บธ.๐๐๑/๖๓

บันทึกข้อความ

ส่วนงาน คณะวิทยาศาสตร์ สำนักงานคณบดี งานบริหารและธุรการ โทร ๓๘๐๐
ที่ อว ๖๙.๕.๑.๑/๖๒๐ **วันที่** ๔ มิถุนายน ๒๕๖๙
เรื่อง ขอรายงานสรุปเนื้อหาและการนำไปใช้ประโยชน์

เรียน คณบดีคณะวิทยาศาสตร์

ตามที่คณะวิทยาศาสตร์ได้อนุญาตให้ข้าพเจ้าเข้าร่วมงานประชุมวิชาการระดับนานาชาติในงาน The ๖th International Conference on Science, Technology & Innovation (๒๐๒๖) คณะวิทยาศาสตร์ มหาวิทยาลัยแม่โจ้ และนำเสนอผลงานวิจัยในหัวข้อเรื่อง Plasticized Corn Husk Cellulose Ester Films: Thermal Behavior and Mechanical Performance เมื่อวันที่ ๒๙ พฤษภาคม ๒๕๖๙ สถานที่ คณะวิทยาศาสตร์ มหาวิทยาลัยแม่โจ้

บัดนี้ข้าพเจ้าได้เข้าร่วมงานประชุมวิชาการระดับนานาชาติ The ๖th International Conference on Science, Technology & Innovation (๒๐๒๖) เป็นที่เรียบร้อยแล้ว ดังนั้น จึงขอรายงานสรุปเนื้อหาและประโยชน์ที่ได้รับ ดังนี้

๑. สรุปเนื้อหาที่ได้รับจากการเข้าประชุม/อบรม ฯลฯ

เข้าร่วมงาน The ๖th International Conference on Science, Technology & Innovation (๒๐๒๖) และนำเสนอผลงานวิจัยแบบโปสเตอร์ โดยได้รับรางวัล Silver Medal Award ในการนำเสนอผลงานรูปแบบโปสเตอร์

๒. ประโยชน์ต่อการปฏิบัติงานในตำแหน่งหน้าที่

ได้พัฒนาตนเองจากการนำเสนอผลงานทางวิชาการในระดับนานาชาติ รับฟังการนำเสนอผลงานจาก Keynote Speakers และจากการเข้าเยี่ยมชมผลงานทางวิชาการจากผู้นำเสนอท่านอื่นๆ และมีบทความฉบับเต็มในการตีพิมพ์ในวารสารทางวิชาการ

๓. ประโยชน์ต่อหน่วยงาน (ระดับงาน/หลักสูตร/คณะ)

ได้รับรางวัลในการนำเสนอผลงานทางวิชาการในระดับนานาชาติ สร้างชื่อเสียงให้กับหลักสูตรและคณะวิทยาศาสตร์

พร้อมนี้ได้แนบรูปภาพการเข้าร่วมงานและประกาศนียบัตร มาพร้อมนี้แล้ว จำนวน ๑ ชุด

จึงเรียนมาเพื่อโปรดทราบ

ลงชื่อ อุษารัตน์ รัตนคำนวณ ....
(ผู้ช่วยศาสตราจารย์ ดร.อุษารัตน์ รัตนคำนวณ)
วันที่ ๔ มิถุนายน ๒๕๖๙

ความคิดเห็นของผู้บังคับบัญชาชั้นต้น (ประธานอาจารย์ผู้รับผิดชอบหลักสูตร/ผู้อำนวยการสำนักงาน/หัวหน้างาน)

นำความรู้ไปใช้ประโยชน์ในการพัฒนางานวิจัย และตีพิมพ์ผลงานทางวิชาการในระดับนานาชาติได้

....

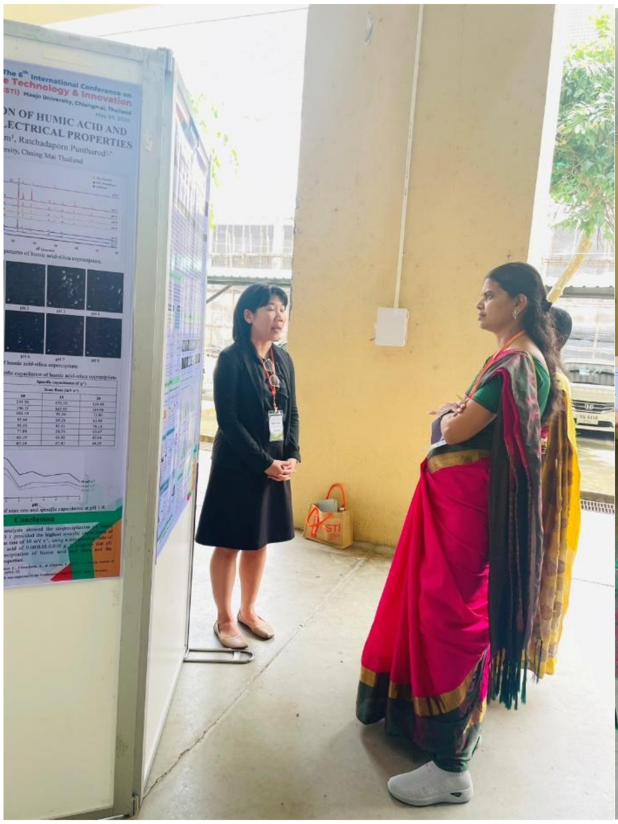
(ผู้ช่วยศาสตราจารย์ ดร.อุษารัตน์ รัตนคำนวณ)

วันที่ ๔ มิถุนายน ๒๕๖๙

หมายเหตุ : ๑. เอกสารแนบเช่น สำเนาบทคัดย่อ หรือโปสเตอร์(ย่อขนาด A๔) หรือบทความฯ ฉบับเต็มสำเนาใบรับรองหรือหนังสือรับรองหรือใบประกาศนียบัตรหรือวุฒิบัตรฯลฯ ซึ่งเป็นหลักฐานว่าได้เข้าร่วมงานจริง

๒. กรณีที่ประสงค์จะรายงานฯ กรณีไม่ได้งบพัฒนาบุคลากรหรือไม่ใช้งบประมาณ ให้ใช้แบบฟอร์มฯ นี้

๓. ให้จัดรูปแบบและขยายพื้นที่ตามรายละเอียดเนื้อหาหรือข้อความ ตามความเหมาะสม




ICSTI2026
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May 29, 2026
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ICSTI-MJU

FACULTY OF SCIENCE, MAEJO UNIVERSITY

THIS IS TO CERTIFY THAT

Chadaporn Srimai, Usarat Ratanakamnuan

has successfully presented an Poster presentation entitled:

Plasticized Corn Husk Cellulose Ester Films: Thermal Behavior and Mechanical Performance

at **The 6th International Conference on Science, Technology & Innovation (ICSTI-MJU 2026)**
held on May 29,th 2026, organized by the Faculty of Science, Maejo University, Chiang Mai, Thailand.

Awarded in appreciation of your valuable contribution to the conference.

Assoc. Prof. Dr. Yuwalee Unpaprom
DEAN, FACULTY OF SCIENCE
MAEJO UNIVERSITY, THAILAND

Assoc. Prof. Dr. Weerapon Thongma
PRESIDENT
MAEJO UNIVERSITY, THAILAND

The 6th International Conference on
Science Technology & Innovation (6th ICSTI) - Maejo University 2026

May 29, 2026

Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

Time	Schedules			
08.00-08.30	Registration			
08.30-09.00	Opening Ceremony			
09.00-10.00	Keynote Speaker: Professor Dr. Caroline Rose Topic: "Green Biotechnology: Transforming the Future of Smart and Sustainable Agriculture" Address: St. Joseph's College of Arts and Science for Women (Autonomous) Hosur, Tamil Nadu, India			
10.00-10.30	Morning Break			
10.30-12.30	Poster Presentation Session at Underbuilding Area, Chula Phorn Building, Faculty of Science, Maejo University			
	Parallel Oral Presentation Sessions			
	Session 1: 3103	Session 2: 3104	Session 3: 3105	Session 4: 3210
12.30-13.30	Lunch			
13.30-14.30	MEMORANDUM OF UNDERSTANDING			
14.30-16.30	Poster Presentation Session at Underbuilding Area, Chula Phorn Building, Faculty of Science, Maejo University			
	Parallel Oral Presentation Sessions			
	Session 1: 3103	Session 2: 3104	Session 3: 3105	Session 4: 3210
16.30	Closing Session			
Announcement of awards on website				

The 6th International Conference on Science Technology & Innovation (6th ICSTI) - Maejo University 2026
"The Science Drive Intelligent Well-being Agriculture"
May 26, 2026
Time Zone Reference: All session times are in **Indochina Time (ICT, UTC+7)**, which is the local time in **Bangkok, Thailand**
Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

<table>
<tr><th>Time</th><th colspan="4">Schedules</th></tr>
<tr><td>08.00-08.30</td><td colspan="4">Registration : Room 3100</td></tr>
<tr><td>08.30-09.00</td><td colspan="4">Opening Ceremony : Room 3100
Join Zoom Meeting : https://zoom.us/j/97059995147?pwd=Yag9Eg6iXPzwJbla2uk1pd0h3RkqKG.1
Meeting ID : 970 5999 5147
Passcode : 360323</td></tr>
<tr><td>09.00-10.00</td><td colspan="4">Room :3100
Keynote Speaker : Professor Dr. Caroline Rose, St. Joseph's College of Arts and Science for Women (Autonomous) Hosur, Tamil Nadu, India
Join Zoom Meeting : https://zoom.us/j/97059995147?pwd=Yag9Eg6iXPzwJbla2uk1pd0h3RkqKG.1
Meeting ID : 970 5999 5147
Passcode : 360323</td></tr>
<tr><td>10.30-10.45</td><td colspan="4">Morning Break</td></tr>
<tr><td rowspan="3">10.30-12.30</td><td colspan="4">Poster Presentation Online at Room : 3105
Join Zoom Meeting : https://zoom.us/j/98086352546?pwd=4Dj77IIlF8RpV7B0Bs0Xa16iXUBhC1.1
Meeting ID : 980 8635 2546
Passcode : 453327
Poster Presentation On-site at Ground Floor, Chulabhorn Building, Faculty of Science, Maejo University</td></tr>
<tr><td colspan="4">Parallel Oral Presentation Sessions</td></tr>
<tr><td>Session 1: Room 3103</td><td>Session 2: Room 3104</td><td>Session 3 : Room 3105
Oral & Poster Online Presentation
Join Zoom Meeting
https://zoom.us/j/98086352546?pwd=4Dj77IIlF8RpV7B0Bs0Xa16iXUBhC1.1
Meeting ID : 980 8635 2546
Passcode : 453327</td><td>Session 4: Room 3210
Oral & Poster Online Presentation
Join Zoom Meeting
https://zoom.us/j/93351187129?pwd=GgcObQSKwkAplzosSRVGGlOY0CaEb4.1
Meeting ID : 933 5118 7129
Passcode : 351753</td></tr>
</table>

