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Rediscovering Palm Byproducts

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Book of Abstracts

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FOREWORD

The Palmae family includes a wide variety of species and they're considered the main source of livelihood for significant proportion of the world population.

Unfortunately, their byproducts (secondary products) are often regarded as waste, despite that they represent a sustainable material base for a wide spectrum of industries ranging from compost, wood substitutes, pulp, up to fiber reinforcements for advanced composites.

ByPalma is the only conference solely focusing on the byproducts of palm plantation around the globe and their current and potential applications. This includes all Palmae family, such as Date palms, Coconut palms, Oil palms, Doum palms, sugar palm…etc.

This conference will highlight the great potential of the palm byproducts in the circular bioeconomy of the future!

- Bringing together leading academic scientists, researchers, artisans, entrepreneurs and industry professionals active in the area of palm byproducts R&D, manufacturing, and crafts from all around the globe to exchange recent developments, technologies, innovations, trends, concerns, challenges and opportunities.
- Rediscovering palm byproducts and maximizing their added-value and creating an economical resource that can help in the sustainable development of vast rural areas in different countries in the world.
- Establishing an international network of scientists, artisans, and industry professionals

ByPalma 2021 conference is covering a wide range of trends on palm byproducts in wood substitutes, composite reinforcements, biotechnology, fertilizers, food, paper, textiles and bioenergy.

ByPalma 2021 is the main gathering for celebrating and rediscovering palm byproducts!

Kuala Lumpur, 28th September 2021

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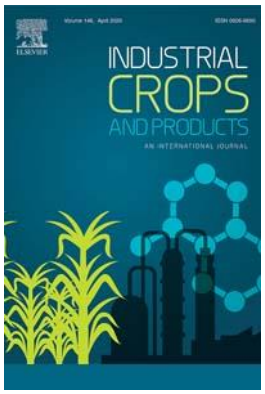

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OIL PALM TRUNK UTILIZATION – OPPORTUNITY FOR THE FUTURE

Arno Fruehwald
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Keywords: Palm Trunks, Material Properties, Processing, Market Products

ABSTRACT

Today annually some 150 million m³ of OPT remain on the site when clearing and replanting the plantations. Logistic problems, pest issues and only little availability of recycled nutrients for the new plants parallel to declining wood availability from natural forests increases attractiveness for OPT-utilization in the wood based industry. R&D activities started already around the 1980´s in Malaysia. First emphasis was on material research, later on manufacturing to supplement wood products such as plywood, solid wood based products (furniture, doors etc.) and chemicals. Although understanding of material developed quite well, the manufacturing of good quality products with market potential failed because of the use of common processing technology, machines, tools, un-sufficient product design and finally high costs. After a peak around 2005 production volumes in plywood, lumber and furniture decreased in Malaysia until 2015; in other countries OPT is not in focus at all because of missing knowledge.

Since ten years new R&D efforts are on the way which still deal with the material as such but includes new/adopted manufacturing processes and products as well. Research institutions in Germany in cooperation with technology companies in Germany, Europe and Malaysia as well as research partners in Malaysia and Thailand have set up comprehensive development projects for industrial processing of OPT, appropriate product design, tool and process technology, including material logistics, environmental and socioeconomic aspects. Investments in R&D of this group during the last ten years exceeds some US$ 20 million. Presently the first large sawmill and board manufacturing plant is being commissioned. In the light of the availability of some 150 million m³ of OPT per year, of which 50 % is exploitable for industrial purposes without ecological risks but high socioeconomic benefits and an impressive contribution to future climate gives light for the future. 100 m³ of trunks used can provide one job for a year, can generate an economic value of up to US$ 15,000, and a climate value of 100 tCO2. Taking these figures, only Malaysia could create 75,000 jobs, an economic value of more than US$ 1 billion and reduce actual CO2-emissions by 5 %.

KEYNOTE LECTURE

MORPHOLOGICAL CHARACTERISATION AND PROPERTIES OF LEAF SHEATH DATE PALM FIBRE BIOMASS WASTE REINFORCED BIOCOMPOSITES POTENTIAL FOR LIGHTWEIGHT STRUCTURAL APPLICATIONS

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Keywords: Date palm fibre; Biocomposites; Mechanical property, Morphological characterisation; Long-term durability

ABSTRACT

This keynote talk will highlight some of the work performed on date palm fibre reinforced biocomposites, characterisation and their key properties. The talk will focus on three features:

First, the talk will introduce the importance of biobased composites on tackling the current environmental issues. Then it will attempt to highlight the morphological characterisation of date palm fibre, their chemical constituents, fibre structure and behaviour. Second, the talk will then focus on structure property relationships, influence of various environmental conditions on key mechanical and thermal properties of date palm fibre reinforced biocomposites by analysing some results recorded from various experimental works. Some fabrication techniques and their influence on the various properties will also be discussed. Third and finally, the potential lightweight applications of date palm fibre reinforced biocomposites will be further discussed by reviewing some early works.

KEYNOTE LECTURE

SUGAR PALM: FIBRES, BIOPOLYMERS, BIOCOMPOSITES AND OTHER BY-PRODUCTS

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Keywords: Sugar palm; Fibres; Biopolymers; Biocomposites

ABSTRACT

Sugar palm (Arenga pinnata (Wurmb.) Merr) is a versatile palm species that may be used to make a number of products such as lumber, bio-fibres, biopolymers, biocomposites, as well as foodstuff and beverages. Green materials have recently become critical components in addressing environmental issues. Simultaneously, these materials aid in the resolution of issues originating from the scarcity of petroleum-based materials and their inability to degrade. The sugar palm tree is a multipurpose plant that can produce bio-fibres, bio-matrices, and biocomposites for a variety of applications, making it one of Malaysia's many green material sources. Although the sugar palm can yield a variety of products, the three most notable are palm sugar, fruits, and fibres. This fibre is extremely resilient, resistant to seawater, and simple to manufacture because it is accessible naturally in the form of woven fibre. This presentation covers recent achievements in research into sugar palm fibres and biocomposites, as well as research into the production of new biodegradable polymers produced from sugar palm starch, particularly in Malaysia and at Universiti Putra Malaysia. Surface treatment of sugar palm fibre composites, product development, and efforts to improve the qualities of sugar palm fibre composites are all taken into account.

KEYNOTE LECTURE

DIVERSIFIED VALUE ADDED PRODUCTS FROM COCONUT RESIDUE

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Keywords: Coconut residue; Wet processing; Coconut milk powder

ABSTRACT

CFTRI is in forefront in developing technologies for coconut-based products. This paper deals with the technologies developed in the field of coconut research at CFTRI in the last three decades including technology development including wet processing of coconut for the production of spray dried coconut milk powder and virgin coconut oil as well as tender coconut based beverage and coconut spread etc. All these technologies have been successfully transferred to industry. Our current research efforts are focused on production of low fat dietary fiber from coconut residue after the milk extraction, concentration of coconut water by membrane processing, preservation of coconut water by emerging technologies such as dense phase carbon dioxide and high pressure will be discussed.

KEYNOTE LECTURE

A BIOREFINERY FOR EACH BYPRODUCT: AN APPROACH TO MAXIMIZE THE ADDED VALUE FROM THE DATE PALM BYPRODUCTS

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Keywords: Date palm byproducts; biorefinery; sustainable development

ABSTRACT

This keynote lecture is not intended to present "final solutions", but rather suggest a new line of thinking!

What is the status quo regarding the date palm byproducts? Most researcher get so excited and proud of their achievements in developing new products and materials from the date palm byproducts. However, they often neglect to discuss or describe what remained of the resource after extracting their product. This is an effort that may open to them and to others, a path to continue discovering new products.

Inside the field, the date palm byproducts are mostly regarded as waste, they are either open-field burnt, causing environmental pollution, or left in the field facilitating the infestation by dangerous insects like the Red Weevil or causing fire and thus destroying the palm plantations and causing environmental pollution, or sent to the landfills, which is a great economic loss.

To maximize the added value from date palm byproducts, save the environment and generate sustainable labor opportunities in local communities where the date palms are grown, it's suggested to develop a Biorefinery for each date palm byproduct. To attain such an objective new ethics and steps are required. Researchers should be responsible for characterizing, not only their new products which they have developed, but also what remained from the resource (i.e., byproducts of the byproducts). The palm owners should be responsible for preprocessing the date palm byproducts, packaging them appropriately and transporting them to the farm gate. This may facilitate their further handling by other parties to use them to manufacture new products.

KEYNOTE LECTURE

RECENT ADVANCES ON THE SURFACE FUNCTIONALISATION OF LIGNOCELLULOSICS: FUNDAMENTALS, TECHNIQUES OF CHARACTERISATION AND CONCRETE APPLICATIONS

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Keywords: Lignocellulosics; Surface functionalization; Characterisation

ABSTRACT

The present lecture is focused on the recent advances on surface chemical modification of lignocellulosics. It will be divided into four parts:

1. The first part will be devoted to the basic consideration on surface phenomena with a special care about the difficulties associated with surface contamination, the surface energy characterization, the surface properties determinations, etc.

