

# International Journal of Applied Engineering Research (IJAER)

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✦ [Editorial Board Members](#)

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✦ [Vol. 2 No.1 No.2 No.3 No.4](#) (2007)

- ✚ [Vol. 3 No.1 No.2 No.3 No.4 No.5 No.6 No.7 No.8 No.9 No.10 No.11 No.12 \(2008\)](#)
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- ✚ [Vol. 6 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23-24 \(2011\)](#)
- ✚ [Vol. 7 No.1 2 3 4 5 6 7 8 9 10 11 12 \(2012\)](#)
- ✚ [Vol. 8 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 \(2013\)](#)
- ✚ [Vol. 9 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2014\)](#)
- ✚ [Vol.10 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2015\)](#)
- ✚ [Vol.11 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2016\)](#)
- ✚ [Vol.12 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2017\)](#)
- ✚ [Vol.13 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2018\)](#)
- ✚ [Vol.14 No.1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 \(2019\)](#)
- ✚ [Vol.15 No.1 2 3 4 5 6 7 8 9 10 11 12 \(2020\)](#)
- ✚ [Vol.16 No.1 No.2 No.3 No.4 No.5 No.6 No.7 No.8 No.9 \(2021\)](#)
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**Area of Interest :** Image processing, Computer Network

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**Area of Interest :** Image processing, Pattern recognition deep learning, machine learning

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**Area of Interest :** Theory of computation, Computer Networks, Advanced Computer Architecture, Operating Systems, Computer Programming, Network Security, Object Oriented Analysis and Design and Data Base Management System

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**Area of Interest :** Digital Communication, Wireless Communication and M  
Tech Information Theory and Coding

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Area of Interest: I Device structure and materials for sub-0.5V voltage  
operation, I Scaling-down enabling technology, I Low-power, high-speed  
devices and circuits.

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assist technology. Pattern Recognition, Robotic.

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Area of interest: mechanics of materials, experimental mechanics,  
mechanical testing, structural analysis of MEMS.

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Spintronics, High pressure, Dynamics.

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Area of Interest: Random vibration, Seismic response of mechanical system,  
Approximate analysis of nonlinear vibration.

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Area of Interest: CFD (Computational fluid dynamics), energy and resources  
engineering, and systems ecology.

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Area of interest: Turbulence Modeling, Porous Media, Combustion in Porous Media, Numerical Methods, Finite Volume.

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Area of Interest: Computational Fluid Dynamics, Aerodynamics, Turbulence Gas dynamics, Computational Nanotechnology.

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Area of interest: Concrete material and durability, Recycling construction materials, reliability assessment of structures.

**S.Z. Kassab**, Mechanical Engineering Department, Faculty of Engineering, Alexandria University, Alexandria, 21544 **Egypt**  
Area of Interest : Experimental Fluid Mechanics, Lubrication, Energy, Environment and Pollution.

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Area of Interest: Nanomagnetism, Superconductivity.

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Area of Interest: Transport phenomena in microscale multiphase flows, micro sensors and actuators, optical diagnostics and instrumentation.

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**Area of Interest:** Applications of State Estimation to Electric Power Systems, Fuzzy and Neural System Applications to Electric Power Systems.

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Area of Interest: structural safety and reliability; analysis, design, and assessment of reinforced concrete and steel structures.

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**Mohammad Valipour**, Department of Irrigation and Drainage Engineering, College of Abureyhan, University of Tehran, Pakdasht, Tehran, **Iran**

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Area of Interest : Computer and network security, it management, digital



forensics, cryptocurrency, blockchain

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# International Journal of Applied Engineering Research (IJAER)

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Volume 11, Number 7 (2016)