<table>
<tr><th>Time</th><th colspan="4">Schedules</th></tr>
<tr><td>12.30-13.30</td><td colspan="4">Lunch</td></tr>
<tr><td>13.30-14.30</td><td colspan="4">MEMORANDUM OF UNDERSTANDING</td></tr>
<tr><td rowspan="3">14.30-16.30</td><td colspan="4">Poster Presentation Online at Room :3105
Join Zoom Meeting : https://zoom.us/j/98086352546?pwd=4Dj77IIlF8RpV7B0Bs0Xa16iXUBhC1.1
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<tr><td>Session 1: Room 3103</td><td>Session 2: Room 3104</td><td>Session 3: Room 3105
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https://zoom.us/j/98086352546?pwd=4Dj77IIlF8RpV7B0Bs0Xa16iXUBhC1.1
Meeting ID : 980 8635 2546
Passcode : 453327</td><td>Session 4: Room 3210
Oral & Poster Online Presentation

Join Zoom Meeting
https://zoom.us/j/93351187129?pwd=GgcObQSKwkAplzosSRVGGlOY0CaEb4.1
Meeting ID : 933 5118 7129
Passcode : 351753</td></tr>
<tr><td>16.30</td><td colspan="4">Closing Session</td></tr>
<tr><td colspan="5">Announcement of awards on Room 3100</td></tr>
</table>

Parallel Oral Presentation Sessions Schedule

The 6th International Conference on Science Technology & Innovation (6th ICSTI) - Maejo University 2026
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Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

Session 1 : Room 3103

Keynote Speaker: : Dr. D. Kavitha, M.Sc., M.Phil., Ph.D., Vice Principal, Sri Vidya Mandir Arts and Science College (Autonomous), Krishnagiri, Tamil Nadu, India

Chairman : Dr. D. Kavitha, Vicr Principal, Dr. Caroline Rose, Principal, Assoc. Prof. Dr. Kreangkri Ratchagit

Time	Paper ID	Paper Title	Presenter's Name
10.30-10.40	ABRS169019	Future Development of Cartesian Product (×1 to ×11) over Linguistic Complex Logarithmic Operational Laws for Intuitionistic Fuzzy Matrices toward Scientific Innovation, Advanced Technology, and Sustainable Agriculture	Dr. D. Kavitha
10.40-10.50	ABRS169015	Marker–Trait Association Analysis Reveals ABA Signaling–Related Genes Associated with Root System Architecture in Rice under PEG-Induced Osmotic Stress	Assoc. Prof. Saengtong Pongjaroenkit
10.50-11.00	ABRS169026	Sustainable Perlite-Based Insulation Materials from Agricultural Residues for Cold Chain Packaging: Thermal Performance Compared with EPS	Mrs. Siriwan Tungsangprateep
11.00-11.10	ABRS169030	Development and Multi-Source Validation of a Smart Weather Monitoring System for Mountainous Rice Applications	Mrs. Mookarin Nookong
11.10-11.20	ABRS169032	PROCESS OPTIMIZATION AND PHYSICOCHEMICAL CHARACTERIZATION OF PROTEIN HYDROLYSATE SOUP FROM BUK-SIAM MAEJO HYBRID CATFISH USING ENZYMATIC AND THERMAL PROCESSING	Ms. THIPHAPORN RUANGYOT
11.20-11.30	ABRS169057	Energy–Performance Trade-off Analysis of Adaptive GRU-Scheduled PID Control for Vapor Pressure Deficit Regulation in Evaporative-Cooled Greenhouses.	Mr. Natthanan Wanna
11.30-11.40	ABRS169058	Resource Efficiency Analysis of Hierarchical ANN-Supervised Gain-Scheduled PID Control in Inline Fertigation: A Fertilizer Over-Injection Quantification Framework	Mr. Sitthichai Aoklakhon
11.40-11.50	ABRS169059	Two-Stage Filter and Multi-Head EEG Net for Multi-disease Brain Screening: A Dual-Track Deep Learning Approach	Mr. Apirat Ungkabut
11.50-12.00	ABRS169068	Three-Dimensional CFD Validation of Hydrodynamic Behavior in Anaerobic Digester	Ms. Kandarat Lamchumchang
12.00-12.10	ABRS169033	PHYSICOCHEMICAL CHANGES, DIGESTIBILITY, AND ANTIOXIDANT ACTIVITY OF PROTEIN HYDROLYSATE SOUP UNDER SIMULATED GASTROINTESTINAL CONDITIONS	Ms. THIPHAPORN RUANGYOT
12.10-12.20	ABRS169034	ScolioBot: A SMARTPHONE-BASED AI SYSTEM FOR EARLY SCOLIOSIS DETECTION USING DEEP LEARNING MODELS	Mr. Rachita Jantamongkol
12.20-12.30	ABRS169045	AN AI-BASED PRE-SCREENING SYSTEM FOR THE DIFFERENTIAL DIAGNOSIS OF HERPES SIMPLEX, SHINGLES, AND CHICKENPOX VIA MOBILE IMAGES	Mr. Watcharich Harnpajonesuk

Lunch			
14.30-14.40	ABRS169056	Isolation and characterization of a novel Staphylococcus aureus bacteriophage against antibiotic-resistant Staphylococcus aureus	Mrs. Kansuda Suksaman
14.40-14.50	ABRS169010	A Continuum-Mechanics Model of the Arabidopsis Shoot Apical Meristem as a Pressurized Shell	Dr. pasin marupanthorn
14.50-15.00	ABRS169017	A Boundary Layer Resolving Numerical Method for Singularly Perturbed Delay Differential Equations of Large Delay Arising in Control Theory	Dr. Dinesh Kumar S
15.00-15.10	ABRS169077	ENHANCING INDUTRIAL VINEGAR PRODUCTION FROM COFFEE PULP: ROLE OF AERATION RATE ON ACETIC ACID FORMATION	Ms. Naruemon Boonmee
15.10-15.20	ABRS169072	Dose–response effects of Amanita hemibapha subsp. javanica inoculation on growth and ectomycorrhizal colonisation of Dipterocarpus turbinatus seedlings	Mr. Umporn Thongmee
15.20-15.30	ABRS169073	Impact Analysis of Insect-Repellent Biochar Production Costs on the Economic Viability of Rural Cattle Farming	Mr. Siwat Tajamai

Parallel Oral Presentation Sessions Schedule

The 6th International Conference on Science Technology & Innovation (6th ICSTI) - Maejo University 2026

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Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

Session 2 : Room 3104

Keynote Speaker: Dr. C. Ragavan, M.Sc., M.Phil., Ph. D, IQAC Director, Sri Vidya Mandir Arts and Science College (Autonomous), Krishnagiri, Tamil Nadu, India,

Chairman : Dr. C. Ragavan Associate Assistant Professor, Dr. Urailuk Singthong, Tawatchai Petaratip

Time	Paper ID	Paper Title	Presenter's Name
10.30-10.40	ABRS169018	Next generation extended intuitionistic fuzzy set over development of logarithmic, exponential, complex, and linguistic models for scientific innovation, smart technology and sustainable agriculture	Dr. C. Ragavan
10.40-10.50	ABRS169028	Development of Eleven Types of Cartesian Product Operations in Complex Exponential Intuitionistic Fuzzy Matrices	Dr. Senthilkumar S
10.50-11.00	ABRS169029	Comparative Study of Solvent Systems for enhancing their phytochemical from Boesenbergia rotunda.	Mrs. saowalak rotamporn
11.00-11.10	ABRS169035	Optimal Control of a Stochastic Plant Disease Model with Climate-Dependent Transmission Rates	Ms. M. Sangavi Meyyappan
11.10-11.20			
11.20-11.30	ABRS169061	Pythagorean Linguistic Fuzzy Systems: Associative and Distributive Analysis of the ×7 Operator toward Intelligent Scientific Applications	Dr. Ragavan Chinnavan
11.30-11.40	ABRS169070	Mathematical modeling and its applications in Agriculture	Dr. M. Mullai
11.40-11.50	ABRS169027	Improvement of English Skills Using the English Curriculum for Creative Tourism with BCG Model Concept through Community-based Participation in Phrae Province	Asst. Prof.Dr. Kannika Kanjunda
11.50-12.00	ABRS169046	Optimizing Excess-Oxygen Control in an Industrial Walking-Beam Reheating Furnace: A Replicated 2^3 Factorial Study of Scale Loss, Fuel Use, and Emissions Trade-offs	Mr. GAN YIMYAM
12.00-12.10	ABRS169052	INVESTIGATION OF MASS TRANSFER COEFFICIENT OF WATER EVAPORATION THROUGH HYDROGEL SHEET	Mr. Tonkla Hangsoongnern
12.10-12.20	ABRS169053	Enhancement of graphite recovery from LIB-NMC black mass using froth flotation	Mrs. Juntima Loho

12.20-12.30	ABRS169054	Ammonia Management Strategies for Enhancing Biogas Production from Broiler Chicken Manure in Thailand	Ms. Thidarat Jitjanesuwan
		Lunch	
14.30-14.40	ABRS169066	Removal of Antibiotics from Hospital Wastewater Using TiO_2-Catalyzed Ozonation	Ms. JARUWAN MANUI
14.40-14.50	ABRS169067	Sustainable Biomass Fuel Production: Carbonization-Based Enhancement of Rice Straw and Sugarcane Bagasse Briquettes	Mr. Gusunconow Noddbundpizud
14.50-15.00	ABRS169069	Circular Aquaculture: Utilizing Processed Meat Waste to Enhance Growth, FCR, and Economic Efficiency in Tilapia and African Catfish Production	Mrs. Karnchana Karnchanamayoon
15.00-15.10	ABRS169074	Potential Assessment of Charcoal Production Using Earth Pit Kilns and Pollution Smoke Treatment Efficiency During Carbonization	Mr. Nigran Homdoung
15.10-15.20	ABRS169075	Analysis of variables affecting atmospheric water generation using vapor compression refrigeration	Mr. Tirawat Wongsatiam
15.20-15.30	ABRS169076	Quantifying Tree Biomass Carbon and Carbon Credit Potential in a Tropical Golf Course under the T-VER Scheme: Evidence from Summit Green Valley Chiang Mai Country Club	Ms. Porntip Chanrat
15.30-15.40	ABRS169078	Carbon Stock Assessment of Temple Green Spaces for Urban Carbon Neutrality: A Case Study of Maejo Municipality, Chiang Mai	Ms. Porntip Chanrat
15.40-15.50	ABRS169065	Algebraic structures of the specialized cartesian product $\times 7$ over intuitionistic linguistic fuzzy sets for advanced technology and sustainable agriculture	Dr. J. Venkatesan

