piece of prepared plastic film (1 × 2 cm) was buried in soil, at room temperature for a month. The samples were checked every week to monitor their decomposition.

Spectrophotometric analysis

The UV-Vis spectroscopic analysis was performed for the bioplastic in order to calculate the permeability and ensure which of the films is more transparent (using Analytik jena UV/VIS specord 210 plus spectrophotometer) in the wavelength range of from 290-650 nm.

FTIR analysis

FTIR spectra of the bioplastic samples were performed using a PerkinElmer Frontier FT-IR spectrometer with a universal ATR (single crystal diamond/zinc-selenium) accessory, in the wavenumber range of 4000 cm-1 to 400 cm^{-1}.

Thermogravimetric analysis

The thermal analysis of the bioplastic was performed using differential scanning calorimetry (DSC) in N_2 atmosphere, heating/cooling rate was 10°C/min, and flow rate was 20 ml at temperature from 0-500 °C.

Surface morphology

Using a scanning electron microscope (SEM), 1-micrometer images were captured to study the surface structure and microstructural details of the bioplastic samples.

Results and discussion

The Effect of Base

Two different bases (NaOH and KOH, 12.5% both) were used for the extraction of cellulose from both lignin and hemicellulose from the plant. The perentage yield of the extracted cellulose was calculated using the following equation:

$$amount\ of\ cellulose = \frac{\text{(g) cellulose mass}}{\text{(g) fiber mass}} \times 100$$

Slightly different results were observed between the two bases, underscoring the effectiveness of both sodium hydroxide and potassium hydroxide in extracting cellulose from lignin and hemicellulose (Figure 2). Consequently, 12.5% KOH was chosen for further cellulose extraction from the sample. Additional studies were conducted to investigate the impact of varying KOH concentrations (5%-12.5%) on cellulose extraction. The findings revealed that a higher cellulose yield (41.4%) was obtained at the lower base concentration of 5%. Furthermore, the data indicated that the amount of cellulose in the stem exceeded that in the leaves (Figure 3).

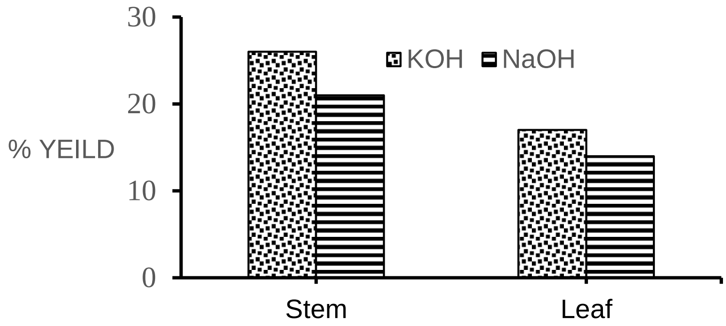


Figure 2: The effect of base on the percentage yield of cellulose. Base concentration: 12% KOH and 12% NaOH.

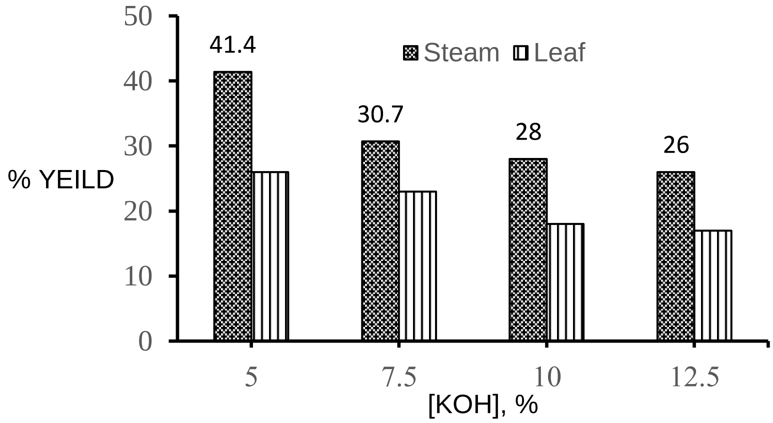


Figure 3: Cellulose yield at different KOH concentrations.