2. The second part will be focused on the relevant characterization techniques, including classical low-resolution ones and more efficient tools such as: X-ray photoelectron (XPS) and more recently Time of Flight Secondary Ion Mass Spectrometry (ToF SIMS). This presentation assesses the merits and the drawbacks of these techniques [1, 2].

3. The third part points out the interest in using polysaccharides (cellulose mainly starch) in several functional materials. These two raw materials could be subjected to several surface modification strategies, namely (i) physical treatments (ii) chemical grafting by direct condensation, “grafting from” and “grafting onto” approaches. In this context, recent works investigating green solvent-based or solvent-less systems will be reported [1, 2].

4. All these treatments aim at providing these substrates specific functions, such as hydrophobic character, anti-microbial properties, etc. [1, 2]. Typical examples of achievements in this field will be given and discussed.

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VALORIZATION OF DATE PALMS BYPRODUCTS IN THE PRODUCTION OF WOODEN PRODUCTS AND INSULATION PANELS BY USING NATURAL AND INDUSTRIAL GLUE

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Keywords: Date palm, byproducts, wooden products, insulation panels

ABSTRACT

The Southern regions of Algeria are characterized by hot and dry climate during eight months from March to October. Temperatures in summer reach over 45° C in shadow. These zones are commonly called “Oasis” where date palms are largely cultivated for dates their principal product. On the other hand, the annual pruning operation of palm groves produces huge quantities of byproducts as waste. These later are either thrown away or burned. This study examines the valorization of those byproducts in the production of wood products and insulation panels. Nowadays there is no manufacturing of wood production in Algeria. All kinds of wood especially, the chipboard and MDF are imported at very expensive prices. On the other hand, the main raw material used in the manufacture of insulation panels is cork. This material has been recovered in large quantities from the forests of northern Algeria, but unfortunately its production has decreased in the past two decades. The objective of this research is to present some manufacture protocols for starting the production of wooden products and insulation panels based on date palm byproducts and offering an environmental solution for the exploitation of date palm byproducts.

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COCONUT COIR PITH LIGNIN BASED FERTILIZER MATRIX FOR CONTROLLED RELEASE OF UREA

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Keywords: Nitrogen fertilizer, Controlled release, Urea, Lignin, Coconut coir pith

ABSTRACT

To meet increasing food demands, it is of paramount importance to develop systems that boost production and alleviate environmental problems. Urea, the commonly used, hydrophilic nitrogen fertilizer, benefits from the concept of controlled release. S-U-B-L fertilizer matrix was synthesized using starch (S), urea (U), borate (B) and lignin (L). Lignin was extracted from coconut coir pith under acid, alkaline and organosolv protocols, labeled L_1, L_2 and L_3, respectively, and structure confirmed by FT-IR spectroscopy. L_1 and L_3 had the highest and lowest yields, while L_2 and L_1 possessed the smallest and largest particle sizes, respectively. Urea release studies of lignin incorporated fertilizer matrices S-U-B-L_1 and S-U-B-L_2, showed a slower and gradual release rate of 70% urea within 5 hours, when compared to urea, in which a burst release of 98% occurred within 90 min, and S-U-B, in which a fast release of 73% occurred within 75 minutes, with an overall release of 73% in 5 hours. S-U-B-L_2 showed the highest efficiency with a controlled urea release rate of 42% within 75 minutes, in contrast to S-U-B-LA_1 to which released 51%. Powder X-Ray Diffraction (PXRD) confirmed the amorphous nature, while Scanning Electron Microscopy (SEM) revealed the surface morphology of fertilizer matrices.

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CO-COMPOSTING DATE PALM TREE WASTES AND ITS EFFECTS ON SOIL FERTILITY

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Key Words: Date palm tree wastes, chicken Manure, composting, and sandy soil.

ABSTRACT

UAE is one of the world major producer of dates. In 2015, the country had more than 42 million date palm trees and this number is increasing gradually. Every year there is more than 600,000 tons of date palm tree wastes are generated in farms. Composting of date palm tree wastes has been improved and time needed for maturation is reduced when mixed with chicken manures, and the produced compost has good quality. Amended sandy soil with produced compost showed better physical, chemical and biological properties against control treatment. In this experiment we used several treatments e.g chicken manure compost, CMC, and date palm tree composted wastes, DPTCW in different ratios, to evaluate its quality as organic fertilizer and to study its effects on the properties of sandy soils. CMC reached maturation faster than DPTCW and has higher contents of NPK nutrients than DPTWC, while organic matter content was higher in the DPTWC, which is good for soil conditioning. Tested sandy soil showed higher organic carbon content and numbers of microorganisms has been increased in all treatments against control.

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PALMYRAH (BORASSUS FLABELLIFER L.) PALM PRODUCTS AND BY PRODUCTS IN INDIA - PRESENT STATUS AND SCOPE

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Key words: Palmyrah, products, byproducts, rural area, India

ABSTRACT

Palmyrah is an important palm in the family Arecaceae playing an important role in the day-to-day life of poor and landless farmers. Palmyrah palm adorns the dry landscape of the semi arid tropics areas of India, nearly population of 150 million palms. Due to its multifarious uses, the palm is equated to the “Kalpa Vriksha”in the mythology. Palmyrah is regarded as a total palm as each and every part of the palm right from fruit to root is having many fold economic uses. Palmyrah referred as tree of life with nearly 800 uses including food, beverage, fibre, fodder, medicinal and timber. Among the various edible uses of the palm, the sweet sap tapped from the inflorescence for making palm sugar is of prime importance. The endosperm of the young fruit, like tender coconut, is a delicacy in summer. The petiole fiber and leaf blade are used to make products such as brushes and handicrafts. The tree serves as a source of raw material for several cottage industries.

The palm is slow growing and having life of more than hundred years which will useful in many ways at rural level. But due to lack of research based information, it was not taken up filly for utilization. Hence, research has taken up for development of value added products for commercial application for the products like neera, endosperm, fruit, haustorium, apocolon and its byproducts i.e jaggery, candy, sugar, chocolate etc. along with leaf and stem based products.

THERMAL AND ACOUSTIC BEHAVIOR OF WALL THERMAL INSULATION MATERIALS MADE OF TREATED FIBER OF OIL PALM EMPTY FRUIT BUNCH AND SUGARCANE BAGASSE FIBER

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Keywords: Oil Palm fibers; Sugarcane bagasse fiber; Biophenolic resin; Hybrid composites; Thermal properties; Acoustic properties.

ABSTRACT

This paper deals about the effect of 2%v/v silane and 4%v/v hydrogen peroxide treatment on thermal and acoustic behaviour of oil palm empty fruit bunch (OPEFB) and sugarcane bagasse fiber (SCB) reinforced phenolic hybrid composites for wall thermal insulation application. The pure and hybrid composites with different formulation ratio 70:30 (7OPEFB:3SCB), 50:50 (5OPEFB:5SCB) and 30:70 (3OPEFB:7SCB) of hybrid composite has been prepared by hand layup method. The treated OPEFB:SCB fiber and phenolic resin were fabricated with target density range of 0.5 g/cm^3. The thermal analysis and thermal conductivity testing of pure and hybrid composites were evaluated. Impedance tube were used for acoustic behaviour analysis of composites. The hybridization of hydrogen peroxide treated, HT 50:50 (5OPEFB:5SCB) display better thermal stability with final residue 58.69% followed by hybridization of silane treated ST 50:50 (5OPEFB:5SCB), 45.10% of residue. Four different air gaps thickness (0 mm, 10 mm, 20 mm and 30 mm) are investigated in this study. The result show, silane treated ST 50:50 (5OPEFB:5SCB) and hydrogen peroxide treated HT 50:50 (5OPEFB:5SCB) hybrid composites presented better improvement in sound absorption coefficient, α>0.50. Thus, we concluded that thermal and sound absorption performances of hybrid composites from agro waste promising environmentally friendly alternative solution in wall building material production.