## CONTENTS

**Axial Compressive Behavior of Square Concrete Columns Externally  
Collared by Light Structural Steel Angle Sections**

pp 4655-4666

Pamuda Pudjisuryadi, Tavio and Priyo Suprobo

**The effect of Electromagnetic Stirring during Solidification on the Copper  
Structure**

pp 4667-4675

B. Hamri

**Binding Energy of Subatomic States of Hydrogen**

pp 4676-4678

Vladimir K. Nevolin

**Design and Optimization of Rectangular Microstrip Patch Array Antenna  
Using Frequency Selective Surfaces for 60 GHz**

pp 4679-4687

Ehab Dheyab and Nidal Qasem

**Measuring and Strengthening Well-being at Regional Level in OECD  
Countries: Application of the QCA Method**

pp 4688-4699

Young-Chool Choi and Ji-Hyun Jang

**Simulation of Soil Water Retention Curve using Artificial Neural  
Networks with Pseudocontinuous Pedotransfer Functions**

pp 4700-4706

M. Adams Joe and P. Rajesh Prasanna

**On Secure Convex and Restrained Convex Domination in Graphs**

pp 4707-4710

Carmelita M. Loquias and Enrico L. Enriquez

**Prediction of Daylight Availability For Visual Comfort**

pp 4711-4717

Sandhyalaxmi G Navada, Chandrashekhara S Adiga and Savitha G Kini

**An enhancement crypto-compression scheme for image Based on chaotic  
system**

**pp 4718-4725**

**Manel Dridi, Bekgacen Bouallegue, Mohaned Ali Hajjaji and Abdellatif Mtibaa**

**[Application of Inquiry-Based Science Assessment Questions on Earth Science Content Domain \(V\)](#)**

**pp 4726-4730**

**Young-Tae Kong and Sang-Je Park**

**[Case study of science writing with Argumentation on Biological ethics \(I\)](#)**

**pp 4731-4735**

**Young-Tae Kong and Myo-Jeong Kang**

**[Analysis of TIMSS results \(III\): A Trend analysis of the influence of students' family background factors on the international science achievement](#)**

**pp 4736-4739**

**Young-Tae Kong**

**[Secured Data Aggregation in Wireless Sensor Networks](#)**

**pp 4740-4745**

**P. Padmaja and G. V. Marutheswar**

**[A Hybrid Filtering Technique for Denoising the Citrus Fruit Images](#)**

**pp 4746-4750**

**M. Renuka Devi and V. Kavitha**

**[Power Efficient Scheduling for Network on Chip Applications on Multicore Processor](#)**

**pp 4751-4757**

**R. Rubavani, S. Saranraj, S. Saranya and R. Ranjani Devi**

**[The Dimensional Reduction to Improve the Speed and Accuracy of Neural Network in Identifying the Senior High School Students' Major](#)**

**pp 4758-4762**

**Arief Hermawan**

**[Detection Of External Defects On Mango](#)**

**pp 4763-4769**

**Pujitha N, Swathi C, Kanchana V**

**[Text Document Clustering Using Dimension Reduction Technique](#)**

**pp 4770-4774**

**A. Sudha Ramkumar and B. Poorna**

**[Analysis on the Noise Reduction Characteristics of a Railway Bridge with a Sound Absorption System](#)**

**pp 4775-4782**

**Hyun-Ung Bae, Jong-Tae Lee, Young-Do Jeong, Ki-Yong Yoon and Nam-Hyoung Lim**

**[Temporal Reuse based MAC Protocol in Underwater Acoustic Networks](#)**

**pp 4783-4786**

**Sunmyeng Kim**

**[Trust Based Security Enhancement Mechanism For Neighbor Discovery Protocol In IPV6](#)**

**pp 4787-4796**

**K. Perumal and M. Jessie Pauline Jeya Priya**

**[An Energy Saving Approach in Wireless Body Sensor Networks for Health Care Monitoring](#)**

**pp 4797-4802**

**Sudha. R and Devapriya.M**

**[Solar Energy Analytics Using Internet of Things](#)**

**pp 4803-4806**

**B. Vikas Reddy, Sai Preetham Sata, Sateesh Kumar Reddy and Bandi Jaswanth Babu**

**[Genetic and Greedy Optimization Algorithms for Effective Production Scheduling Techniques with Minimizing Makespan](#)**

**pp 4807-4812**

**D. S. Jenaris and P. Periyasamy**

**[A Survey on Parametric Evaluation of Nodes in Mobile Ad hoc Networks](#)**

**pp 4817-4821**

**N. Snehalatha and Paul Rodrigues**

**[Cubical Representation and Minimization through Cubical Technique A Tabular Approach](#)**

**pp 4822-4829**

**Rajesh Kumar and Saurabh Rawat**

**[Improved Associativity Based Routing for Multi Hop Networks Using TABU Initialized Genetic Algorithm](#)**

**pp 4830-4837**

**H. Santhi, N. Jaisankar, Aroshi Handa and Aman Kaul**

**[Towards a Relational Framework for Supply Chain Analytics](#)**

**pp 4838-4843**

**Santanu Mandal**

**[Heirostics to Multicast Route Discovery \(HMRD\): Engergy Eggicient Multicast Routing Topology for Mobile Ad Hoc Networks](#)**