Parallel Oral & Poster Online Presentation Sessions Schedule

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Session 3 : Room 3105

Keynote Speaker : Dr. D. Jayaprakash, Assistant professor, Dwaraka Doss Goverdhan Doss Vaishnav college (A), Arumbakkam, Chennai, Tamil Nadu, India,

Join Zoom Meeting: https://zoom.us/j/98086352546?pwd=4Dj77IlIF8RpV7B0Bs0Xa16iXUBhC1.1

Meeting ID : 980 8635 2546

Passcode : 453327

Chairman : Dr. D. Jayaprakash, Assoc. Prof. Dr. Chupong Pakpum, Dr. Kittikorn Hantrakul , Rev. Sr. Dr. Dona Grace Jeyaseely

	Paper ID	Paper Title	Presenter's Name
10.30-10.40	ABPL269007	Factors Influencing Soybean Meal Prices in Thailand's Animal Feed Industry: An Analysis Using PLS-SEM Structural Equation Modeling	Mrs. Natcha Khampangpetch
10.40-10.50	ABRL169001	An Optimal Allocation for Fire Hydrant Distribution in Urban Area: A case study in Bangkok, Thailand	Assoc. Prof. Saifon Chaturantabut
10.50-11.00	ABRL169011	EFFECT OF HARVESTING MATURITY ON POST HARVEST QUALITY OF PURPLE PASSION FRUIT (PASSIFLORA EDULIS SIMS CV. DAINONG 1) DURING AMBIENT STORAGE	Mrs. Thi Nga Vu
11.00-11.10	ABRL169012	Postharvest quality and sensory evaluation of Vietnamese lychee cv. U hong (Litchi chinensis Sonn.)	Mrs. Thi Tu Quynh Nguyen
11.10-11.20	ABRL169013	Unlocking Predictive Power: A Deep Dive into Cryptocurrency Futures with Time-Varying GBM and Mixed-GARCH Models	Mr. Wongtawan Uthumrat
11.20-11.30	ABRL169014	Intelligent Deep Learning Architecture for Automated Pulmonary Atelectasis Identification in Radiographic Images through Hybrid U-net and VGG-16 Integration	Mrs. SHILPA N
11.30-11.40	ABRL169023	A Comparative Analysis of IoT Traffic Segregation Utilizing Dedicated and Distributed VLANs	Mr. Chaknarin Kongcharoen
11.40-11.50	ABRL169031	Layout-Independent Utility Data Extraction: A Semantic Approach Integrating RPA and Generative AI	Assoc. Prof.Dr. PRASERTSAK TIAWONGSOMBAT
11.50-12.00	ABRL169037	The Development of International Market Entry Strategy through E-Marketplace for Local Entrepreneurs: A Case Study of Woven Handicraft Products from Pa Bong Community, Chiang Mai, Thailand	Ms. Jutaluck Saipang
12.00-12.10	ABRL169038	Edge-Native Privacy-Preserving Fall Detection System Using Optimized Skeleton-Based Pose Estimation on NVIDIA Jetson	Ms. Thanchanok Tan-in

12.10-12.20	ABRL169039	Efficient 3D-Aware Face Frontalization via Lightweight Diffusion Adapters for Pose-Invariant Face Recognition	Ms. Nichamon Pilata
12.20-12.30	ABRL169040	Enhancing Credit Risk Prediction using TabNet: A Comparative Study with Interpretable Deep Learning on Imbalanced Financial Data	Ms. Supreeya Pangkhuntod
Lunch			
14.30-14.40	ABRL169041	Enhancing BI-RADS Classification in Digital Mammography: A Vision-Language Foundation Model Approach using Mammo-CLIP on the VinDr-Mammo Dataset	Ms. Chutimon Nunthasena
14.40-14.50	ABRL169042	Toward Clinical Transparency: A Comparative Analysis of CNN and Vision Transformer Architectures for Explainable Brain Tumor MRI Classification	Ms. Areenee Hayeepador
14.50-15.00	ABRL169079	Potential of Biogas Recovery from Industrial Wastewater and CO2-Equivalent Emission Mitigation	Ms. Witchuda Uea-aree
15.00-15.10	ABRS169025	EVALUATING THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN ENHANCING MARKET EFFICIENCY FOR FARMERS WITH SPECIAL REFERENCES TO CHENGALPATTU DISTRICT	Dr. Jayaprakash D

Parallel Oral & Poster Online Presentation Sessions Schedule

The 6th International Conference on Science Technology & Innovation (6th ICSTI) - Maejo University 2026

"The Science Drive Intelligent Well-being Agriculture"

May 26, 2026

Time Zone Reference: All session times are in **Indochina Time (ICT, UTC+7)**, which is the local time in **Bangkok, Thailand**

Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

Session 4 : Room 3210

Keynote Speaker : Dr. B. K. Jaleesha, Assistant Professor, St. Joseph's College of Arts and Science for Women (Autonomous) Hosur, Tamil Nadu, India

Join Zoom Meeting: https://zoom.us/j/93351187129?pwd=GgcObQSKwkAplzosSRVGGlOY0CaEb4.1

Meeting ID : 933 5118 7129

Passcode : 351753

Chairman : Dr. B. K. Jaleesha, Assistant Professor Mr. K. Vignesh, Assistant Professor, Dr. Buraskorn Nuntadilok,

Time	Paper ID	Paper Title	Presenter's Name
10.30-10.40	ABRL169043	Wiener Fuzzy Neural Optimization through Shape-Aware Channelling in Nonlinear Networks for Sustainable Environment	Dr. JALEESHA B. K
10.40-10.50	ABRL169047	A Wearable System Using Micro:bit and Machine Learning to Monitor Upper-Limb Rehabilitation for Stroke Recovery	Ms. Natpreeya Rerkpreedapong
10.50-11.00	ABRL169048	BEYOND THE BREAK: A MICRO:BIT ASSISTED TRAINING DEVICE FOR LOWER BODY BONE RECOVERY	Mr. RoyIn Na Phatthalung
11.00-11.10	ABRL169049	Flex AI: Smart Knee Rehabilitation	Ms. Nunnapat Romsala
11.10-11.20	ABRL169050	G(AI)T MOBILITY: THE MICRO:BIT ASSISTED GATEWAY FOR LOWER BODY REHABILITATION THROUGH AN INTERACTIVE GAMEPLAY SYSTEM.	Mr. Kanthi Siriangkanon
11.20-11.30	ABRL169055	MICRO:BIT-INTEGRATED INTERACTIVE BRUSHING GLOVE FOR GAMIFIED PEDIATRIC ORAL HYGIENE AND MOTION TRACKING	Ms. Primluck Pisabodintra
11.30-11.40	ABRL169060	Machine Learning Prediction of Susceptible versus Non-susceptible Antimicrobial Susceptibility from Quality-Controlled Inpatient Microbiology Data	Mr. somnuek sinthupuan
11.40-11.50	ABRL169062	Perceived Fairness in Souls-like Combat: A Weak-Point AI System in Unreal Engine 5	Mr. Worathon Taweechaitanasakul
11.50-12.00	ABRL169063	The Development of an Emotion-Responsive Interactive Installation Using Ultrasonic Sensing and Microcontroller-Based Physical Computing	Ms. Nitsara Yeamuthai
12.00-12.10	ABPL269003	Effects of Long-Term Storage on Exosome-Like Nanoparticle Characteristics in Fingerroot Juice	Ms. Intiporn Mingsakul
12.10-12.20	ABPL269008	Enhancing developmental competence and post-thaw quality of in vitro bovine embryos	Ms. Siriphon Suwanna

		through BOEC-derived extracellular vesicles.	
12.20-12.30	ABPL269011	Influence of Meteorological Factors A Case Study of Bangkok and Chiang Mai Thailand	Mr. Thepthiporn Saiuparad
Lunch			
14.30-14.40	ABPL269030	Optimization of Ultrasound-Assisted Extraction of Squalene from Rice Bran Using Response Surface Methodology	Mr. Suttipong Mengyoo
14.40-14.50	ABRL169071	Enhancing Siamese Fighting Fish Performance through PSB-Enriched Moina sp.: Effects on Growth, Coloration, and Water Quality	Ms. Nattasiri Suddoung

Poster Presentation Session On-site at Underbuilding Area, Chulabhorn Building, Faculty of Science, Maejo University

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Chula Phorn Building, Faculty of Science, Maejo University, Chiang Mai, Thailand

Keynote Speaker : Dr. T. Mahalakshmi, Assistant Professor, St. Joseph's College of Arts and Science for Women (Autonomous) Hosur, Tamil Nadu, India

Poster Presentation On-site at Ground Floor, Chulabhorn Building, Faculty of Science, Maejo University

Chairman: Dr. T. Mahalakshmi, Assistant Professor, Dr. M. Sangavi, Dr. M. Mullai, Dr. Dinesh Kumar S, Ph.D.

Time	Paper ID	Paper Title	Presenter's Name
10.30-10.40	ABPS269006	SEGMENT-SPECIFIC IMMUNE MODULATION IN THE OVIDUCTS OF LAYING HENS DURING SALMONELLA ENTERITIDIS INFECTION ASSOCIATED WITH VERTICAL TRANSMISSION RISK	Mr. Thanawut Mangkang
10.40-10.50	ABPS269012	BANGKOK'S MILLION TREES: ASSESSING DIVERSITY AND CLIMATE RESILIENCE	Ms. Warissara Kako
10.50-11.00	ABPS269013	INSECT DIVERSITY AND POTENTIAL ECOSYSTEM SERVICES IN TROPICAL ROOF GARDENS	Ms. Chanikan Saenganurak
11.00-11.10	ABPS269015	EFFECT OF pH ON THE CO-PRECIPITATION OF HUMIC ACID AND SILICA FROM LEONARDITE AND THEIR ELECTRICAL PROPERTIES	Assoc. Prof. Ratchadaporn Puntharod
11.10-11.20	ABPS269016	The potential of biological treatment for Lead (Pb) and Cadmium (Cd) polluted soil	Ms. Khanitha Sawangwatthanagun
11.20-11.30	ABPS269017	Plasticized Corn Husk Cellulose Ester Films: Thermal Behavior and Mechanical Performance	Asst. Prof.Dr. Usarat Ratanakamnuan
11.30-11.40	ABPS269018	MICROWAVE-ASSISTED SYNTHESIS OF NASICON-TYPE $Na_3Zr_2Si_2PO_{12}$: EFFECT OF PROCESSING PARAMETERS ON PHASE FORMATION	Asst. Prof.Dr. Weerinradah Tapala
11.40-11.50	ABPS269019	Design and Fabrication of Bio-Based Hydroquinone Functional Materials from Citrus hystrix Dc. for Antioxidant Performance Enhancement in nonpolar Systems	Asst. Prof. Uthumporn Kankeaw
11.50-12.00	ABPS269020	GC–MS Characterization and Insecticidal Activity of Five Herbal Plants and Their Fermented Mixtures Against Plutella xylostella	Asst. Prof. Supaporn Sangsrichan
12.00-12.10	ABPS269021	Fabrication of Green Composites from Waste Paper-Based Materials for Thermal Insulation Applications"	Mr. porntep janjunatat
12.10-12.20	ABPS269022	ENCAPSULATION OF PHENOLIC COMPOUNDS FROM STROBILANTHES CUSIA LEAVES AND CHARACTERIZATION	Assoc. Prof.Dr. Thitiphan Chimsook
12.20-12.30	ABPS269023	ENCAPSULATION OF BEETROOT EXTRACT USING SODIUM ALGINATE/SODIUM ALGINATE-CASEIN SODIUM SALT: STUDY OF PHYSICAL AND CHEMICAL PROPERTIES	Assoc. Prof.Dr. Thitiphan Chimsook