SCALING-UP PRODUCTION OF MICROFILTERED COCONUT WATER WITH PROBIOTIC (*LACTOBACILLUS PARACASEI* SUBSP. *PARACASEI* STRAIN CRL431®)

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Keywords: Non thermal processing, Microfiltration, Functional beverages, Lactic Acid Bacteria

ABSTRACT

Green coconut water has an important market demand worldwide, but the current offer is still not meeting all the requirements of functional foods because of the addition of preservatives and artificial flavors after pasteurization. As coconut water is highly thermosensitive, athermal treatments, such as crossflow microfiltration (CMF), have been developed. Nonetheless, industrial application of CMF to coconut water has been scarce since it yields a product with a very low turbidity and high pH with important food safety concerns. To tackle both challenges, probiotic culture *Lactobacillus paracasei* subsp. *paracasei* (strain CRL431®) was added aseptically to microfiltrated coconut water (MCW) with vitamin C, using a 0,2 µm pore diameter ceramic membrane. Previously, an aliquot of MCW with 5% sucrose and 0.5% yeast extract, was fermented with the probiotic for 12 h to obtain up to 10^9 CFU/ml. The inoculum was added aseptically to MCW (1% V/V) to achieve a final content of at least 10^6 CFU/ml. Coconut water with the probiotic was then packed in PET bottles using an ultra-clean system, stored 28 days at 4 °C and analyzed for pH, acidity, ºBrix, turbidity, sensory analysis and microbial count. Statistical analyses evidenced a probiotic content of at least 10^6 CFU/mL allowing to claim the product as a probiotic drink in which no evidence of deterioration was observed. Additionally, sensory analyses results were positive showing an increase in the perceived coconut flavor and turbidity (up to 30 NTU), values similar to fresh coconut water. Focus group analysis, with consumers of healthy products, also gave positive insights: combined health attributes of a non-dairy source of probiotics and natural coconut water without added preservatives. The process was scaled up at the level of a small agroindustry in Costa Rica currently producing microfiltered coconut water with probiotics.

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A STUDY MODELS OF HANDLING OF PALM SECONDARY PRODUCTS FOR MEDIUM DENSITY FIBERBOARD PRODUCTION AN EXAMPLE OF AL- QASEEM, SAUDI ARABIA

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Keywords: Palm Secondary Products, date palm by products, palm residues handling, Al- Qaseem, Transporting methods.

ABSTRACT

Manufacturing Medium Density Fiberboard (MDF) from Palm Secondary Products (PSP) depends primarily on collection and handling costs. A field study was conducted at Date Palm Plantations in January 2018 of Al-Qaseem area, Saudi Arabia. The main objective was to evaluate the optimal and economical method to collect (PSP) from the wide range plantation distributed in 8 districts of this area to the suggests MDF factory residence with many transport forms (as its, shredded in jumbo bag, shredded in truck box and compressed).Technical and operational aspect recommended to divided palm farms to (3) sectors according to the distances to MDF factory residence. The capacity of the MDF factory is 60,000 tons annually, at a rate of 200 ton PSP supplying daily in 300 day per year. In sector A, The study recommended that 10 trucks (3.45ton/load) 4 times a day directly as it's to the MDF factory with a total supplying quantity of 137.8 tons. The remained supplying quantity (62.2 tons) was covered by transporting 3 large trucks operate 3 time a day. Results revealed that the cost of handling one ton was 119.85, 138.60 and 137.17 SR as raw material (as its), in truck box and in jumbo bag, respectively.

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OIL PALM TRUNK PLYWOOD – 15 YEARS' EXPERIENCE

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Keywords: oil palm trunk, timber, veneer, plywood, furniture

ABSTRACT

The Malaysian timber industry is an important income generator for the Malaysian's economy. In 2020, the export revenue of timber and timber products was valued an excess of RM22 billion. The supply of raw material is central in order to further develop this thriving industry towards continuous growth. With natural forests being kept safe via sustainable forest management practices and with heightened awareness in conservation and green practices, the timber industry is looking at alternative raw material. There are 5.8 million hectares of oil palm plantations in Malaysia. After 25 years, the oil palm trees will begin yielding less fruit and need to give way for replanting of new young trees. This presents a boon to the timber industry as the felled oil palm trunk (OPT) is a renewable source of alternative raw material. It is expected close to 13 million OPT logs will be felled to make way for replanting every year based on average 100,000 hectares of oil palm plantations. This alternative material has come at the right time for timber industry. With tough competition in the global marketplace, rising costs and tight supply of timber, the timber industry has been looking for a revival.

The solution appears to be in OPT which is able to be processed into plywood. Initiative that carried out by Malaysian Timber Industry Board (MTIB) and the timber industry, both in the past 15 years and present, has enabled OPT to become a new and an important source of raw material for conversion into veneer, plywood and then to furniture. The OPT plywood manufacturing process is same with the conventional plywood process, from log yard, peeling, drying, gluing, pressing, finishing etc. Based on the nature characteristic of oil palm wood such as rough surface, high moisture content, density variation etc., the industries need to do some modification or enhancement on the process. MTIB have done a number of activities particularly in plywood quality enhancement with resin treatment, process or machinery upgrade for dewatering, peeler with segregation, pre drying chamber, platen press and roller dryer on the drying process and latest on densification, chemical treatment to suit the furniture requirements. On the home-front, the furniture sector offers many possibilities for palm plywood. Timber-based furniture, in 2020, achieved earnings in export revenue of about RM10.6 billion contributing 48% of the total in revenue for Malaysian timber products. The OPT has shown exciting potential for the making of palm plywood and has become an alternative raw material for the wood-based industry. Malaysian furniture manufacturers produce a wide range of furniture suited to all indoor and outdoor spaces such office, home and garden. With the furniture industry being highly export oriented, it provides a promising future for Malaysia to produce high quality palm plywood and palm timber furniture for the domestic and export

markets. Given also that consumers in developed countries are demanding that wood-based and furniture products in the market be eco-friendly, palm plywood and palm furniture have the potential to be the next wave.

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CHEMICAL COMPOSITION AND CHARACTERIZATION OF DATE PALM EMPTY FRUIT BUNCH FIBER OF FIVE VARIETIES GROWING IN SOUTHEAST ALGERIA

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Keywords: Date palm, cultivar, chemical composition, Morphology, XRD, SEM.

ABSTRACT

Natural fibers are now emerging as viable alternatives to glass fibers either alone or combined in composite materials for various applications in automotive parts, building structures and rigid packaging materials. Date palm tree can produce annually large quantity of natural fibers that can be utilized in different industries and resolve different socio-economic and environmental problems.

In the present study, the chemical composition (organic and mineral) of five cultivars of Date Palm trees Empty Fruit Bunch fiber (DPEFB) was investigated. The preliminary results revealed that empty fruit bunch of Degla baidha cultivar contain the higher cellulose percentage (49.28%) and the less lignin content (26.19%). Two different methods were used to extract the minerals from the vegetal samples. The inductively coupled plasma/optical emission spectroscopy (ICP/OES) was used to quantify the studied minerals. The surface morphology, X-Ray Diffraction and Fourier transform infrared spectroscopy (FTIR) analysis were investigated as well.

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PROPERTIES OF OIL PALM WOOD RELEVANT FOR MATERIAL USE

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Keywords: oil palm wood, properties, strength, stiffness,

ABSTRACT

Being monocotyledons, palm wood shows distinct differences in the anatomical structure compared to common wood species. It consists of lengthwise oriented vascular bundles (composed of vessels for water transport and sclerenchymatous fiber caps with thick walls and high density, formed to fiber bundles for structural stability) embedded in parenchymatous ground tissue (thin walled cells, low density, easily buckle under load, contains lots of water and sugars). Thus, if vascular bundles are considered as reinforcements and ground tissue as matrix, oil palm wood can be seen as unidirectional long-fiber-reinforced bio-composite. The anatomical structure defines the properties. On small-size test specimens MOE and MOR in bending, Young´s modulus and strength in tension and compression (parallel and perpendicular to the vascular bundles), torsional strength, shear strength, torsional modulus and G-modulus (in three main directions), embedding strength, screw withdrawal strength (parallel and perpendicular), swelling and shrinkage and thermal conductivity were tested. Almost all property values depend on the density in power law relationships with much higher exponents compared to common wood species. The density depends primarily on the age of the palm tree and the size, number, and anatomical structure of its vascular bundles. Thus, palm trunks show a significant density gradient over both trunk height and cross section [1]. The number of vascular bundles decreases logarithmically from the cortex to the center of the trunk [2] and therefore density and elasto-mechanical properties decrease accordingly. The number per area of VB increases along with stem height [2], but because the anatomical structure of the VB varies as the stem height increases (cells in the upper trunk are younger and missing intensive secondary cell wall thickening), the bulk density and elasto-mechanical properties decrease accordingly. Therefore, the size and number of vascular bundles per area is not a sufficient visual grading criteria for oil palm lumber.

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GRADING OF OP-LUMBER – TECHNIQUES AND CHANCES FOR UP-GRADING MATERIALS

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Keywords: Oil palm wood, X-ray, ultrasonic velocity, natural frequency, dynamic MOE

ABSTRACT

Almost all property values of oil palm wood show extreme variation within the trunk, but defined properties are a prerequisite for commercial uses. Therefore, grading of the material according to the desired properties is an important processing step. As shown in the presentation “Properties of Oil Palm Wood relevant for Material Use”, the properties depend on the density in power law relationships with much higher exponents compared to common wood species as well as on the age of the vascular bundles (respectively on the trunk height).

The most appropriate method to determine density is to X-ray along and across the board length. Together with the X-ray absorption-rate information, the board dimension and a homogeneous moisture content is needed. The density gradient over the width of kiln-dried oil palm boards was measured using DENSE-LAB X from Electronic Wood Systems. A calculation tool was developed to determine density class boarders for ripping the boards lengthwise into strips with defined elasto-mechanical properties (if the height within the trunk is known).