**pp 4844-4848**

**K. Seshadri Ramana and A.A. Chari**

**Detection and Removal of Graphical Components in Pre-Printed Documents**

**pp 4849-4856**

**N. Shobha Rani, Vineeth,P and Deeptha Ajith**

**Empirical Study of Service quality and customer satisfaction using SERVQUAL in Private and PSU credit card service providers**

**pp 4857-4865**

**VanishreePabalkar, Pankaj Kanwal, Sachin Kushwaha and Virender Thakur**

**Macro Perspective: E-Waste Environmental Impacts**

**pp 4866-4873**

**Kanchan Patil**

**Shared Neighbor Clustering Approach based on Affinity Propagation**

**pp 4874-4877**

**A. Jenneth and K. Thangavel**

**Optimal Feeder Reconfiguration and DG Placement in Distribution Network**

**pp 4878-4885**

**Sarfaraz Nawaz, Mohd. Imran, Avadhesh Kumar Sharma and Anjali Jain**

**Process and Impacts of Illegal Land Subdivision: Its Relevance to Planning**

**pp 4886-4892**

**Swapna Sarita Swain and Omkar Mohanty**

**A Survey on visible light communication appliances used in inter-vehicular and indoor communication**

**pp 4893-4897**

**S. Vijay and K. Geetha**

**An Integrated Defense Approach for Distributed Denial of Service Attacks In Mobile Ad-Hoc Network**

**pp 4898-4910**

**Karthikeyan Thyagarajan and Arunkumar Thangavelu**

**The Technology of Interview**

**pp 4911-4916**

**A. Kurmanbayeva, A. Kundahbayeva, and N. B. Eshuatova and Zh. Nogaibayeva**

**Dynamic Ontology Based Model for Text Classification**

**pp4917-4921**

**K. Purna Chand and G. Narsimha**

**[Review of Tunnel Field Effect Transistor \(TFET\)](#)**

**pp 4922-4929**

**Satish M Turkane and A. K. Kureshi**

**[Economic Implication of Power Outage in Nigeria: An Industrial Review](#)**

**pp 4930-4933**

**Abel Ehimen Airoboman, Peter Aigboviosa Amaize, Augustus Ehiremen Ibhaze and Olayinka Omowunmi Ayo**

**[Prevention of CSRF Attack using STG pattern and JSED](#)**

**pp 4934-4938**

**Kadambari Chaudhari and Manisha Tijare**

**[Area Efficient and High Speed VLSI Based Pipelined 64-Point Radix-4 Mixed Architecture Design](#)**

**pp 4939-4944**

**K. Malathy and B. Justus Rabi**

**[Efficient Fault Detection Model Design "Hamming SEC-DAED-TAED-TETRA AED" Based AES Encryption and Decryption](#)**

**pp 4945-4950**

**M. Vaidehi and B. Justus Rabi**

**[A Combined Framework for Routing and Channel Allocation for Dynamic Spectrum Sharing using Cognitive Radio](#)**

**pp 4951-4953**

**S. Arul Selvi and M.Sundararajan**

**[Dynamic Quantum Shift Algorithm For Load Balancing in High Performance Clusters](#)**

**pp 4954-4960**

**Roopashree N, Roopashree N and Sneha K V**

**[Automatic Test Generation from UML Sequence Diagrams for Android Mobiles](#)**

**pp 4961-4979**

**Anbunathan R and Anirban Basu**

**[Selection of Commercial and Open Source LMS: Multi-Criteria Analysis and Advanced Comparative Study](#)**

**pp 4980-4989**