Solubility Test

The solubility test of the prepared bioplastic shows its stability and insolubility in organic solvents, such as ethanol, methanol, acetone, partially soluble in NH_3, and acetic acid, and completely soluble in strong basic medium (NaOH, 1N, HCl, 1N). Table 1, revealed the solubility of the bioplastic.

Table 1: Solubility test of the bioplastic

Solvent	Solubility		
	Insoluble	Partially Soluble	Completely Soluble
NH_3	-	+	-
CH_3COOH	-	+	-
CH_3CH_2OH	+	-	-
CH_3OH	+	-	-
$(CH_3)_2CO$	+	-	-

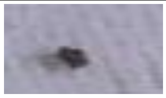
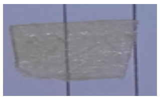
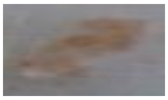
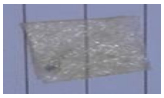
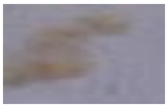
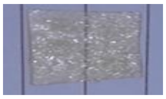
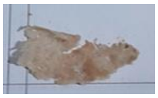
 ISBN 978-9959-891-67-9

NaOH (1N)	-	+	-
HCl (1N)	-	+	-

Degradation Test

The biodegradability of the bioplastic films was evaluated over a period of three months by monitoring the reduction in weight (Table 2). The results revealed that films with varying cellulose contents exhibited different degradation rates. Notably, samples containing higher amounts of cellulose (e.g., 0.5 g) degraded more slowly than those with lower concentrations. This suggests that increasing the cellulose content enhances the film's structural integrity, thereby reducing its susceptibility to microbial decomposition (Keshk, 2014; Bonilla et al., 2013).

Table 2: Degradation test of bioplastic film (1×2cm) in the soil

Amount of cellulose (g)	Before burial	After burial (months)		
		One	Two	Three
0.1				
0.2				
0.3				
0.4				
0.5				

UV/Vis Analysis

The transparency of the fabricated biofilms was examined by measuring their transmittance (absorption) of ultraviolet/visible light. The data show a decrease in transmittance as the amount of cellulose in the plastic films increases (Figure 4). Films containing 0.5 g of cellulose are the least transparent due to the high cellulose content (Avérous & Pollet, 2014; Kalia, Kaith, 2011).

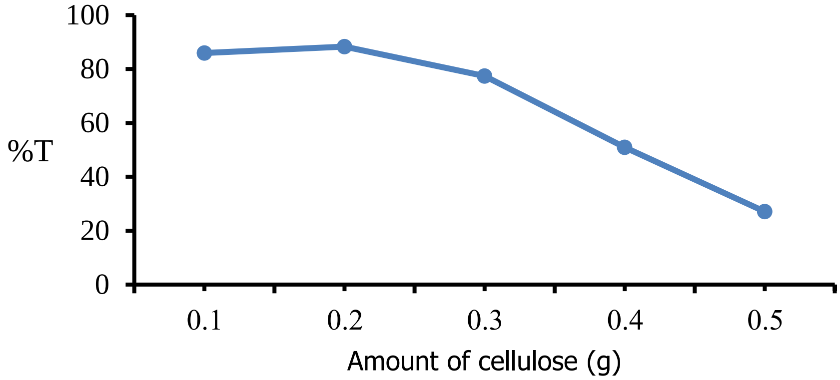


Figure 4: UV/Visible Transmittance of Bioplastic Films.

FTIR Analysis

The FTIR spectrum (Figure 5) of the bioplastic film shows a peak at 3294 cm^{-1}, due to the (OH) group present in cellulose, as well as peaks at 2934 cm^{-1} for the (C-H) stretching group. Peaks at 1642 cm^{-1}, 1412 cm^{-1} and 1332 cm^{-1} are related to the bending vibrations groups of (OH), (C-H), CH_3 and CH_2, respectively. Peak observed at 1025cm^{-1} is related to the (C-O-C) ester group(Avérous & Pollet, 2014).