Because strength is strongly related to stiffness (cf. presentation “Properties of Oil Palm Wood relevant for Material Use”), the applicability of ultrasonic and natural frequency measurements for strength grading purposes were evaluated by comparing the dynamic MOE from ultrasound using STEINKAMP BP 5 device with plane and conical probes for longitudinal waves (50 kHz) and longitudinal vibration using Timber Grader MTG by Brookhuis and GrindoSonic MK6. The flexural vibrations were evaluated using GrindoSonic MK6, as well as the static MOE and MOR in bending and tension standard test. Ultrasonic and natural frequency measurements in longitudinal and flexural vibration are applicable for strength grading of dry oil palm lumber. Especially longitudinal vibration seems well suited to be used in an industrial production environment.

MILLING AND DEVELOPMENT OF NOVEL PRODUCTS USING DATE SEED POWDER AND BUCKWHEAT FLOUR

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Keywords: Date seed, Milling, Buckwheat Flour, Traditional food, Hammer mill

ABSTRACT

Increasing health issues among children necessitates today's snacks industry to produce a product which has extra-ordinary qualities, i.e. gluten free, high nutrient level, ready- to-use, edible during fasting, suitable mainly for children but can be consumed by people of all age groups. A nutrient rich tradition product including *masala vada*, *halwa*, sweet and salty biscuits, was prepared using date seed powder and buckwheat flour. Initially, date seed was subjected to milling using multi mill and hammer mill to convert the seed into fine powder. Further, it was passed through 60µm mesh, to obtain an even fine particle size date seed powder. Physicochemical characteristics of date seed powder was analyzed. Energy consumed for milling of date seed powder was also calculated based on time consumed for milling 1kg of date seeds, in triplicate. Particle size, texture profile analysis, colour and sensory analysis were analyzed. Also, the proximate analysis was carried out for the developed products in comparison with the existing commercial products. The developed products contained protein ranging from (17.45 - 20.26%), calcium (134.48 - 164.22 mg/100g), Iron (1.09 - 1.24 mg/100g), Magnesium (140.26 - 148.37 mg/100g), manganese (0.27 - 0.35 mg/100g), zinc (1.22 - 1.25 mg/100g), copper (134.48 - 164.22 mg/100g), potassium (361.50 - 472.50 mg/ 100g) and sodium (130.55 - 134.45 mg/ 100g). The product would be suitable for all age groups, including celiac population and can be very good source of dietary fibre. The outcome of this study may have a greater effect on the malnutrition children of the country. In addition, consuming date seed would help the date Industry to utilize its waste into nutritious products.

GLT FROM OIL PALM WOOD – BUILD-UP, PRODUCTION AND ELASTOMECHANICAL PROPERTIES

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Keywords: GLT, oil palm lumber, density, GLT production, product properties, building products

ABSTRACT

The use of oil palm wood for load-bearing purposes requires defined strength and stiffness values for the design of structural members like glued laminated timber (GLT). Due to the enormous density variation of oil palm wood within the trunk, it is mandatory to rip the boards lengthwise into strips with almost homogenous density for further grading (cf. presentation “Grading of OP-Lumber – Techniques and Chances for Up-Grading Materials”). In this preliminary investigation, 50 % of the GLT produced lamellas, that are ripped lengthwise according to their density pattern using X-ray. The strips are glued to density homogeneous lamellas. The other 50 % of the GLT are lamellas of “full size” (non-ripped) with a naturally density gradient over the width. The lamella types were arranged in each case according to their density (properties) to combined (c) GLT (from ripped and non-ripped lamellas). In a 4-point-bending test according to DIN EN 408:2012 the elastomechanical properties of GLT and especially the influence of the lamella density and the ripping of the lamellas were determined by using two different beam setups. The results show a correlation between the density and the bending strength. The target characteristic strength values were achieved, the characteristic values of the beams with non-ripped lamellas are lower than that of GLT with ripped lamellas. A correlation between bending strength and local MOE can be seen. In summary, a separation of oil palm boards according to their density across the board width as well as a grading according to density ranges leads to an improvement of the properties of GLT from oil palm wood for load-bearing purposes.

BIOTECHNOLOGICAL POTENTIAL OF PRESSED OIL PALM TRUNK SAP

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Keywords: Oil palm trunk, Biotechnology, Pressed sap, Nutrients, Preservation

ABSTRACT

In the production process of palm oil, the oil palm (*Elaeis guineensis*) is felled after a life-time of 25 years due to decreasing yields and must be newly replanted. Especially the upper part of the trunk has barely utilized in industrial scale because of its poor structural properties. However, because of its high moisture and sugar content the pressed sap from the trunks offers high potential as growth medium for microorganisms and fermentative production of industrial relevant products.[1]

In our work we analyzed the sugar-composition and dry mass of the pressed sap in detail from different heights and diameter. Furthermore, we compared the nitrogen amounts in different sections.

As microbial infestation of the obtained sugary pressed sap is another major challenge different preservation methods and combinations were tested such as pasteurization, concentration and acidifying. In addition, the bacterial growth and product formation in untreated and preserved sap was compared.

Our results show a heterogeneous distribution of sugars and nitrogen amount in different parts of the oil palm trunk. In particular, the sap of the upper part of the oil palm trunk has a great potential as growth-medium for microorganisms and for the fermentative production of industrial relevant products. With our developed preservation method, the pressed sap can be stored for at least 8 weeks. Additionally, we could proof that the bacterial fermentation of the sap is even with the preserved sap successful. This leads to the conclusion that the pressed sap from the oil palm has great potential as a growth medium for microbial cultivation applications.

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MECHANICAL DEWATERING OF WET OIL PALM LUMBER PRIOR TO PRESS-DRYING

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Keywords: Oil Palm Lumber, Compression, Press-Drying, Bio-Sugars

ABSTRACT

Oil palm trunks consist of two main structural elements, hard vascular bundles and soft parenchyma ground tissue. The vascular bundles build the water transport system and strengthening structure of the palms and the parenchyma serves as the storage tissue for water and nutrients. Due to shorter rotation cycles compared to other palms, oil palm wood has lower densities, a wide density range (150-600 kg/m³ dry) and high moisture content. Moisture content varies, reversely to density, with the highest values of up to 600 % at the trunk core in the upper trunk. Kiln drying is difficult for material with low density and high moisture content especially from inner trunk sections and with increasing height because of the younger, softer material at the top of the palm. The higher and inner trunk parts are prone to drying defects such as cell collapse, cracks and mold. Mechanical dewatering of wet oil palm lumber in an unheated double roller press reduces the high water content and generates sugar-containing sap (pressed water) that could be used as a source for biochemicals. Following the mechanical dewatering, thermo-mechanical press-drying in a heated single daylight press was used to dry the material to mc ≈ 12 % and increase the material density. Density increment leads to higher strength and other properties. The share of mechanically removed water varied from 3 % to > 50 % of the total removed water from wet state to dry state (20 °C, 65 % rh). Inner boards from the top of the trunk had the highest dewatering rates while outer boards from the bottom of the trunk showed the lowest. The influence of the process parameters and the material parameters like board-location within the trunk on the dewatering is discussed in the paper.

ENZYMATIC DIGESTION OF OIL PALM TRUNKS TO CULTIVATION MEDIUM FOR *LACTOBACILLUS*

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Keywords: oil palm (Elaeis guineensis), Pre-Treatment, Lactobacillus

ABSTRACT

The oil palm (*Elaeis guineensis*) is the most widely cultivated plant for the production of vegetable oil, palm oil. When palm oil productivity decreases after a life-time of 25 to 30 years, the palms are felled and the oil palm trunks (OPT) remain as waste on the field. Oil palm trunks consist of polymeric materials such as lignin, cellulose and starch, as well as monosacchorides like glucose and fructose. Cellulose and starch can be hydrolyzed by enzymes called cellulases and amylases, to single glucose molecules. The resulting sugary solution provides a good source as cultivation medium for microorganisms.

In this study sawdust from the oil palm was utilized, which was accumulated as waste when processing the oil palm trunk. For the enzymatic degradation of OPT with cellulases, first a pre-treatment of OPT is essential to enhance enzymatic accessibility. The pre-treatment as well as the processing steps are cost intensive und need high energy levels, which is challenging. For the pre-treatment a classic autoclaving program (121°C, 1h) was carried out in neutral, basic or acidic milieu. Then the cellulose was digested with an applied cellulase mixture and the starch with amylases to glucose. The economic viability of these hydrolyses will be assessed.

These steps paved the way to a sugary cultivation medium for *Lactobacillus plantarum*. *Lactobacillus* is known for its probiotic characteristics and is found in functional food but also in animal nutrition's. Furthermore, *L. plantarum* produces lactic acid, which is an industrial relevant chemical and is, for example, a precursor of polylactic acid bioplastics. In this study, we were able to show that sawdust was a good starting material for enzymatic digestion and no further grinding was necessary. Enzymatic hydrolysis of cellulose and starch led to a promising cultivation medium for *Lactobacilli* strains.