**Abdellah Bakhouyi, Rachid Dehbi, Mohamed Talea and Zouhair Ibn Batouta**

**[Technology commercialization: Experience of the U.S and Possibilities for Oil and Gas Industry Russia](#)**

**pp 4990-4994**

**Ilinoca Alina and Dmitrieva Diana**

**[Analysis of UPS impact on voltage THD at point of common coupling](#)**

**pp 4995-4998**

**Aleksey A. Belsky and Vasiliy S. Dobush**

**[Performance Evaluation of Wind Turbine with Doubly-Fed Induction Generator](#)**

**pp 4999-5004**

**Agus Jamal, Slamet Suropto and Ramadoni Syahputra**

**[Analysis and Forecast of Tourist Traffic in the Russian Far East](#)**

**pp 5005-5007**

**Alexander Kosolapov, Nonna Guremina and Anastasia Topchiy**

**[Reference Sensor Pattern Noise with Quaternion-Based Encryption for DICOM Images](#)**

**pp 5008-5013**

**L. Saraladeve and A. Chandra Sekar**

**[Reading and Re-reading: A Review of Interpretations on Kamala Das's My Story](#)**

**pp 5014-5015**

**Jasmine Jose, V. Rajasekaran and Godwin Raj**

**[Performance Analysis of Small Business Servers](#)**

**pp 5016-5019**

**N. Malarvizhi, K. Meena, D. Sujeethalakshmi, K. Rajathi and G. Tamilmani**

**[BNIMS: Block-based Non-Iterative Mean-Shift Segmentation algorithm for Medical Images](#)**

**pp 5020-5027**

**P. Pedda Sadhu Naik and T. Venu Gopal**

**[Application of LabView as real time SCADA in power system transmission line](#)**

**pp 5028-5031**

**Shuma Adhikari, Nidul Sinha and Thingam Dorendrajit**

**[Multiple Intelligence based Cooperative and Collaborative Learning](#)**

**pp 5032-5037**

**Rajashree Jain, Viren Rao and Harshit Sunda**

**[An Efficient Frequent Pattern Mining Algorithm to Find the Existence of K-Selective Interesting Patterns in Large Dataset Using SIFPMM](#)**

**pp 5038-5045**

**Saravanan Suba and Christopher. T**



**DPAT based knowledge retrieval for online buyers using Decision Making Approach**

pp 5046-5051

K. Kannan and K. Raja

**Steel-Trussed Sandwich Panel-Design For Axial**

pp 5052-5054

Ashraf M. Shalaby

**Enhanced Functional Properties of Mg Alloys by Cryogenic Machining**

pp 5055-5059

Mohd Danish, Turnad Lenggo Ginta and Bambang Ari Wahjoedi

**Integrating Instance Selection and Bagging Ensemble using a Genetic Algorithm**

pp 5060-5066

Sung-Hwan Min

**Cascade Stage Artificial Neural Network for Identifying Volcano Hotspots using Satellite Images**

pp 5067-5071

S. Muni Rathnam and T. Ramashri

**Methodical Approach to Evaluation of the Russian Peat Deposits Exploitation Attractiveness Based on Geology-Technological Criteria**

pp 5072-5078

Alexey Evgenevich Cherepovitsyn and Pavel Sergeevich Tsvetkov

**Hybridized Soft Computing Approaches Based Data Mining Techniques For Protein Dataset**

pp 5079-5085

A.Revathi and P. Sumathi

**A robust regression scale of residual estimator: SSAC**

pp 5086-5090

Muthukrishnan R and Ravi J.