Lunch			
14.30-14.40	ABPS269024	Green Chemistry Approach to Herbal Oil Production from Thai Medicinal Plants: Physicochemical and Fatty Acid Analysis	Asst. Prof.Dr. ANAKHAORN SRISAIPET
14.40-14.50	ABPS269025	FACILE SYNTHESIS OF CEO_2 NANOFIBER/F-MXENE NANOCOMPOSITES WITH ENHANCED STRUCTURAL INTEGRATION FOR ADVANCED FUNCTIONAL APPLICATIONS	Ms. Sirorat Moollor
14.50-15.00	ABPS269026	PROTEIN FINGERPRINTING OF MAY WILD HONEY (Apis dorsata) FROM MULTIPLE GEOGRAPHIC ORIGINS: A THREE-YEAR PROTEOMIC PROFILING STUDY	Dr. Ekawit Threenet
15.00-15.10	ABPS269027	Biocatalytic Reduction of Carbonyl Compounds by Purple Plants	Dr. Piyatida Klumphu
15.10-15.20	ABPS269028	Enhancing the Properties of Poly(lactic acid)/Poly(e-caprolactone)/Polyhedral Oligomeric Silsesquioxane Blend-Nanocomposites	Dr. Sairoong Muangpil
15.20-15.30	ABPS269029	Molecular Characterization and Structural Analysis of Flavonoid Biosynthetic Genes and a Putative CaF3'5'H in Curcuma alismatifolia 'Blue-Tung'	Asst. Prof. Naruemon Khemkladngoen
15.30-15.40	ABPS269031	Aqueous EDLC-Type Capacitor Using Activated-Carbon-Coated Aluminum Current Collectors	Assoc. Prof. Chupong Pakpum
15.40-15.50	ABPS269032	Unusual Variations of the Foramen Rotundum: Anatomical Findings and Clinical Significance	Dr. Piyakarn Boontem Matusiak
15.50-16.00	ABRS169036	Mathematical Modeling of Vital Organ Failure and Treatment Outcomes with Lindley Distribution	Dr. MAHALAKSHMI T

Plasticized Corn Husk Cellulose Ester Films: Thermal Behavior and Mechanical Performance

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Keywords: Corn husk, Cellulose, Cellulose Ester, Plasticizer, Thermal properties, Mechanical properties

Abstract. Corn husk cellulose ester films were produced as sustainable polymer materials, and their mechanical and thermal properties were tailored through the incorporation of plasticizers. Cellulose was first extracted from corn husk using delignification, bleaching, and acid hydrolysis and then esterified with lauroyl chloride to yield cellulose laurate. The modified cellulose was then solvent cast into films using glycerol, dibutyl phthalate (DBP), and triethyl citrate (TEC) as plasticizers at concentrations ranging from 1 to 10 wt%. The effects of plasticizers on the thermal and mechanical properties of corn husk cellulose ester films were investigated. The degradation temperature (Td) of the cellulose ester film was 219°C. Plasticizer addition generally reduced thermal stability due to enhanced chain mobility and decreased intermolecular interactions. However, low glycerol contents (1-2 wt%) slightly improved Td, possibly due to improved molecular compatibility and dispersion within the polymer matrix. Mechanical testing revealed that increasing plasticizer content reduced tensile strength and Young's modulus while improving film flexibility. Additionally, films with low glycerol contents (1-2 wt%) demonstrated improved elongation at break, indicating an acceptable balance between strength and ductility. These results indicate that plasticizer addition plays an important role in regulating the performance of cellulose ester films, paving the way for the production of flexible and sustainable biopolymer materials derived from agricultural waste.

Introduction

Development of biodegradable materials based on cellulose has become a very attractive option since cellulose is an abundant natural polymer with outstanding properties and a wide variety of applications. Cellulose is a renewable material that can be obtained from agricultural waste. In particular, agricultural residues such as corn husk represent an attractive low-cost feedstock for cellulose extraction and value-added material development. However, native cellulose has a semi-crystalline structure and strong inter- and intramolecular hydrogen bonds, which lead to low solubility and restricted processability. Furthermore, cellulose decomposes before melting, which limits its direct applicability in thermoplastic processes. To solve such limitations, cellulose is frequently modified into derivatives such as esters and ethers, which improve thermal performance and allow film production using solution-based methods. Cellulose laurate was effectively produced from corn husk cellulose in earlier research [1], proving that using agricultural waste to produce functional biopolymers is practical.

However, compared to conventional synthetic polymers, the tensile characteristics of cellulose laurate films made from corn husk in this study were rather poor. Since cellulose ester films inherently brittle and exhibit limited flexibility, improving their ductility and processability remains a major challenge. The usual approach to improving the flexibility and ductility of biopolymer corn husk cellulose laurate film is to add a plasticizer, which is a low molecular weight nonvolatile substance, into the film to reduce biopolymer chain-to-chain interactions, thereby resulting in improved film flexibility and stretchability. The plasticizer will interfere itself between the polymer chains and interact with the forces held together by extending and softening the polymer matrix [2].

A variety of plasticizers have been used in polymer systems, including phthalate esters, citrate esters, and glycol derivatives [3-4]. Traditional phthalate-based plasticizers have been widely used due to their effectiveness, however, concerns about their environmental and health effects resulted in an increased interest in safer and more sustainable alternatives. The use of eco-friendly natural or biodegradable plasticizers like glycerol or TEC in substitution of conventional plasticizers is a concern [4-5]. However, the influence of various plasticizers on the performance of cellulose ester films generated from agricultural biomass is not entirely clarified.

In this study, cellulose laurate films derived from corn husk were altered by adding various plasticizers, such as glycerol, DBP, and TEC. The effects of plasticizers on thermal and mechanical properties of cellulose laurate films from corn husk were investigated. This research aims to illuminate the role of plasticizer in enhancing the performance of cellulose-based films, thereby contributing to the creation of sustainable and flexible biopolymer materials.

Materials and Methods

Materials Corn husk was gathered from a nearby field at Maejo University in Chiang Mai, Thailand, and utilized as a source of cellulose. Sodium hydroxide (97%), hydrochloric acid (37%), toluene (99.5%), and chloroform (≥99%) were purchased from RCL Labscan (Thailand). Pyridine (99.5%), lauroyl chloride (98%), and triethyl citrate (98%) were purchased from Merck (Germany). Hydrogen peroxide (35%) was supplied by QReC (Asia). Glycerol (99.5%) and dibutyl phthalate (99.8%) were obtained from Ajax Finechem and Sigma Aldrich, respectively. All chemicals were used as received without further purification.

Extraction of Corn Husk Cellulose The alkali treatment was performed to purify the cellulose by removing lignin and hemicellulose from corn husk fiber. The corn husk fiber was treated with an alkali solution (0.5 M NaOH) at 80°C for 4 h to remove lignin and hemicellulose. Following alkali treatment, the bleaching process was completed by adding 5 v% H_2O_2 in alkaline medium. After bleaching, the fibers were hydrolyzed for 2 h under reflux using 2.0 N HCl. The hydrolyzed material was washed with distilled water until neutral pH and dried at 60°C overnight.

Synthesis of Cellulose Ester Corn husk cellulose (2.0 g) was suspended in 50 ml of toluene medium under constant stirring at room temperature for 30 min. Then, excess lauroyl chloride (10 ml) and 5 ml of pyridine were added to the mixture. The reaction mixture was refluxed under continuous stirring for 12 h. At the end of the reaction, 100 ml of ethanol was added to quench the reaction. The mixture was vacuum-filtered over fritted glass, and the solid was thoroughly washed several times with ethanol. Finally, the corn husk cellulose ester was dried at 60°C overnight to constant weight and stored in a desiccator at room temperature.

Preparation of Cellulose Ester Film Plasticized corn husk cellulose ester films were prepared using different concentrations (1-10 wt%) of plasticizers (glycerol, DBP, and TEC) by the solvent casting technique. Cellulose laurate (2.0 g) was dissolved in 20 ml of chloroform, followed by the addition of plasticizers. The solution of cellulose ester polymers solubilized in chloroform was evenly poured and spread on a glass plate maintained under ambient laboratory conditions (Chiang Mai, Thailand) for 24 h to allow complete solvent evaporation. The dried films were peeled off and stored in a desiccator prior to testing. Film thickness was measured using a micrometer at multiple positions and used in mechanical property calculations. To assure repeatability, all film preparations were conducted three times.

Thermal Analysis Thermogravimetric analysis (TGA) was performed using a Thermoplus TG1820 analyzer. Approximately 20 mg of sample was heated from 25 to 600°C at a heating rate of 10°C/min under a nitrogen atmosphere.

Mechanical Properties Tensile properties of the films were evaluated using a LLOYD LF Plus universal testing machine equipped with a 50 N load cell, following the ASTM D882 standard. Film specimens (0.8 × 7.5 cm) were tested at a crosshead speed of 5 mm/min at room temperature. Film thickness was measured at three different positions using a micrometer, and the average value was used for calculations. Each formulation was tested in five replicates, and the results are reported as mean values ± standard deviation. Data variability was evaluated to ensure reproducibility of the measurements.

Result and Discussion

Physical Appearance of Corn Husk Cellulose Films. The physical appearance of unplasticized and plasticized cellulose laurate films is presented in Fig.1–4. The unplasticized film (Fig. 1) exhibited a transparent and relatively smooth surface with minor air bubbles, which can be attributed to solvent evaporation during the casting process. The average corn husk cellulose film thickness was approximately 110 µm. There were visible changes in the morphology of the film upon the addition of plasticizers (glycerol, DBP, and TEC). As the concentration of plasticizer increased, the plasticized films (Fig. 2–4) progressively became less uniform and more opaque. This occurrence can be attributed to the possible micro-heterogeneity caused by the presence of plasticizer molecules in the polymer matrix. Transparency is decreased when cellulose ester chains' intermolecular connections are disrupted, causing changes in refractive index. This behavior is consistent with previous reports, where increased plasticizer content led to the formation of heterogeneous and porous microstructures, resulting in enhanced light scattering and higher opacity. [6].