ENVIRONMENTAL ASPECTS OF OPT-UTILIZATION FOR PRODUCTS AND ENERGY

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Keywords: OPT, Nutrients, CO2, Climate Aspects, Tropical Forests

ABSTRACT

Like all resource utilization, the use of renewable materials such as wood, agri- and palm-fibers causes negative and positive effects in environmental terms. OP-plantations are under political pressure, because they are established on former tropical forest land. Flora and fauna issues often rated higher than production and use of palm oil regardless that oil palms have the highest area productivity of all oil producing plants. The fiber materials like EFB, fronds and especially trunks are valuable sustainable materials for various uses, also replacing other less sustainable materials. Most important environmental issues are (1) effects on tropical forests, (2) loss of fertilizers with fiber extraction and (3) climate effects. Several research projects have shown impressive results in the above mentioned issues. (1) The production of fibers in OP-plantations is high, for trunks 2, fronds 3 and EFB 4 dry t/(ha·y). In terms of usable quantities at least the fiber mass is equal or higher compared to tropical forests. The new trend is planting fast growing trees like Albizia on topical forest land with impressive growth rates and harvest of up to 5 dry t/(ha·y). But here fibers are the only product, in OP-plantations oil and fibers are produced simultaneously. In future OP-fibers can supplement/substitute tropical timber and reduce pressure on tropical forests in terms of timber harvesting. (2) When using 50 % of the trunk volume during plantation clearing only a minor share of nutrients are exported with the trunk material. Returning residues, possibly upgraded with fertilizer, to the planted young palms can lead to an improved nutrient management in OP-plantations. (3) The use of palm fiber material in consumer products similar to wood for furniture, building components etc. and use of residues (including out-of-use products) for energy has a positive climate effect. In contrast to non-renewable materials a positive climate effect of some 1.5 to 2.0 t CO2 emission reduction is calculated due to material and energy substitution as well as carbon storage effects. Smart products, smart production processes, recycling and energy at the end of life make palm fibers to a material for sustainable future.

OIL PALM TRUNK UTILIZATION – OPPORTUNITY FOR THE FUTURE

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Keywords: Palm Trunks, Material Properties, Processing, Market Products

ABSTRACT

Today annually some 150 million m³ of OPT remain on the site when clearing and replanting the plantations. Logistic problems, pest issues and only little availability of recycled nutrients for the new plants parallel to declining wood availability from natural forests increases attractiveness for OPT-utilization in the wood based industry. R&D activities started already around the 1980´s in Malaysia. First emphasis was on material research, later on manufacturing to supplement wood products such as plywood, solid wood based products (furniture, doors etc.) and chemicals. Although understanding of material developed quite well, the manufacturing of good quality products with market potential failed because of the use of common processing technology, machines, tools, un-sufficient product design and finally high costs. After a peak around 2005 production volumes in plywood, lumber and furniture decreased in Malaysia until 2015; in other countries OPT is not in focus at all because of missing knowledge.

Since ten years new R&D efforts are on the way which still deal with the material as such but includes new/adopted manufacturing processes and products as well. Research institutions in Germany in cooperation with technology companies in Germany, Europe and Malaysia as well as research partners in Malaysia and Thailand have set up comprehensive development projects for industrial processing of OPT, appropriate product design, tool and process technology, including material logistics, environmental and socioeconomic aspects. Investments in R&D of this group during the last ten years exceeds some US$ 20 million. Presently the first large sawmill and board manufacturing plant is being commissioned. In the light of the availability of some 150 million m³ of OPT per year, of which 50 % is exploitable for industrial purposes without ecological risks but high socioeconomic benefits and an impressive contribution to future climate gives light for the future. 100 m³ of trunks used can provide one job for a year, can generate an economic value of up to US$ 15,000, and a climate value of 100 tCO_2. Taking these figures, only Malaysia could create 75,000 jobs, an economic value of more than US$ 1 billion and reduce actual CO_2-emissions by 5 %.

FROM SAWN TIMBER TO ENGINEERED WOOD PRODUCTS FROM OIL PALM WOOD

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Keywords: PalmwoodNet, Oil Palm Trunks, OPT, Palm Wood, Engineered Timber Products, Sustainability, Processing, Cutting Tools, Leitz

ABSTRACT

Machining the raw material "oil palm wood" for the production of solid and engineered wood products makes special demands on tools and machining processes. The fibre structure consisting of very hard vascular bundles embedded in a soft parenchyma make the cutting processes for obtaining smooth surfaces difficult. Furthermore, the high silicate and ash contents have a highly abrasive effect on the tool cutting edges thus reducing tool life.

Over a period of three years, the PalmwoodNet consortium has developed industrial manufacturing processes for engineered timber products from oil palm wood. The focus was set on blockboards and multi-layer boards for furniture, building materials, etc. The specific density gradient and structure of oil palm wood within one trunk was used to design product properties (e.g. weight, strength) for specific uses. The different structure of these composite materials places special demands on the cutting processes and their sequence.

Leitz target was to develop suitable cutting processes and tools. For this purpose, the wear mechanisms, the cutting process itself as well as suitable cutting materials and cutting edge geometries were systematically analysed. Based on the input materials (of different prefabrication degrees) for the respective panel products, the machining processes were determined from an economic point of view. Under practical conditions with industrial machines, long-term experience was obtained on the application behaviour of the tools. Reference values for production output and tool consumption to be used as key performance indicators were determined.

Four-side planing of the rough sawn boards as well as all sawing processes for cutting the boards into fixed lengths and ripping or splitting them in fibre direction are of central importance. Abrasive silicate and mineral particles in oil palm wood inevitably require the use of wear-resistant cutting materials. Particularly in the case of low-density material, cutting the hard vascular bundles requires very sharp cutting edges with small wedge angles. With modern carbides, a good compromise between wear resistance and toughness was found, and in combination with a suitable cutting geometry, high-performance and economical tooling and machining solutions were designed.

Besides the manufacturing processes for the production of panel materials, the further processing into final products such as doors, furniture parts or acoustic panels was also investigated and processing solutions for trimming and edge banding, light cut-outs and contour milling as well as drilling and lock case milling were developed.

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POTENTIAL OF DATE PALM FROND WASTE FOR PARTICLEBOARD INDUSTRY

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Keywords: Particleboard, Date palm, Palm frond, Core layer, Particle size, Sieve.

ABSTRACT

The shortage of raw wood for wood-based panels (WBPs) industries is a major challenge in Iran nowadays (Shalbafan et al. 2018). Utilization of agriculture residue is considered to be a promising option to decrease the competition of raw wood supply for WBPs industries. Importantly, Iran is one of the world largest cultivation area for date palm with approximate area of 240,000 hectare which generate large quantity of date frond waste per year. Although, three local small-sized factories tried to produce particleboards from date palm frond waste, but their panels with a density lower than 850 kg/m^3 was not met the standard requirement. In this study, three-layered particleboard was produced using conventional fine wood particles as faces and date palm frond particles as core layer. The palm frond particles (PFP) were prepared using two different chipping methods of chipper-flaker (CF particles) and flaker-hammer mill (FM particles) equipment described by Eghtedarnejad et al. 2021. It was also tried to improve the panels' quality using various mixture of PFP in face and core layers. The PFP particles were mixed with conventional fine and coarse wood particles at a weight ratio of 50 to 50% and 25 to 75%, respectively. The panels were produced using conventional urea-formaldehyde resin with the aim density and thickness of 650 kg/m^3 and 16 mm, respectively. The results showed that the internal bond values significantly raised by increasing the content of smaller particles generated by CF chipping method in the core layer. In addition, the thickness swelling and water absorption was lower in panels with un-sieved CF particles. The bending properties (bending modulus of elasticity and bending strength) was not influenced by varying the core layers particles. In general, the minimum requirement of particleboard properties according to EN-312/P2 (for interior application of particleboard) was successfully fulfilled. There are more details regarding the particles, their sieving procedures as well as the panels' preparation from the PFP which will be presented during conference.

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INNOVATIVE MODERN FURNITURE INSPIRED BY EGYPTIAN IDENTITY MADE FROM PALM FRONDS AND DIGITAL PRINTING TRENDY UPHOLSTERY DESIGNS

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Keywords: Furniture designs, Printed textile designs, trendy upholstery, Innovative modern furniture

ABSTRACT

Egypt is ranked in the first place among the top five date producing countries in the world according the latest report 2020. The leaf (jarid in Arabic), which is (palm fronds) is one of the most important and untapped local resources that, (through recycling, Up cycling, re-use and all the sustainability development strategies and tools), could produce many environmentally friendly products such as manufactured wood, carina, furniture ... and others. Furniture produced from palm leaves is one of the small industries scattered throughout Egypt, this paper focuses and outlines the utilization of (palm leaflets and fronds) mixed by trendy digital printed upholstery fabrics in making innovative modern furniture inspired by Egyptian identity according the international fashion trends. The paper aims to increase using palm leaves and fronds mixed with printed upholstery to make high end modern furniture. Also, It carries the characteristic of the Egyptian identity in terms of shape and composition and is characterized by low cost compared to the factory equivalent of natural wood, which gives an advantage High competitiveness with the possibility of achieving excellent profits in addition to the possibility of reducing import rates make Zero waste from palm, when spreading and circulating fronds and palm leaves furniture in different types of spaces as until now production is limited to structural furniture such as seats and tables, which will return to the Egyptian economy with many benefits, including The material benefit, the provision of job opportunities for small entrepreneurship and start-ups , the exploitation of local materials, the reduction of pollution rates by using palm leaves and fronds and digital printing textile which is eco-friendly printing, Also, the provision of a green-friendly final product made of local materials with an Egyptian identity.