**Energy Based Topology Control in Wireless Sensor Networks**

pp 5091-5096

S. Venkataramana, P.V.G.D. Prasad Reddy and S. KrishnaRao

**Evolution of Children's Literature: Oral Tradition to Digitalization: A Literature Review**

pp 5097-5102

Elizabeth Biju and K. Meenakshi

**A Scalable Ensemble Architecture for Collaborative Filtering in**

**Recommender Systems****pp 5103-5109****T.Srikanth and M.Shashi****Investigating the Effect of Asymmetrical Faults at Some Selected Buses on the Performance of the Nigerian 330-kV Transmission System****pp 5110-5122****Ademola Abdulkareem, Awosope C. O. A and Adoghe A. U and Alayande, S. A****A Review of Data Dissemination through Broadcast Channel****pp 5123-5127****Rajesh N****Experimental Investigation on the Study of Mechanical Properties and Modelling Analysis of Hybrid Composite Cement Beams Reinforced with Multilayered Carbon Nano Tubes and Glass Fibres****pp 5128-5131****Anand. M. Hunashyal, Nagaraj R. Banapurmath, Shankar A. Hallad3, Dr. S. S. Quadri, Chetan Kulkarni, Akshay Pujar M, and Ashok S. Shettar****Performance Analysis of TimeLine Algorithm against CONS, PBS\_PRO and BestGap in Grid Environment using Alea****pp 5132-5138****Bimal VO and M. Anand Kumar****Long wavelength Tanh Soliton Solutions of KdV Equation****pp 5139-5141****Tapas Kumar Sinha, Sanjib Malla Bujar Baruah and Joseph Mathew****Ayurvedic Plant Species Recognition using Statistical Parameters on Leaf Images****pp 5142-5147****Pushpa BR, Anand C. and Mithun Nambiar P****Personal Identification via Hand Feature Extraction Algorithm****pp 5148-5151****Samuel A. Daramola and Morakinyo Adefunmiyin****An Environmental Friendly Material: Epoxide-Based Resin from Vegetables Oil for Bio-Fiber Reinforced Composites****pp 5152-5155****Flora Elvístia Firdaus****Investigation of Neural and Fuzzy Neural Networks for Diagnosis of Endogenous Intoxication Syndrome in Patients with Chronic Renal Failure****pp 5156-5162**

# An Environmental Friendly Material: Epoxide-Based Resin from Vegetables Oil for Bio-Fiber Reinforced Composites

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## Abstract

The growing interest in reducing environmental impact of polymers or composites due to increased awareness to eco-friendliness. The finite petroleum resources has impacted to decreased pressures for the dependence on petroleum products which has increased in maximizing the use of renewables material. Bamboo are used for principal constituent of reinforced composite which incorporated to epoxide based resin from vegetables oil; canola, soybean, corn, and sunflower. The products obtained resulted the promising composites material for green environmental and also acceptable mechanical property.

**Keywords:** Environmental, bio-epoxide resin, vegetable oils, composite material

## Introduction

The shortage supply of non-renewable resources has urged to using renewables material. The use of large volumes of polymer based synthetic fiber composites in many sector despite their high cost has led to disposal problems. The synthetic material are well established for a wide variety of applications. (AK Mohanty, M Misra, G Hinrichsen, 2000; 276:1-24); (D Cho *et al.*, 2002); (AK Mohanty, M Misra, LT Drzal, 2002); (T Peijis, 2003); (P Wambua and Ivens J, 2003). Many research has explored of using technological innovations as an effort to save environment (Kong and Narine, 1997); (Petrovich, Zhang, Javni, 2005), by switching the raw materials into vegetable oils; low toxicity, soluble, and high purity (Guner, Yagci, and Erciyes, 2006).

A greater environmental consciousness have established the use of bio- fiber which triggering greater effort to find materials based on natural resources in latter's eco-friendly attributes. The significant attraction of bio-fibers is their low cost and some unique attributes, such as being less abrasive to tooling yet effective surface treatments avoid organic solvent are logical to make the reactive surface. Alkali treatment is an effective method to improve fiber-matrix adhesion in bio-fiber composites. The hybridization to non degradable polymeric matrices which may make it not fully biodegradable. Hybridization effect of bio- fibers with synthetic fibers on various properties has been extensively studied, very limited studies with hybrids of bio-fibers mainly with non degradable matrices have been reported (KG Satyanaryana, F Tomczak, THD Sydenstricker, 2006). In order to produce fully renewable and biodegradable composites both the polymeric matrix and the reinforcement

must be derived from renewable resource, normally produced by plants in a period of less than one year (Narayan, 2006). Bamboo stick will degrade in 1-3 years while plastic 450 years and glasses and tyres uncertain time, including most biodegradable materials including composites, degrade rapidly in 2 weeks to 6 months (KG Satyanarayana, *et al.*, 2009). The major objection of using natural fiber for reinforcement in thermosetting matrix resin is to achieve improved mechanical property of composite material due to poor wettability and weak interfacial bonding; a hydrophilic fiber to hydrophobic matrix (Carvalho, 1997); (Marcovich *et al.*, 1997). Bamboo fiber has superior mechanical properties but the brittleness can not be avoided because fiber covered by lignin.

This research has been carried out to find the optimize mechanical properties of 4 kind epoxide vegetable oil (canola, soybean, corn, and sunflower ) based resin with in binding the surface of bamboo which giving the best mechanical properties.