Additionally, the thickness of the plasticized films was higher than that of the unplasticized film, with values between 130-250 µm. This increase can be explained by the presence of plasticizers, which improve chain mobility and decrease intermolecular cohesion, resulting in less compact film formations during solvent evaporation. The increase in film thickness with increasing plasticizer content has been widely reported and is attributed to the ability of plasticizer molecules to occupy intermolecular spaces, thereby increasing the distance between polymer chains and reducing structural compactness [7-8]. In addition, hydrophilic plasticizers such as glycerol can promote water retention and swelling within the polymer matrix, further contributing to thickness enhancement [9-10].

Interestingly, films plasticized with TEC exhibited apparent shrinkage at higher concentrations (Fig. 4). This behavior may be related to the limited compatibility between the relatively bulky TEC molecules and the cellulose laurate matrix. Due to differences in molecular size and polarity, the incorporation of TEC at elevated concentrations may result in a less uniform distribution within the polymer network. The lack of compatibility between the plasticizer and the cellulose matrix induces internal stresses, resulting in film distortion or shrinkage as the solvent evaporates during the casting process.

Glycerol-plasticized films, on the other hand, showed comparatively higher homogeneity at low concentrations, indicating better compatibility with the cellulose ester matrix. Overall, the observed changes in physical appearance show that plasticizer type and concentration have a considerable impact on film morphology, which is probably to affect subsequent thermal and mechanical properties.

Fig. 1 Physical appearance of unplasticized corn husk cellulose laurate film

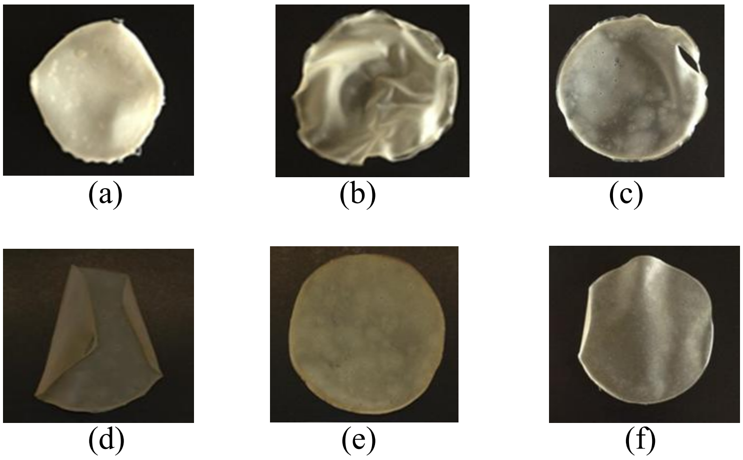


Fig. 2 Physical appearance of corn husk cellulose laurate film plasticized with (a) 1 wt% of glycerol, (b) 2 wt% of glycerol, (c) 4 wt% of glycerol, (d) 6 wt% of glycerol, (e) 8 wt% of glycerol, and (f) 10 wt% of glycerol, respectively.

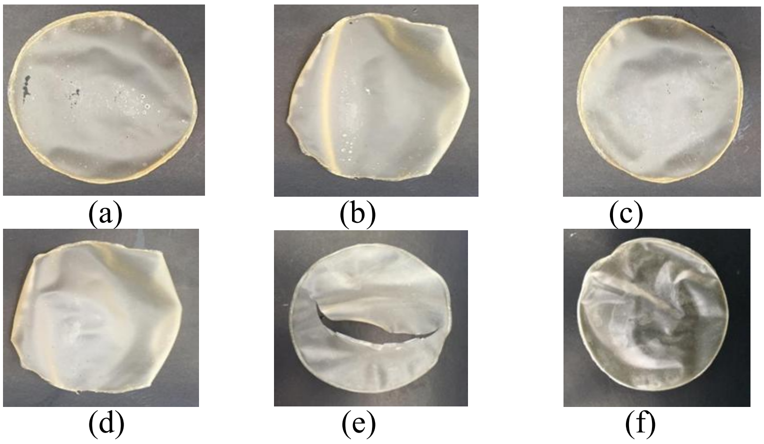


Fig. 3 Physical appearance of corn husk cellulose laurate film plasticized with (a) 1 wt% of DBP, (b) 2 wt% of DBP, (c) 4 wt% of DBP, (d) 6 wt% of DBP, (e) 8 wt% of DBP, and (f) 10 wt% of DBP, respectively.

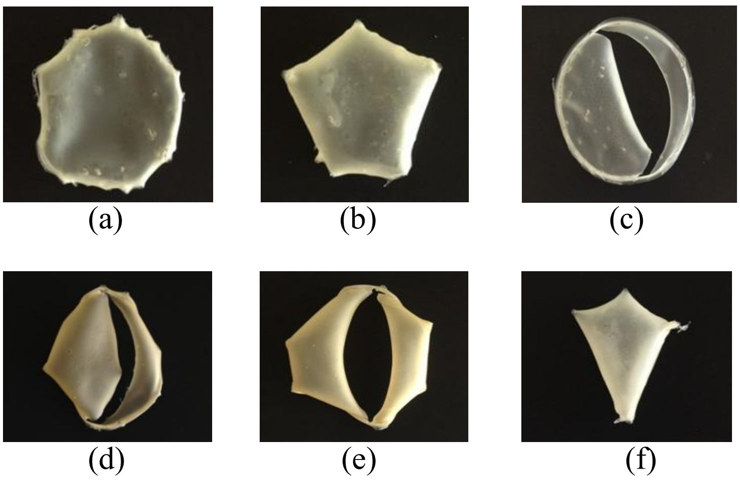


Fig. 4 Physical appearance of corn husk cellulose laurate film plasticized with (a) 1 wt% of TEC, (b) 2 wt% of TEC, (c) 4 wt% of TEC, (d) 6 wt% of TEC, (e) 8 wt% of TEC, and (f) 10 wt% of TEC, respectively.

Thermal Analysis. Thermal stability of plasticized cellulose laurate films was evaluated using thermogravimetric analysis (TGA), and the degradation temperature (T_d) values are summarized in Table 1 and illustrated in Fig. 5. The T_d of unplasticized cellulose ester film was 219°C, which was used as a reference point. The effect of plasticizer type and content on the thermal stability of cellulose laurate films is shown in Table 1. The results show that plasticized films degraded at lower temperatures than unplasticized samples. As a result, the use of plasticizers reduced the thermal stability of corn husk cellulose ester film. This behavior is related to increased molecular mobility and reduced intermolecular interaction within the polymer matrix of plasticized films. An interesting pattern was found for the films plasticized with glycerol. At low concentrations of glycerol addition (1-2 wt%), the T_d of cellulose ester film increased from 219°C to 229°C and 226°C, respectively. This result suggests a possible stabilizing impact, which might be caused by increased intermolecular interactions or glycerol dispersion within the polymer matrix. However, glycerol-plasticized cellulose laurate film shows a significant decrease in Td at higher concentrations (≥4 wt%), reaching a low of 152°C at 6 wt%. This observed pattern indicates that the hydrogen bonds in the cellulose structure are weakened by excessive glycerol, resulting in a decrease in thermal stability.

On the other hand, films plasticized using TEC and DBP showed a consistent decrease in thermal stability as the plasticizer content increased. T_d for cellulose laurate film plasticized with DBP gradually decreased from 209°C at 1 wt% to 164°C at 10 wt%, whereas TEC-plasticized films exhibited a similar trend, decreasing from 213°C to 162°C over the same concentration range. The decrease in T_d resulting from the presence of plasticizer is often reported in polymeric films. This behavior is explained by the decreased intermolecular hydrogen bonding and increased chain mobility due to the plasticizer, resulting in a decrease of thermal decomposition [7, 11-12].

At higher concentrations of three plasticizers, glycerol showed the most obvious decline in thermal stability, whereas DBP and TEC displayed more gradual and consistent effects. This variation can be attributed to the interaction between molecule size and plasticizing efficiency of plasticizer. The small molecular size and high polarity of glycerol allow it to penetrate the polymer network rapidly, effectively breaking intermolecular cohesion and enhancing chain mobility. As a result, glycerol-plasticized films showed improved physical homogeneity at low concentrations, but their high plasticizing efficiency caused their thermal stability to decline progressively.

TEC and DBP, on the other hand, responded differently due to their very large structures. Physical shrinkage and visible phase separation resulted from TEC's poor compatibility with the hydrophobic cellulose laurate matrix, especially at higher loads. However, their bulky structure limited their capacity to penetrate the polymer matrix as deeply as glycerol, resulting in a more modest and gradual decrease in T_d.

Table 1 Degradation temperature (T_d, °C) of plasticized cellulose laurate film at different concentrations of plasticizer

Concentration of plasticizer (wt%)	Degradation temperature (T_d, °C)		
	Plasticized film with glycerol	Plasticized film with DBP	Plasticized film with TEC
0	219	219	219
1	229	209	213
2	226	200	208
4	190	197	190
6	152	192	181
8	165	178	167
10	180	164	162

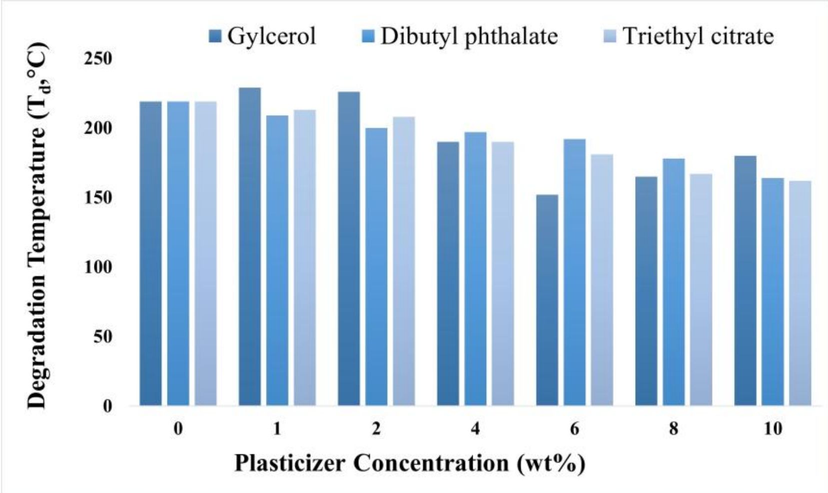


Fig. 5 Degradation temperature (T_d, °C) of plasticized cellulose laurate film at different concentrations of plasticizer

Mechanical Properties. The impact of plasticizer type and concentration on mechanical performance was examined by analyzing the tensile characteristics of cellulose laurate films. The film specimens used for tensile testing have a consistent size of 7.5 × 0.80 cm, ensuring consistency in mechanical data (Fig. 6). The variation of tensile strength, Young's modulus, and elongation at break as a function of plasticizer type and content is presented in Fig. 7(a–c). The unplasticized cellulose ester film showed tensile strength, Young's modulus, and elongation at break at 10.73±1.18 MPa, 341.50±11.73 MPa, and 15.58±4.00%, respectively. Due to strong intermolecular interactions within the cellulose structure molecule, the films demonstrated high stiffness, suggesting a rigid character.