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MECHANICAL AND MORPHOLOGICAL PROPERTIES OF DATE PALM TWIGS / HIGH-DENSITY POLYETHYLENE BIOCOMPOSITE: EFFECT OF FIBERS CONTENT AND TREATMENTS

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Keywords: Date palm fiber; High-Density Polyethylene; Treatment; Compatibilizer agent.

ABSTRACT

In this study, the effect of treatments and fibers loading content of date palm fibers on the mechanical and morphological properties of high-density polyethylene (HDPE) composites were evaluated. The date palm fibers were extracted from date palm twigs (DPT) of "*Phoenix dactylifera L"* trees and modified DPT fibers with Sodium hydroxide solution (NaOH) of 1wt %, Potassium permanganate (KMnO4) of 0.125 wt. %, and the use of maleic anhydride (MA) grafted HDPE (HDPE-g-AM) as a compatibilizer to improve the interfacial bonding of DPT/HDPE biocomposites. The Compatibilizer agent was obtained from a mixture of 5% Dicumyl peroxide (DCP), 0.3% MA and HDPE in an internal mixer "Brabender, HDPE biocomposite reinforced with three different DPT fibers loadings (10, 20, and 30 %) by using a two-cylinder mixer followed by compression molding, Mechanical and morphological properties of DPT/HDPE biocomposites were analysis by advance equipment .The obtained results show that the stress, elongation at break, and impact strength of composites decreased with the increase of fibers content, but the modulus of elasticity gradually increases. On the other hand, a remarkable increase in tensile and resilience properties depending on the modification of the fibers surface and the introduction of HDPE-g-AM. Furthermore, Atomic force microscopy results showed a reduction in the roughness of composites surface with the different treatments of DPT fibers. Our results confirmed the efficiency of treatments on the compatibility between fibers and the matrix. We concluded from this work that the use of DPT as a green and low-cost material in HDPE composite represents an alternative material to the synthetic fibers in many applications particularly in the automotive industry.

NEW SYNTHESIS ROUTES TOWARD ENHANCED INTERFACIAL BONDING IN BIO-COMPOSITES

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Keywords: Natural filler, Chemical treatment, Functionalization, Crosslinking, Bio-Composite.

ABSTRACT

The use of natural fillers extracted from crop residues to make bio-composites provides a sustainable alternative over wood-based derived fibers [1]. Nonetheless, the filler/polymer compatibility hinders large-scale application of bio-composites due to weak interfacial adhesion [2]. To address this challenge, the aim of this work is to develop a new technique comprising chemical treatment of filler and synthesis routes for polymer matrix to enhance bonding between the two components. The methodology will be dementated through development of a class of bio-composites from natural filler extracted from date palm agro-residues and polypropylene (PP) matrix. Firstly, the extracted fillers were chemically treated using a newly developed structured method [3] to enhance their intrinsic strength and surface properties. In specific, mercerization is used to alleviate amorphous biomass content and regulate the penetration level of NaOH-based ionic solution to react with OH group in hemicellulose and lignin to modify fiber surface characteristics and increase the content of crystalline cellulose. The mechanical, physical, and thermal properties of the treated fibers were significantly improved over the untreated counterparts. Secondly, three new synthesis routes for PP functionalization have been developed to further enhance the filler/polymer compatibility and hence the interfacial bonding. The functional groups residing on surface of synthesized PP-g-COOH, PP-*g*-*m*TMI, and PP-*g*-IEM will react with hydroxyl group attached to filler surface forming a chemical crosslinking between both elements. Findings revealed that filler crosslinked with PP-*g*-IEM exhibited the highest mechanical properties over the other forms of bio-composites. The current study furnishes a framework to fabricate a new class of materials by promoting new and effective chemical crosslinking between treated fillers and functionalized PP.

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LARGE SCALE BIO-SUCCINIC ACID PRODUCTION FROM INORGANIC SALTS PRETREATED OIL PALM EMPTY FRUIT BUNCH USING *ACTINOBACILLUS SUCCINOGENES*

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Keywords: large scale, succinic acid, semi SSF, oil palm empty fruit bunch

ABSTRACT

The abundance of accumulated oil palm wastes such as empty fruit bunch, frond and trunk has led to the research of numerous value-added products including biofuel, organic acids, polymer composites and other beneficial products. For the first time, bio-succinic acid is produced from inorganic salts pretreated oil palm empty fruit bunch (OPEFB) in large-scale fermenter via fermentation process. In this study, OPEFB is pretreated sequentially using alkalic and metal salts (sodium phosphate dodecahydrate and zinc chloride) before undergoing fermentation process in a16 L bioreactor using *Actinobacillus succinogenes* ATCC 55618. The optimum fermentation conditions were adopted from small-scale setting and implemented in the large-scale setting. Two different fermentation approaches were studied; simultaneous saccharification and fermentation (SSF) and modified simultaneous saccharification and fermentation (mSSF). Total reducing sugar (TRS) yield and succinic acid concentration were quantified to compare the efficiency of both methods. The findings revealed that the mSSF produced higher concentration of TRS yield and succinic acid compared to the conventional SSF method. At 72 hours, SSF of inorganic salts pretreated OPEFB obtained maximum concentration, yield and productivity of succinic acid of 38.85 g/L, 0.39 g/g and 0.54 g/L/h, respectively. On the other hand, maximum TRS yield obtained from pre-hydrolysis was 0.79 g/g at 72 hour and maximum concentration of succinic acid (50.5 g/L) was acquired under the mSSF at 132 hours with yield and productivity of 0.51 g/g and 0.38 g/L/h, respectively. Therefore, the mSSF is a novel process that has propitious potential for mass production of bio-succinic acid product in large-scale setting which can be further executed in the industrial scale.

THE INDUSTRIAL APPLICATIONS OF DATE PALM TREE SECONDARY METABOLITES AND TISSUE CULTURE TECHNOLOGY

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Keywords: Phoenix dactylifera, Secondary metabolites, Tissue culture, Bioreactors, Pharmaceutical industries.

ABSTRACT

The date palm (Phoenix dactylifera L.) tree became one of the most important cultivated palms around the world, because of highly nutritional fruit in addition to the multiple uses of all tree parts. Intensive studies indicated to the importance of dates as a rich source of secondary metabolites including carotenoids, phenols, lignin, flavonoids, tannins and sterols. Recent studies have demonstrated the therapeutic aspects of many bioactive compounds in date palm tissues such as antioxidants (lutein, β-carotene and vitamin A), antibacterial (vanillic acid, gallic acid and syringic acid), antifungal (tannic acid) and anti-cancer (quercetin) and anti-sterility (β-sitosterol and stigmasterol). Biotechnology approach provides the in vitro production of date palm secondary metabolites by cell suspension cultures and the scale up by bioreactors. The review describes the most important bioactive compounds isolated from date palm tissues, and the prospect applications of tissue culture technology for successful nutraceuticals and pharmaceutical industries.

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EVALUATION OF ENVIRONMENTAL IMPACT OF PALM-FIBER BASED GEOTEXTILE USING A LIFE CYCLE METHOD

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Keywords: Mediterranean palm, Palm-fiber Geotextile, Life cycle assessment (LCA), Cradle to gate

ABSTRACT

Currently, the geotextile industry is dominated by petroleum-based products, and the market share of bio-based geotextiles is still very low. With climatic and more generally environmental issues, combined with the scarcity of petroleum resources, the use of bio-based products appears to be an avenue of choice to explore. Through this study, we intend to raise the environmental benefits of a natural geotextile woven from fibers extracted from the leaves of the dwarf palm plant, an abundant renewable resource in Morocco and Mediterranean basin. We used the life cycle assessment analysis from cradle to factory gate following the requirements of ISO 14040 and ISO 14044 standards. Our main objective is to provide an environmental profile for this natural geotextile to encourage its use in soil protection and to stimulate therefore the local economy.