## Experimental Procedures

### Materials

In this research, 4 kinds of natural oils used; canola oil, sunflower oil, and corn oil the products are produced by Switzerland AG Coda- Mazola and soybean oil by Salim Ivomas Jakarta. The C-C double bond in triglyceride were transformed into epoxide by peracetic acid *in situ*. The products so called as epoxy resin; blended of epoxy from natural oil with hardener which manufacture by polychemie Indonesia in the ratio 1:1, the resin is performed as matrix of fiber reinforced composite. The resin are then applied to bamboo fiber (*Gigantochlea Apus*) was obtained from its stem now mainly cultivated in Bogor West Java- Indonesia. The specimen were cut into the dimension of (length x width x thickness) in general (10.05 x 2.05 x 0.2) cm<sup>3</sup>.

### Property of vegetable Oil

The density of the resins; blending of epoxide natural oil with hardener; canola resin was 0.4949 gr/cm<sup>3</sup>; sunflower resin was 0.4949 gr/cm<sup>3</sup>, and soybean resin was 1.4401 gr/cm<sup>3</sup> while synthetic epoxide resin was 0.7175 gr/cm<sup>3</sup>. The property of natural oil's and its epoxide forms are depicted in table 1.

The chemical structure, with many hydroxyl groups interact with water molecules. The cellulosic fibers interact with water not only at the surface, but also in the bulk. Due to storage without any treatment the bamboo fiber kept water on a

specified moisture which can lead to mold formation on the surface and effected to weaken mechanical properties.

**Table 1:** Property of vegetables Oil and its epoxide forms

No	Natural Oil	Iodine Value (% wt)	Oil in epoxide Form	
			Acid value (mgr KOH/gr)	Oxirane (mgr KOH/gr)
1	Canola	92.89	2.558	3.4
2	Sunflower	82.7	2.2	6.5
3	Soybean	86.7	0.0244	6.68
4	Corn oil	89.9	1.5	3.0



**Figure 1:** Bamboo fiber without Alkaly Treatment

In this research, the treatment was done by alkalyusing NaOH solution with variation of the concentration of 0 %, 5 %, 10 %, 15 % ( v / v ).

## Methods

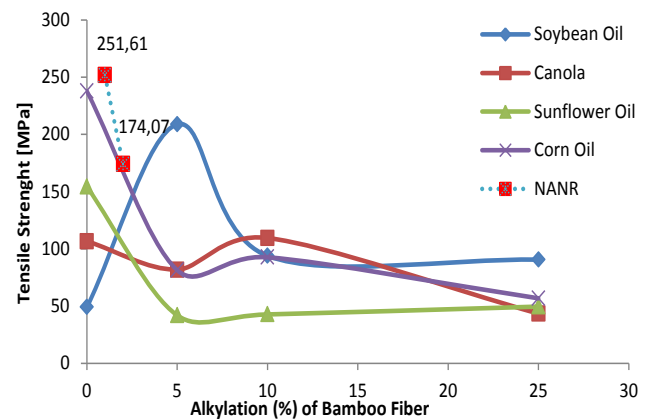
- Tensile Strenght Test:** The test was designated as ASTM D3379. Using Shimadzu AGS-50kN Xplus, with room humidity 50.5%. The tensile test was carried out within speed of testing 2 mm/min with grip distance 50 mm. The dimension of bamboo fiber specimen was 10x 2 x 0.2 cm<sup>3</sup>
- Bending strenght:** The test was designated as ASTM D3379 using Shimadzu AGS-50kN Xplus with room humidity of 53%. The pressure rate 1.651 mm/min. The grip distance is 25 mm.
- Compressive strenght:** The test was designated as ASTM D3039 using Shimadzu AGS-50kN Xplus. With humidity of 53%. The pressure rate 1.3 mm/min. The grip distance is 25 mm.
- The cellular images after compressive strenght application to bamboo reinfoced composite were characterized using SEM micrograph using Philip SEM-DAX XL30 W/TMPPW6635/15 using ASTM D 3036

## Results and Discussion

### Tensile Strenght of Composite fibers

The typical tensile strenght of bamboo using 4 kinds epoxide resin are remarkably low with the higher concentration of alkali. Infact alkaline solution immersion leading to the formation of larger number of voids. Lost of cuticle leads to rough surface (Sreekala *et.al.*, 1997).