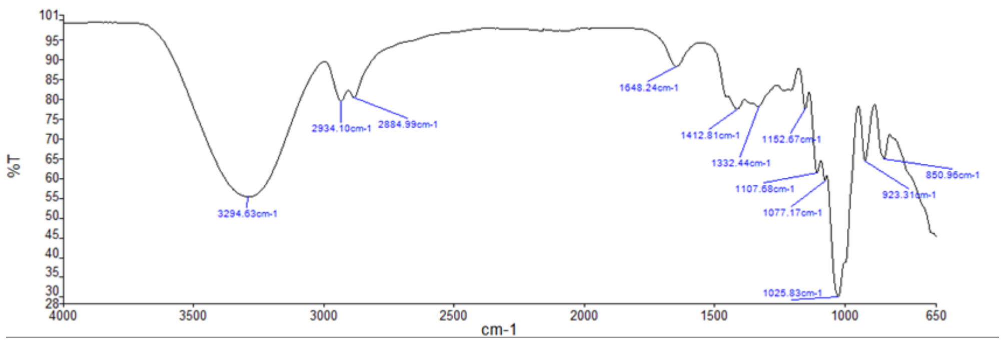


Figure 5: FTIR spectrum of bioplastic.

Thermal Analysis

Studying the thermal properties of the bioplastic films (Figure 6) revealed that the film might absorb water or moisture at 103°C. After that, the film start to lose its crystalline arrangement at 220°C and begins to transform into a liquid or viscous state, and its melting point (Tm) is 235.4°C (Tsuji & Ishizaka, 2001)

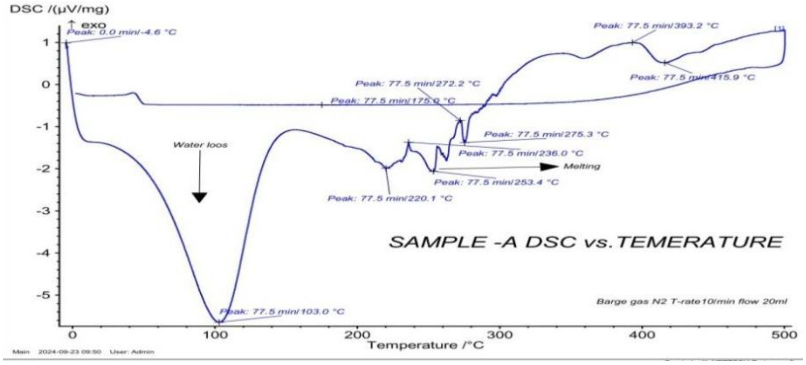


Figure 6: DSC thermogram of bioplastic.

Surface morpholo*gy*

The scanning electron microscopic (SEM) image of the biofilm is shown in Figure 7. The image depicts regular and smoother phases, along with rough phases observed in certain areas.

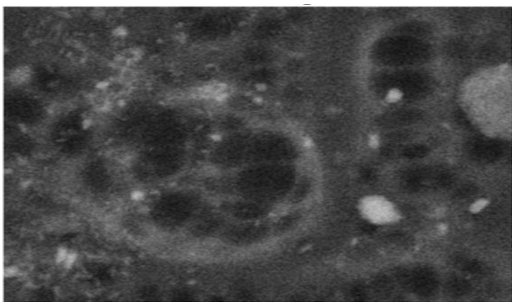


Figure 7: SEM morphology of Common reed cellulose bioplastic.

Conclusions

Common reed is an invasive plant that spreads rapidly in wetlands when conditions are suitable and thus can be a source of cellulose fiber. In this study, cellulose was obtained from the stems and leaves of common reed that grows in the meditation climate. Cellulose was collected after removing the waxy material from the surface of the plant fibers, followed by removing lignin and hemicellulose using basic processing. KOH gives better production than NaOH, with percentage yield of 41.4% Plastic films containing different amounts of cellulose were prepared. Films with higher cellulose concentration were found more resistant to soil. However, films with lower concentration of cellulose are more transparent than the higher. The biofilm was also confirmed by IR. The melting point plastic film melts and this was proven using DSC analysis 253 °C.