The LCA analysis results showed that the transportation phase is the main contributor to almost every environmental impact category. We also noticed that no environmental impact was identified for the raw material supply phase which is characterized by a traditional harvest of raw palm leaves from the palm plant that grows spontaneously in eco-friendly environment. A comparison with two examples of petroleum-based geotextiles available in the market shows that palm-fiber based geotextile presented the lower impacts in all the categories, with the exception of eutrophication and ozone layer depletion potentials, its carbon footprint is relatively low and can save an average of 0.85 Kg CO_2 eq. per surface unit (1 m^2), nevertheless, its water consumption exceeds that recorded for synthetic geotextiles. Finally, palm-fiber geotextile can compete with the synthetic one used in soil erosion, it is designed from renewable resource, naturally biodegradable, requires little energy for its production, and contribute to the reduction of greenhouse gas emissions.

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DEVELOPMENT OF MECHANIZED SYSTEM FOR PRODUCTION OF DATE-PALM JAGGERY GRANULES

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Keywords: Date-Palm, Jaggery, Sugar product, Traditional process, Jaggery granulator

ABSTRACT

Date-palm jaggery, popularly known as *khejur gur* (in India), is prepared by boiling-concentration of the sap (juice) collected from date-palm trees. Because of its characteristic aroma and flavor, it is mostly used as sweet agent in the Indian subcontinent and for making traditional confectionary items. Since the collection period of juice is only in the winter (mid November to early February), the idea of convenient use of solid jaggery for extended period was undertaken with the development of proto-type mechanized granulator for making granulated jaggery. The process comprised of boiling-concentration of juice under normal pressure, followed solidification by cooling, granulation with the developed system.

The developed proto-type granulating machine consisted of a half-round-bottom cylindrical horizontal trough to hold 20 kg solid jaggery. An axial shaft carries three rows of blades mutually 120° apart to each other, and the blades were fixed at 30° to the shaft and in staggered positions. The power transmission was with motor and chain and sprocket mechanism.

The material was fed into the machine and granulated by rotating the agitator blades for 15 minutes followed by hot air drying of the product at 50°C (final moisture content 1.5 – 2% db), sieving and packaging. Performance of the developed machine was evaluated at 5 levels of initial moisture contents (8.4 to 16.25 %db) and 5 levels of rotational speeds (48 - 132 rpm). Particle size distributions of the products were analyzed subsequently.

Mass mean particle diameter varied linearly with the moisture content of the feed, yielding average particle size of 656 µm for feed containing 8.4 (%db) moisture and rotational speed of 120 rpm. The mean particle size was 700 µm when the machine was operated at 132 rpm with feed moisture content of 12 (%db).

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EFFECT OF SALICYLIC ACID ELICITOR ON SOME SECONDARY METABOLITES PRODUCTION FROM CALLUS DATE PALM IN VITRO

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Keywords: Salicylic acid, Secondary metabolites, Date palm, Callus, Steroids

ABSTRACT

Secondary metabolites of date palm (*Phoenix dactylifera* L.) have received special attention given their health-benefit claims and potential uses in the booming functional food and nutraceutical industries. The analysis of date palm tissue has shown the abundance of secondary metabolites including phytosterols, e.g., steroids. Many previous studies used salicylic acid (SA) elicitor to the synthesis of secondary metabolites in medicinal plants have been conducted in order to increase the economic value of these species. The objective of this study was to evaluate the effect of SA as a abiotic stress on the production of total steroids in callus of date palm cv. Sewi. Callus received from shoot tip explants were transferred on MS medium containing of 0.5mg/l 2,4-D, 2.0mg/l Kin and the SA application was at concentrations of (0.0, 1.0, 1.5, 2.0 and 2.5 mg/l) for 30 days under in vitro conditions. The effect of SA on the metabolism date palm was evaluated through biochemical parameters. The SA at 2.0 mg/l resulted in linear increases in biomass accumulation of callus, vegetative growth and total dry mass. The application of SA at 2.0mg/l was most effective in eliciting the production of total steroids, with a consequent improvement of the estrogen, androstene, hydroxyprogesterone, and progesterone activity of the plant extract. It can be concluded that SA application constitutes an advantageous management practice for commercial production of *Phoenix dactylifera* increasing the nutraceutical and medicinal values of this species.

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OPT – READY FOR INDUSTRIALIZATION: PRODUCTS & MARKETS, TECHNOLOGIES, MILL DESIGN AND ECONOMIC OUTCOME

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Keywords: OPT, Processing, Products, Markets, Technology, business model, Oil palm trunks

ABSTRACT

After intensive R & D and thorough testing of all process steps, OPT has reached the status of industrialization. Moehringer as one of the core-partners of PalmwoodNet, Germany is acting as the General Contractor for industrial solutionsto process OPT into highly-valuable products [1]. This contribution will first present potential markets and specific products from OPT. Based on the chosen products the appropriate sawing and process technologies have been designed and configured in a modular way in order to meet different capacity classes. Finally, some key figures of the economic outcome and the profitability of OPT manufacturing plants will be highlighted.

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PROCESS DEVELOPMENT FOR IHI OPT & EFB FUEL PELLET PRODUCTION

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Keywords: Palm Biomass, EFB, OPT, POME, Methane Fermentation

ABSTRACT

IHI has developed total process to make biomass fuel pellet with OPT and EFB by zero emission process using a advanced methane fermentation process which has been used for industrial waste water treatment.

Through the total process, because fiber of EFB and OPT are cleaned by two step dipping system, alkaline content like potassium and sodium become lower than 500ppm. This low level is very suitable to use not only for biomass fuel boiler like CFB but also for mixed combustion boiler by industrial big boiler.

And because dipping wastewater is treated by an advanced type of methane fermentation reactor called IC reactor and generated biogas is used for heat and power which are necessary to pellet mill, sustainability of those biomass fuel become much higher than normal biomass pellet which is manufactured by existing normal process. The level of this sustainability is meaning that all heat and power are supplied by using biogas which is carbon neutral energy.

And this system has been finally developed for processing not only EFB, OPT but also OPF and MCF. If this system will be applied to normal scale mill, EFB, MCF and POME in a palm mill will treated with together OPT and OPF which are collected near the mill by one process and profit of mill will become 1.3 times bigger and total GHG reduction amount from all palm plantation and palm mill will be as same level as GHG emission which Japan discharged in 2013. This system will be able to provide big economical advantage and big environmental recovery to palm industry.

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FUTURE PROSPECTS FOR OIL PALM BIOMASS UTILIZATION LED BY SATREPS OPT PROJECT

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Keywords: Oil Palm, Oil palm trunk, Value-added products, Reactive oxygen species (ROS) scavenging ability, SATREPS.

ABSTRACT

Palm oil plays a decisive role in the lives of almost every one of us. Palm oil is an incredibly efficient crop, producing more oil per land area than any other equivalent vegetable oil crop. On the other hand, the development of oil palm plantations becomes a major environmental issue, such as deforestation of tropical rainforests and biodiversity loss. To avoid the problems, sustainable land reuse of plantation areas should be encouraged through replantation. Oil palm trees are generally replanted at 25 years intervals due to declining fruit production. So far, a massive amount of logged oil palm trunks (OPT) is usually abandoned in plantation areas and becomes troublesome wastes. Recent research has revealed that OPT is a bioresource with the potential to produce high value-added products. This new SATREPS project (SATREPS OPT project) [1] aims to resolve the environmental problems associated with oil palm replantation by developing efficient technologies by utilizing OPT as biomass resources to realize sustainable oil palm plantation farming the creation of new industries. The SATREPS OPT project is composed of four main research topics towards sustainable plantation farming systems. This session mainly introduces practical value-added products such as fuel pellets and materials from OPT and EFB through our knowledge and technologies among collaborating partners. In addition, we recently discovered the presence of highly reactive oxygen species (ROS) scavenging ability in OPT by employing the electron spin resonance (ESR) spin trapping method. OPT's high ROS scavenging ability also becomes a good source to produce pharmaceutical, cosmetic, and chemicals. This finding is expected to promote the utilization of palm biomass. This research project will play a role as an engine for realizing sustainable oil palm plantation farming and strengthening the partnership and cooperation between Japan and Malaysia.

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CELLULOSE FROM OIL PALM TRUNK AND ITS CONVERSION TO CARBOXYMETHYL CELLULOSE (CMC)

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Keywords: carboxymethyl cellulose (CMC), cellulose, oil palm trunk (OPT)

ABSTRACT

Lignocellulosic biomass is a natural resource made up primarily of cellulose, hemicellulose, and lignin polymers. α-Cellulose was extracted from OPT fibre using ASTM standard and eco-friendly processes. The eco-friendly cellulose extraction method employed an environmentally friendly multistep procedure that included alkaline treatment and chlorine-free bleaching. The purified cellulose was analyzed using Fourier transfer infrared spectroscopy (FTIR) and found to be comparable to standard commercial cellulose derived from cotton linters (Sigma-Aldrich). Subsequently, α-Cellulose extracted from oil palm trunk (OPT) was used as raw material for producing carboxymethyl cellulose (CMC). For the conversion into carboxymethyl cellulose, the α-cellulose was subjected to an etherification process, using sodium hydroxide and monochloroacetic acid (MCAA), with isopropanol as a supportive medium. The calculated CMC yield from cellulose ranged from 115.43% to 160.06%. The developed CMC had varying viscosities dependent upon the cellulose extraction methods employed. CMC produced from cellulose extracted using ASTM method has high viscosity (2319.4-2706.1 cP), whereas CMC produced from eco-friendly processes in the category of low viscosity which is less than 400 cP at 2% dilution in distilled water. These materials have a wide range of possible uses either in food or non-food industries, according to the findings of this work.