The concentration 5% of NaOH is in the range of 3.06-7.58 [MPa] (Figure 2), compared to using E-glass 2.5 [MPa];

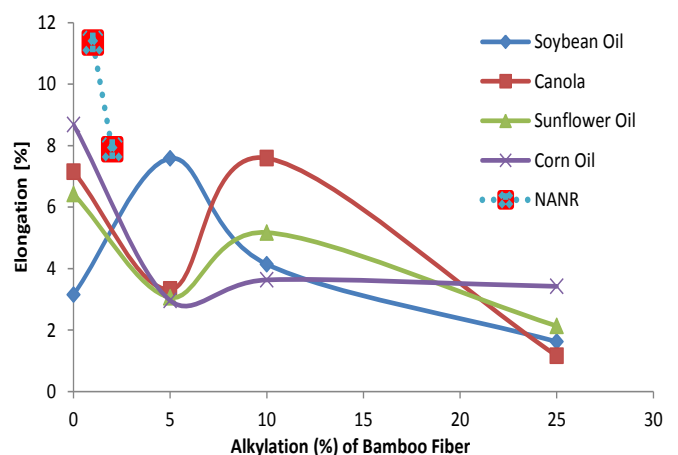


**Figure 2:** Alkylation concentration of bamboo fiber to Tensile strenght of composite <sup>a)</sup>NANR: no alkylation no resin

Kevlar 2.5-3.7 [MPa], and Carbon 1.4-1.8 [MPa] (Amar, Manjusri, Lawrence, 2005), it seemed this is the optimum condition to removed lignin and result the good tensile strenght. According to Joseph *et.al.*, the mechanical properties of alkali treated sisal fiber is tensile strenght 34.27 (MPa), elongation at break 1 (%) while for untreated sisal fiber is 31.12 (MPa), modulus 3086 (GPa), and elongation at break 2 (%).

### Elongation of Composite fibers

The elongation test found in this research, is high until 5% using soybean epoxide resin, but 10% is high for canola, sunflower oil, and corn oil epoxide based resin. The elongation existence is poor with alkylation more than 15% (Figure 3).



**Figure 3:** Alkilation concentration of bamboo to Elongation of composite fiber <sup>a)</sup>NANR: no alkylation no resin

### Compressive Strenght of Composite fibers

The compressive modulus in general is high with alkali treatment 10% for all epoxide vegetable (canola, soybean, sunflower, and corn) oil based resin. The compressvie strenght of bamboo fiber are poor with alkali treatment. In general the compressive is in optimum condition with the treatment of alkylation in the concentration 5% (Figure 4).

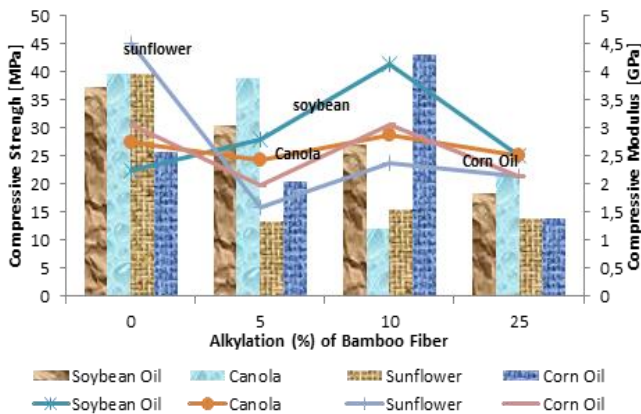


Figure 4: Alkylation to Compressive Strenght of composite

### Bending Strenght of Composite fibers

The bending strenght and bending modulus of fiber composite reinforced it seems to be improved using thermosetting epoxy. The alkali treatment until concentration 25% is seemed not to be effected the bending (Figure 5).