The findings demonstrate that the addition of plasticizers had a substantial impact on the films' mechanical characteristics after plasticization. The tensile strength of cellulose ester films gradually decreased as the plasticizer content increased for all plasticizer types, as seen in Fig. 7(a). Young's modulus values illustrated the same trend as present in Fig. 7(b). The decrease in tensile strength and Young's modulus can be attributed to the interference of plasticizer molecules with the intermolecular hydrogen bonding between cellulose laurate chains. The plasticizers enhance the free volume in the polymer matrix and reduce the density of intermolecular interactions by filling up the space between polymer chains. This result suggests that plasticizer incorporation enhances chain mobility and reduces the stiffness of the polymer films [11]. They reported that the addition of plasticizers to bio-based films leads to a decrease in tensile strength due to the weakening of the polymer-polymer interactions. Similarly, Teixeira et al. [7] observed that the incorporation of glycerol and TEC into cellulose acetate films significantly diminished their mechanical properties while enhancing their flexibility. DBP and TEC showed a more gradual reduction in modulus compared to glycerol, suggesting differences in molecular size and interaction strength with the polymer matrix.

In contrast to the tensile strength and Young's modulus, the elongation at break result showed a different pattern (Fig. 7(C)). The experimental results indicated that only the addition of glycerol at low concentrations (1-2 wt%) successfully improved the elongation at break and total flexibility of the cellulose ester films, despite the fact that the use of plasticizers typically attempts to improve ductility. This initial increase suggests that, at low loading, glycerol effectively intercalates between the polymer chains, enhancing chain mobility. However, as the glycerol concentration increased beyond 2 wt%, a notable decline in elongation was observed. This reduction can be attributed to the anti-plasticization effect, where excessive plasticizer molecules may restrict rather than facilitate chain movement under certain conditions. This result is in accordance with earlier research by Sanyang et al. [11] and Sahari et al. [13], which found that a high glycerol content in bio-based polymer films can cause a notable reduction in elongation at break because of phase separation or polymer matrix saturation. At low glycerol content (1-2 wt%), an optimal balance between intermolecular interaction and chain mobility is achieved, resulting in both improved flexibility and slightly enhanced thermal stability. However, at higher concentrations, excessive glycerol disturbs hydrogen bonding and promotes phase separation, resulting in a decrease in both thermal stability and mechanical properties.

In the case of DBP and TEC, the elongation at break declined gradually across all concentrations, failing to achieve the expected plasticizing effect. This behavior can be explained by either anti-plasticization or phase separation resulting from the structural incompatibility between these bulky plasticizers and the cellulose laurate matrix. Due to their larger molecular size and different polarity, DBP and TEC molecules may aggregate instead of dispersing uniformly. These are isolated and act as stress concentrators within the film structure, encouraging crack initiation and brittle failure, resulting in a decrease in the elasticity of the films.

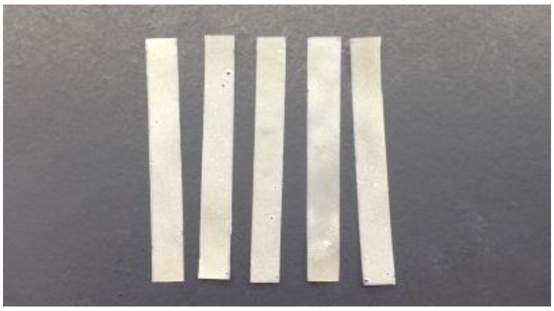
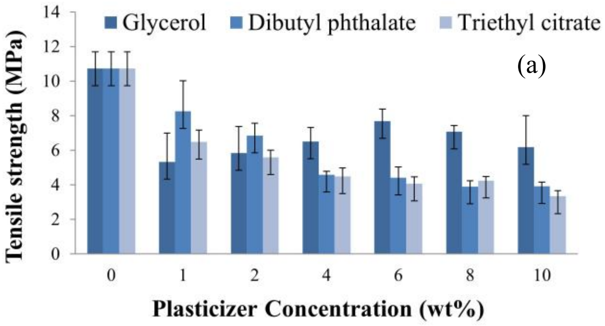
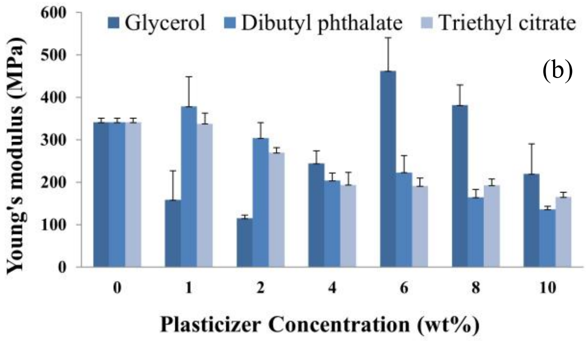


Fig. 6 Cellulose ester film with the dimension of 7.5 x 0.80 cm





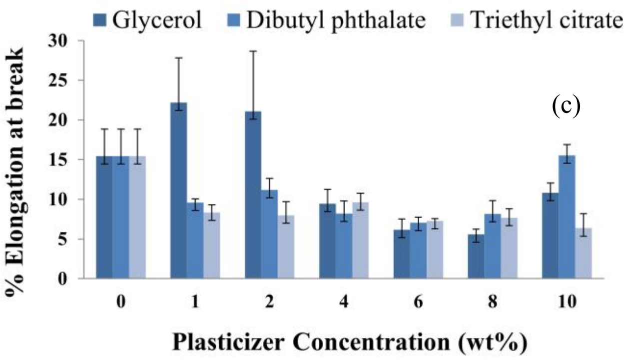


Fig. 7 (a) Tensile strength, (b) Young's modulus, and (c) %elongation at break of cellulose ester films at various additive types and contents.

Conclusion

The successful production of cellulose ester films made from corn husk as sustainable biopolymer materials is demonstrated in this work. Plasticizers were incorporated to tailor the mechanical and thermal properties of the films. The results reveal that both the type and concentration of plasticizer play a critical role in determining film structure and performance. The addition of plasticizer significantly altered the physical properties of cellulose ester films, resulting in increased thickness, opacity, and structural heterogeneity. These changes are related to reduction in intermolecular interactions and partial phase separation within the cellulose ester chain structure.

A thermal study revealed that the incorporation of plasticizers further decreased thermal stability, although low glycerol content (1-2 wt%) showed a slight stabilizing effect, suggesting improved molecular compatibility.

For mechanical properties, plasticization resulted in reduced tensile strength and Young's modulus due to increased chain mobility and free volume. Notably, glycerol at low concentrations provided an optimal balance between flexibility and strength by enhancing elongation at break, whereas higher concentrations and other plasticizers (DBP and TEC) led to reduced extensibility due to anti-plasticization effects and phase separation.

Overall, this work highlights the importance of plasticizer selection in tailoring the structure–property relationships of cellulose-based films. The results provide valuable insight into the design of sustainable and flexible biopolymer materials for potential packaging applications.

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Plasticized Corn Husk Cellulose Ester Films: Thermal Behavior and Mechanical Performance

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ABSTRACT

Corn husk cellulose ester films were produced as sustainable polymer materials, and their mechanical and thermal properties were tailored through the incorporation of plasticizers. Cellulose was first extracted from corn husk using delignification, bleaching, and acid hydrolysis and then esterified with lauroyl chloride to yield cellulose laurate. The modified cellulose was then solvent cast into films using glycerol, dibutyl phthalate (DBP), and triethyl citrate (TEC) as plasticizers at concentrations ranging from 1 to 10 wt%. The effects of plasticizers on the thermal and mechanical properties of corn husk cellulose ester films were investigated. The degradation temperature (T_d) of the cellulose ester film was 219°C. Plasticizer addition generally reduced thermal stability due to enhanced chain mobility and decreased intermolecular interactions. However, low glycerol contents (1-2 wt%) slightly improved T_d, possibly due to improved molecular compatibility and dispersion within the polymer matrix. Mechanical testing revealed that increasing plasticizer content reduced tensile strength and Young's modulus while improving film flexibility. Additionally, films with low glycerol contents (1-2 wt%) demonstrated improved elongation at break, indicating an acceptable balance between strength and ductility. These results indicate that plasticizer addition plays an important role in regulating the performance of cellulose ester films, paving the way for the production of flexible and sustainable biopolymer materials derived from agricultural waste.

Introduction

From Agricultural Waste to Sustainable Biopolymer Film

The growing environmental concerns over conventional plastics have driven the search for sustainable and biodegradable materials. Cellulose, an abundant natural polymer obtained from agricultural waste, is a promising candidate for green materials. Corn husk, a widely available residue, is an attractive source of cellulose for value-added applications.

Why modified cellulose?

Native cellulose has strong inter- and intramolecular hydrogen bonding and a semi-crystalline structure.

- Insoluble in most common solvents
- High crystallinity → low processability
- Decomposes before melting → not suitable for thermoplastic processing

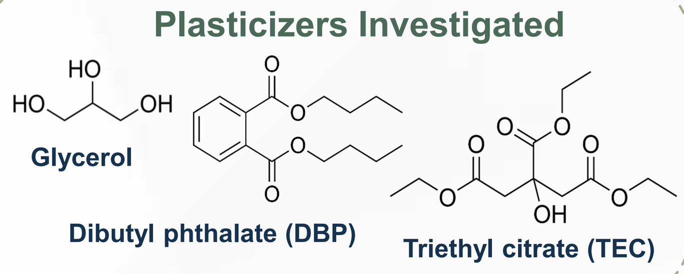
Solution: Convert cellulose to derivatives (e.g., esters) to improve processability and enable film formation through solvent casting

The role of plasticizers

Cellulose ester films are inherently brittle and exhibit limited flexibility. Eco-friendly natural or biodegradable plasticizers (low molecular weight, nonvolatile compounds) are added to:

- Interfere between polymer chains
- Reduce chain-to-chain interactions
- Increase flexibility and ductility