Conflict of Interest: The authors declare that there are no conflicts of interest.

Acknowledgements

I would like to thank Misurata University and Ras Lanuf Oil and Gas Company for conducting some of the analysis related to the study.

References

Avérous, L., & Pollet, E. (2014). *Nanobiocomposites based on plasticized starch*. In **Starch Polymers** (pp. 211–239). Elsevier.

Barcelos, M. C. S., Lupki, F. B., Campolina, G. A., Nelson, D. L., & Molina, G. (2018). The colors of biotechnology: General overview and developments of white, green, and blue areas. *FEMS Microbiology Letters*. https://doi.org/10.1093/femsle/fny239

Bonilla, J., Fortunati, E., Vargas, M., Chiralt, A., & Kenny, J. M. (2013). Biodegradable starch–nanocomposite films produced by electrospinning: Morphology and properties. *Carbohydrate Polymers, 92*(1), 122–130. https://doi.org/10.1016/j.carbpol.2012.08.064

European Bioplastics. (2023). *Facts and figures about bioplastics*. Retrieved July 11, 2023, from http://en.european-bioplastics.org

Haslam, S. M. (1972). *Phragmites communis Trin.* (Arundo phragmites L., Phragmites australis (Cav.) Trin. ex Steudel). *Journal of Ecology, 60*(2), 585–610. https://doi.org/10.2307/2258354

IPCC. (2010). In Barker, T. (Ed.), *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the IPCC*. Cambridge University Press.

Kalia, s., Kaith, B. S., & Kaur, I. (2011). Cellulose fibers*: Bio- and nano- polymer composites: green chemistry and technology. Springer*. https://doi.org/10.1007/978-642-17332-0

Keshk, S. M. A. S. (2014). Bacterial cellulose production and its industrial applications*. Journal of Bioprocessing & Biotechniques, 4*(2), 1–10. https://doi.org/10.4172/2155-9821.1000150

Kumar, A., & Sharma, G. (2017). Extraction and characterization of cellulose from agricultural waste—Wheat straw. *International Journal of Advanced Research, 5*(5), 1975–1983. https://doi.org/10.21474/IJAR01/4237

Tsuji, H., & Ishizaka , T. (2001). Characterization nd biodegradability of cellulose acetate- starch composite films. *Carbohydrate polymers, 45*(1), 9-14.

Mathieu-Denoncourt, J., Wallace, S. J., de Solla, S. R., & Langlois, V. S. (2015). Plasticizer endocrine disruption: Highlighting developmental and reproductive effects in mammals and non-mammalian aquatic species. *General and Comparative Endocrinology, 219*(1), 74–88.

Mauchamp, A., Blanch, S., & Grillas, P. (2001). Effects of submergence on the growth of Phragmites australis seedlings. *Aquatic Botany, 69*(2–4), 147–164. https://doi.org/10.1016/S0304-3770(01)00138-0

Reddy, R. L., Gupta, G. A., & Reddy, V. S. (2013). Study of bio-plastics as green and sustainable alternatives to plastics. *International Journal of Emerging Technology and Advanced Engineering, 3*(5), 82–89.

Salameh, Y. F. A. (2009). *Methods of Extracting Cellulosic Material from Olive Pulp* (Master's thesis). An-Najah National University.

Sun, R., Tomkinson, J., Ma, P., & Liang, S. (2000). Comparative study of hemicelluloses from rice straw by alkali and hydrogen peroxide treatments. *Carbohydrate Polymers, 42*(2), 111–122. https://doi.org/10.1016/S0144-8617(99)00141-3

Sushmitha, B. S., Vanitha, K. P., & Rangaswamy, B. E. (2016). Bioplastics – A Review. *International Journal of Modern Trends in Engineering and Research, 3*(4), 411–413.

Vymazal, J. (2011). Constructed wetlands for wastewater treatment: Five decades of experience. *Environmental Science & Technology, 45*(1), 61–69. https://doi.org/10.1021/es101403q

Yasser, M. A. (2022). The role of renewable biological resources in the production of bioplastics. *Organization of Arab Petroleum Exporting Countries*, 3–13.