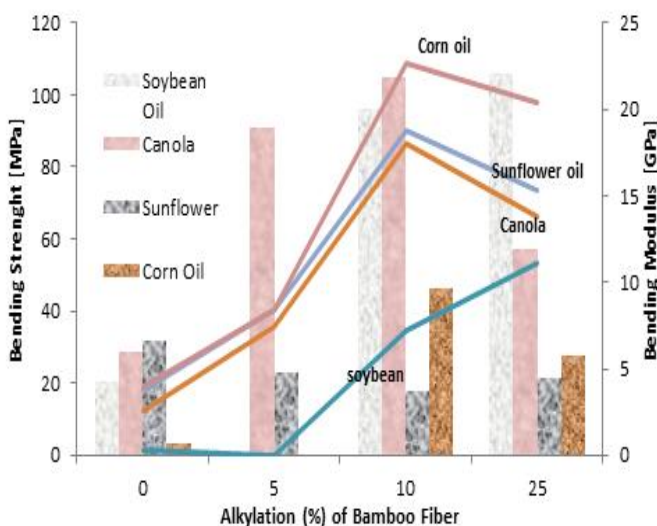


Figure 5: Alkylation to Bending Strenght and Bending Modulus of Composite fiber

### Morphology of composite fibers

Good bonding between matrix and epoxy of vegetables (canola, soybean, sunflower oil, and corn oil) based resin of microfiber phase were observed in all samples. This fortunate fact because the alkali treatment has made the matrix fiber dissolved in the surface through the bulk.

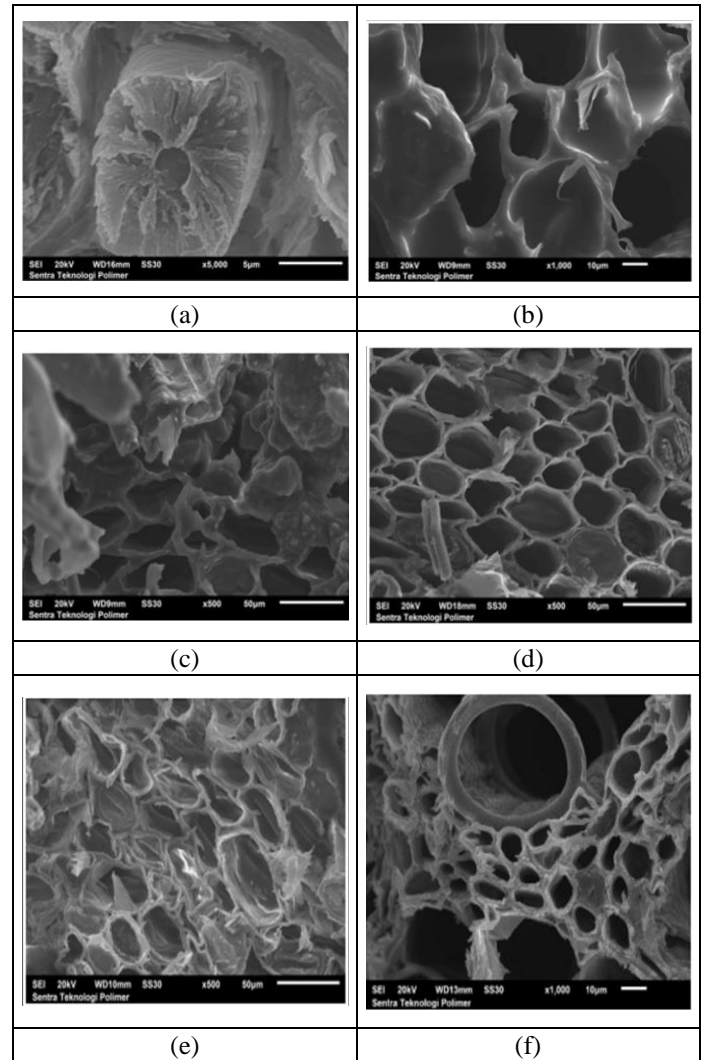


Figure 6: SEM micograph after compressive of composite a) Canola resin without alkaly treatment previously b) Canola with 5% alkaly c) Canola with 10% alkaly d) Canola with 25% alkaly e) fiber without alkaly treatment and without resin f) Soybean with 25% alkaly treatment

### Conclusion

Four products of composite with bamboo fiber reinforced were synthesized by using epoxide form of 4 kind of vegetables oil (canola, soybean, sunflower oil, and corn oil) based resin. The oil, the epoxide were characterized by chemical and physical method. The composites were characterized by mechanical properties. As in general the properties are quite promising to petroleum based.

### Acknowledgement

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