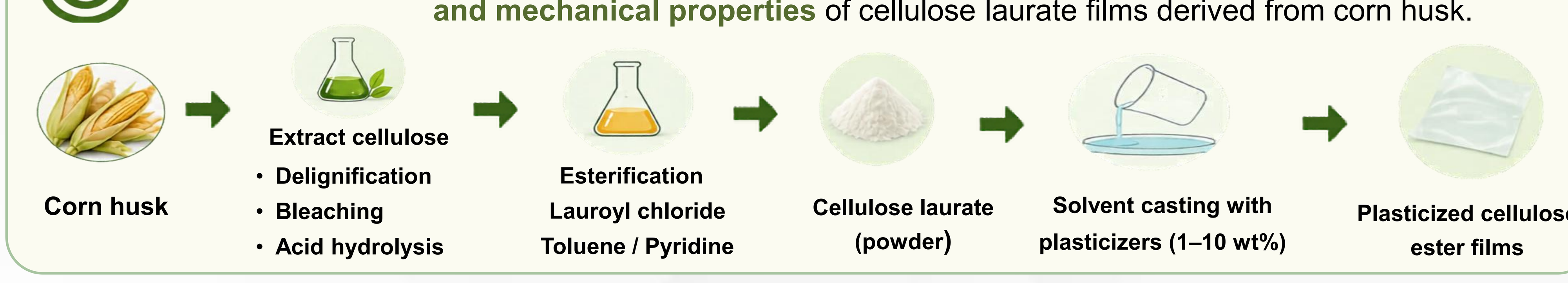
Plasticizers Investigated



Glycerol
Dibutyl phthalate (DBP)
Triethyl citrate (TEC)

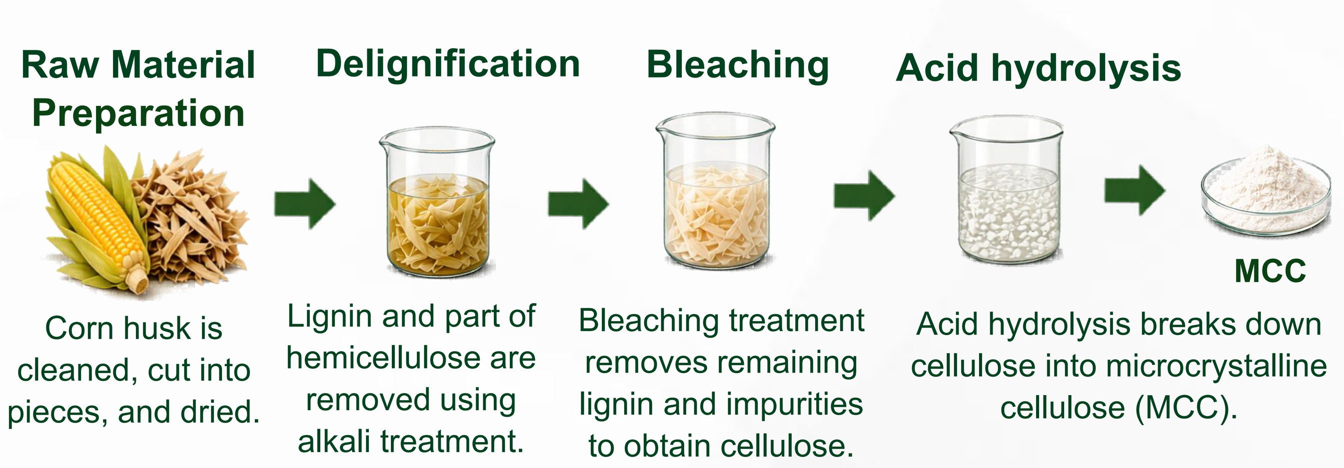
OBJECTIVE

To investigate the influence of **plasticizer type and concentration** on the **thermal and mechanical properties** of cellulose laurate films derived from corn husk.

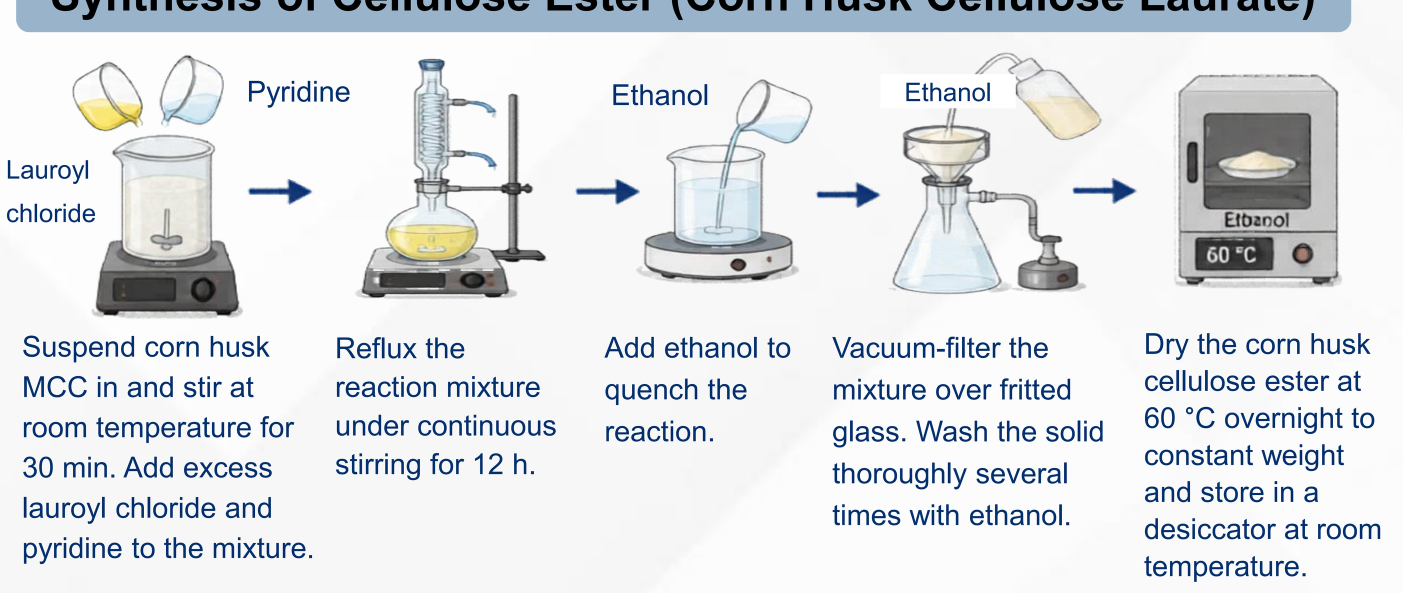


Material and Methods

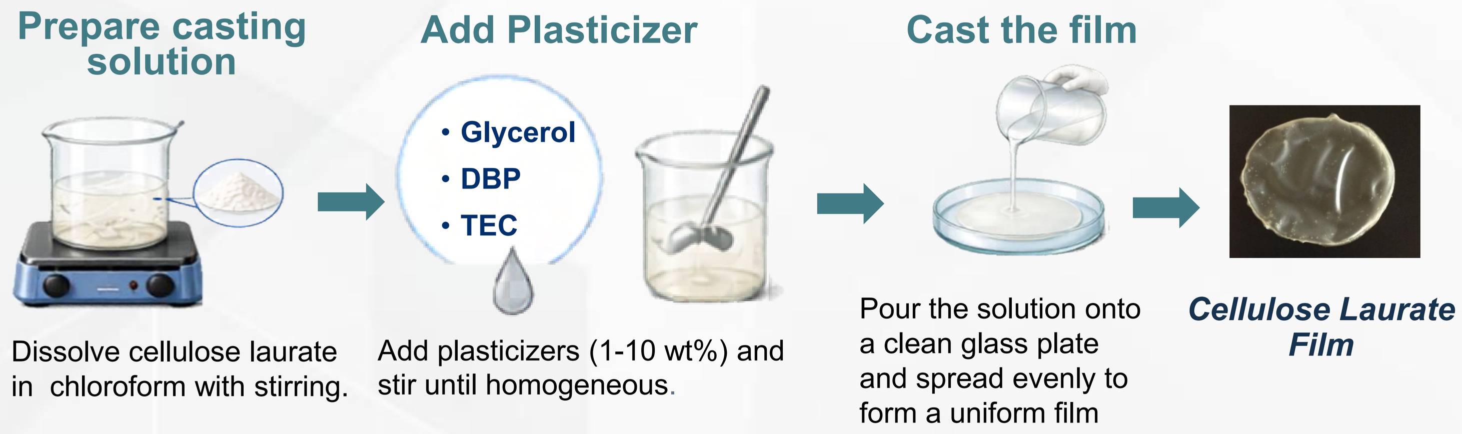
Extraction of microcrystalline cellulose from corn husk



Synthesis of Cellulose Ester (Corn Husk Cellulose Laurate)



Preparation of Corn Husk Cellulose Laurate Films (Solvent Casting Method)



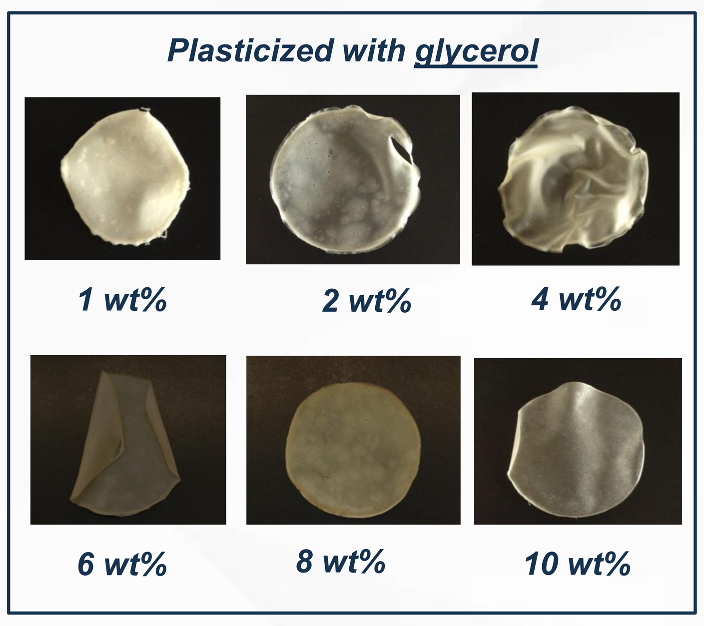
Characterization and Testing of Cellulose Laurate Films

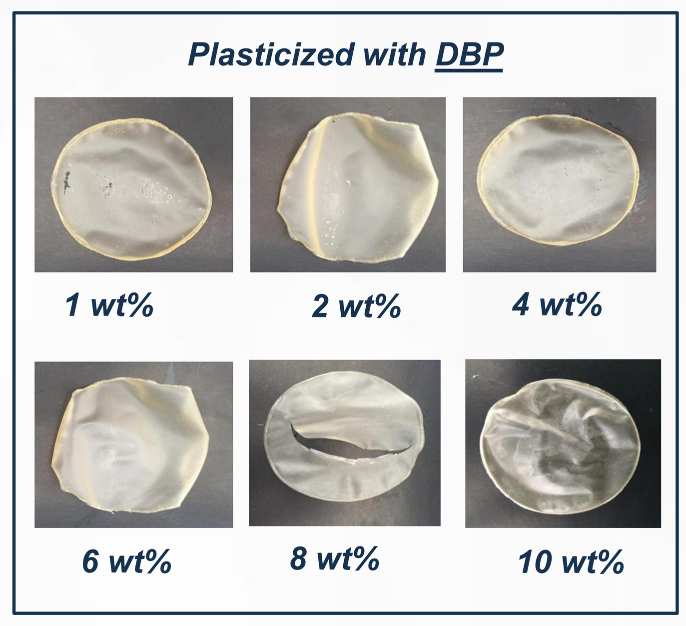
- Physical Appearance
- Tensile Properties
- Thermal Properties: TGA

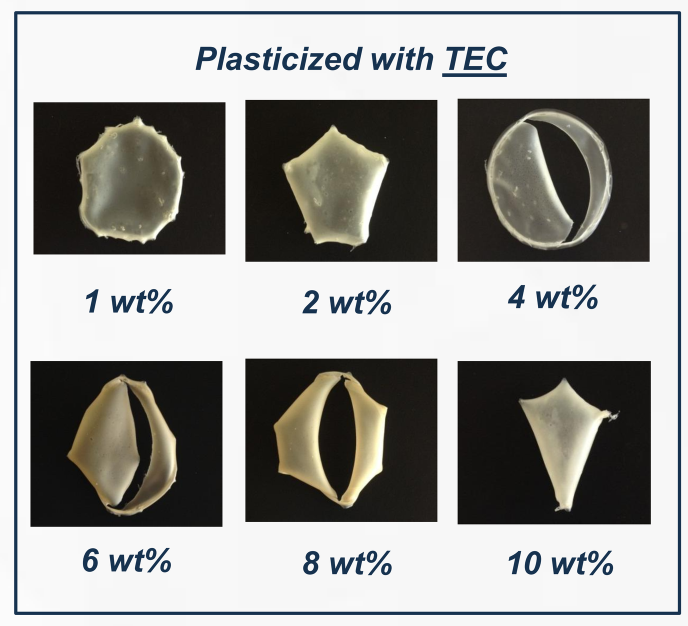
Results & Discussion

Physical Appearance of Corn Husk Cellulose Films

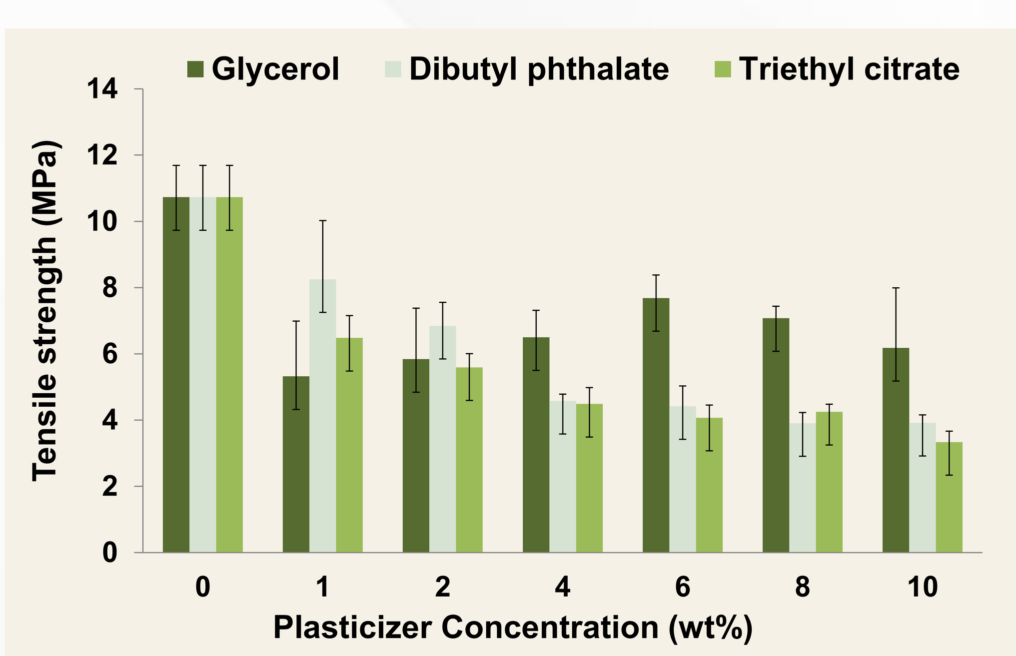
Cellulose laurate film without plasticizer

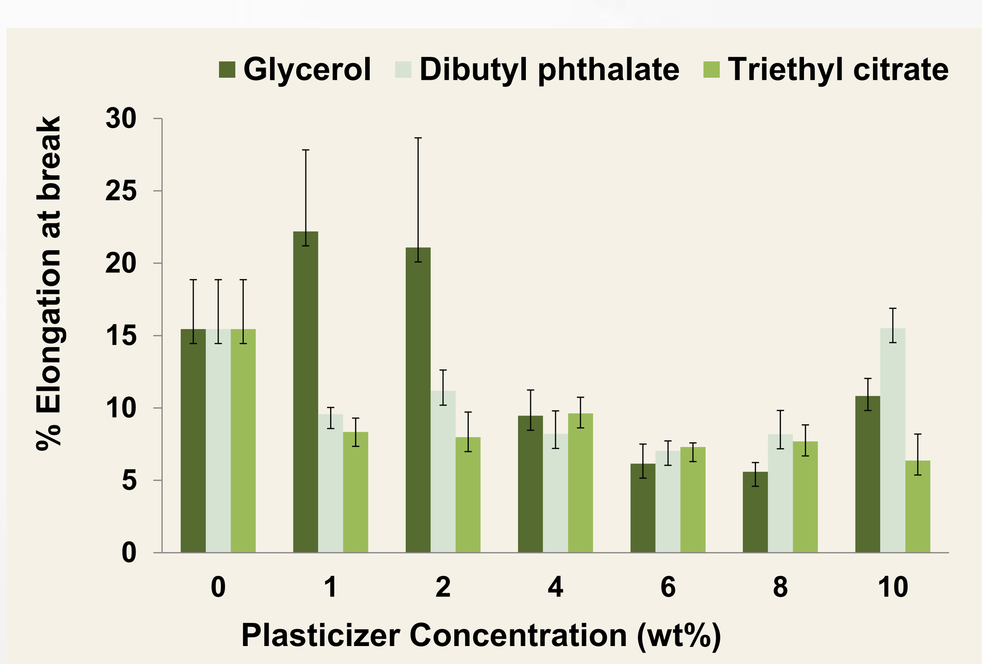


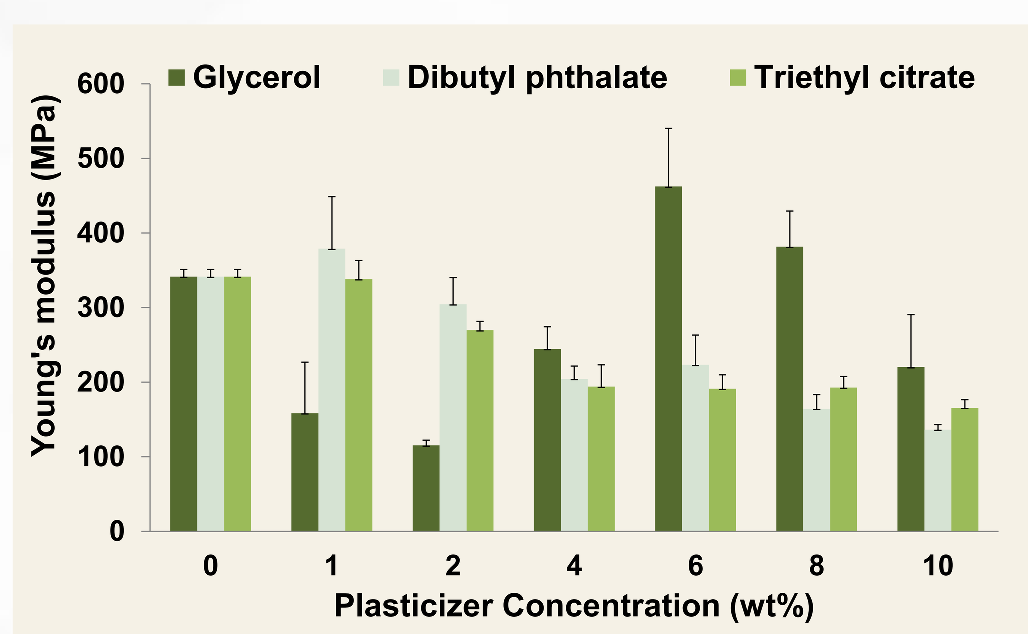


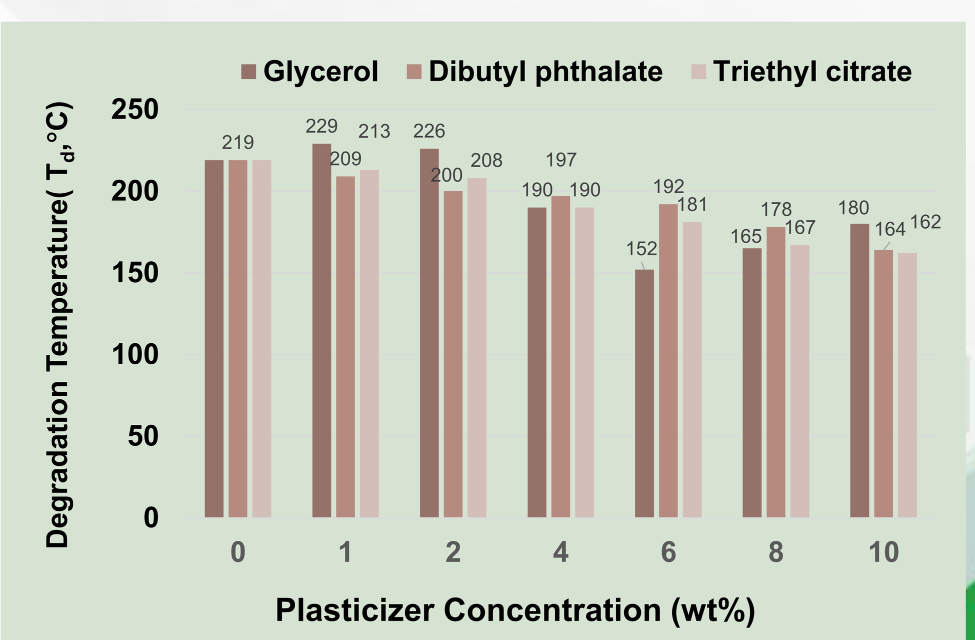


Effect of Plasticizer on Mechanical and Thermal Properties









Conclusion

- Corn husk cellulose was successfully converted into cellulose laurate films.
- Plasticizer type and concentration strongly influenced film structure, thermal stability, and mechanical properties.
- Low glycerol content (1-2 wt%) provided the best balance between flexibility and thermal stability.
- Excessive plasticizer loading reduced tensile strength and thermal stability.
- The films show potential as sustainable biodegradable packaging materials.