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RESEARCH AND DEVELOPMENT OF OIL PALM BIOMASS UTILIZATION TECHNOLOGIES FROM KLUANG PILOT PLANT

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Keywords: Oil Palm Trunk, Oil Palm Biomass, Research and Development, Circular Economy, Zero Waste Technology

ABSTRACT

OPTEraz Sdn. Bhd. is a research and development (R&D) pilot plant established in Kluang, Johor, Malaysia in 2014 via the collaborative efforts between IHI and JIRCAS (Japan) and USM and Kang Sem Enviro (Malaysia). This facility occupies a land area of about half acre with a fully equipped open shade factory capable of handling various processes such as chip and fiber preparation, chip and fiber washing, grinding, press drying, drying, pelletizing and water treatment. An office building beside this factory houses the R&D laboratory. Our facility is built to accommodate not just one but various oil palm biomasses such as oil palm trunk (OPT), oil palm frond (OPF), empty fruit bunch (EFB), mesocarp fiber (MCF) and palm oil mill effluent (POME). The primary objective for the establishment of this R&D pilot plant is to develop efficient processes for the conversion of various oil palm biomass into high value-added products. The first stage of R&D works began in the plant from 2014 until 2018. During this period, we have successfully demonstrated the conversion of OPT and OPF into pellet fuels which are bio-based and renewable alternatives for coal-fired power plants. Besides, due to the nature of OPT which is unsuitable for use as timber, it can instead be utilized as a sustainable resource for pellet fuel. This reduces the concern of having to use timber woods to produce the pellet fuels. Beginning 2019, the plant has been serving the SATREPS project. The aim of this project which is to promote sustainable replantation of oil palm by adding value to the OPT via scientific and technological innovation resonates well with the objective of this plant. Therefore, a lot of R&D work which focuses on the utilization of OPT has been collectively conducted in this plant. While the production of pellet fuel is continued under this project, many other projects such as those that are related to the fermentable sugar rich OPT sap, mineral rich treated effluents, biogas production and water recycling are currently being studied. This plant is expected to become a model for the oil palm industry which successfully demonstrates the implementation of circular economy and zero waste technology post-SATREPS project. The pilot plant can be used as a R&D and reference center by government and plantation developers interested in adapting this technology in future to enhance the sustainability of the oil palm industry.

STRATEGY OF OIL PALM BIOMASS UTILIZATION FROM TEXA

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Keywords: Bio-composites, Oil palm, Empty fruit bunch fibres, Injection molding, Texchem

ABSTRACT

Oil palm's empty fruit bunch, EFB fibres are non-wood waste that are available in abundance annually in Malaysia. Texchem Polymers has successfully transformed EFB fibres into valuable products to enhance its eco efficiency beside helping to alleviate methane gas generation if these EFB are left to rot in the plantations as of current practice. TEXa®, which is the United States Department of Agriculture (USDA) certified polypropylene, PP based bio-composites consists of 51 wt% of EFB fibres. TEXa® bio-composites can be used for injection moulding in applications such as automotive, furniture, household product, home appliances, oral care product, tableware, etc. There is an increasing demand of bio-composite for the past ten years for injection molding applications in contrast with the stagnant global market demand for profile extrusion and compression moulding applications which have limitations in product design. There are however technical challenges like the high outgassing, low thermal stability, low flowability of the EFB fibres that need to be overcome to enable the use of EFB reinforced PP bio-composites for injection molding. EFB/PP bio-composites with a balance of flow and functional performance have been successfully developed and produced via Texchem's in-house biomass pre-treatment process as well as its patented compounding technology. The physical, mechanical and functional performance of the EFB/ PP bio-composites in relation to its processability have been investigated and optimized to meet the demanding requirements in various injection moulding applications.

SUSTAINABILITY CONSIDERATIONS IN PRODUCING CHEMICAL CELLULOSE FROM THE VASCULAR BUNDLE OF OIL PALM TRUNK (OPT)

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Keywords: Chemical cellulose, Oil Palm Trunk (OPT), Alpha-cellulose, sustainable process

ABSTRACT

The utilization of renewable biomass resources in producing value-added products plays a vital role in developing the bio-based economy[1]. To align with sustainable development, the processes and chemicals applied in converting this biomass into biobased products must encompass economic, social, and environmental sustainability considerations[2]. As the biggest vegetable oil contributor, which accounted for 31.4% of total global oils, the palm oil industry also generates massive biomasses in various forms[3]. One of residual biomass is the oil palm trunk (OPT), which is obtained during the replantation of the oil palm trees. The vascular bundle (VBOPT) of OPT is rich in cellulose (ca. 69 % over holocellulose content)[4] and was isolated from the parenchymal cells after the sugar-rich sap extraction, high-pressure screw press, and drying processes. Due to the chemical composition advantage, VBOPT is a high potential sustainable resource to produce chemical cellulose. This study applied a simple water pre-hydrolysis followed by soda pulping with 25 % sodium hydroxide (based on the oven-dry weight of biomass). This process produced a pulp that met the chemical cellulose quality, with the alpha-cellulose content approaching 95 %. Besides, the hemicellulose (gamma-cellulose) content and kappa number of the unbleached pulp were below 3 % and 7, respectively. These findings indicated that the employment of the simple water pre-hydrolysis-soda pulping process could effectively improve the dissolubility of both hemicellulose and lignin while preserved the cellulose from degradation. The unbleached chemical cellulose was further bleached with chlorine-free bleaching (a modified hydrogen peroxide bleaching) to increase its purity and hydrolysability to produce nanocellulose. The results showed that applying simple treatments on VBOPT is feasible to achieve the targeted research objectives without the employment of costly and/or environmentally incompatible chemicals.

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INSIGHTS INTO THE PRODUCTION OF MICROBIAL-BASED BIOPLASTICS USING OIL PALM TRUNK SAP

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Keywords: Oil Palm Trunk, Oil Palm Trunk Sap, Polyhydroxyalkanoate, Cupriavidus necator NSDG-GG ΔB1/pBPP

ABSTRACT

Felled old oil palm trunks (OPT) in common plantation practices are chipped, pulverized and spread onto the plantation lands for nutrient recycling. However, the OPTs have many hidden potentials to be converted into value-added products. One of the by-products from the OPT is sap which is obtained by pressing the inner region of the trunk. It has been reported that OPT sap is rich in fermentable sugars, amino acids, vitamins and minerals which makes it a highly valuable medium for bioproducts such as bioethanol and lactic acid. Similarly, OPT sap can also be potentially used as a carbon feedstock or a cultivation medium in whole to produce microbial bioplastics. These bioplastics, or better known as polyhydroxyalkanoate (PHA) is accumulated in bacterial cells as insoluble polyester inclusions. The bacterial cells in stressed conditions such as in nitrogen depleted environment with excess carbon source converts the carbon feedstocks into the biopolyester inclusions as an energy storage. The carbon feedstock ranges from various oils and sugars. Owing to the potential of these biopolyesters to become an alternative to the petroleum-based plastics, OPT sap which are rich in fermentable sugars can become an economical choice for the production of PHA. In this study we have evaluated a mutant PHA producing bacterium *Cupriavidus necator* NSDG-GG ΔB1/pBPP in utilizing OPT sap with various sugar concentrations to produce poly(3-hydroxybutyrate) [P(3HB)] polymer. It was found that by supplementing OPT sap with a total sugar concentration of 20 g/L as the sole carbon source, this bacterial strain was able to accumulate up 26 wt% PHA in the cells. By adjusting the nitrogen feed to 0.34 g/L whilst maintaining 20 g/L of OPT sap, the strain was able to accumulate up to 43 wt% of PHA. Utilizing undiluted OPT sap as a cultivation medium in whole could only produce up to 25 wt% of PHA in the bacterial cells. This showed that a right balance between the carbon to nitrogen ratio is needed in order to produce PHA using OPT sap as a sole carbon source. On the other hand, the effects of various sterilization methods were tested out parallelly to determine the most effective one that can be used to sterilize OPT sap without compromising the potential for cellular growth and PHA production. It was observed that filter sterilization and autoclaving in mild conditions (110 °C, 15 min) gave similar results compared to the standard autoclaving conditions (121 °C, 20 min) which greatly reduced the cellular growth. In summary, this study has successfully shown that OPT sap can indeed be

used as a carbon feedstock or whole medium for the production of PHA. By fine tuning the cultivation parameters, OPT sap can be potentially used even for large scale PHA productions in future.

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THE EFFECTS OF OIL PALM TRUNK FIBERS ON PLANT GROWTH AND SOIL MICROBIAL COMMUNITY

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Keywords: Oil Palm Trunk, Lignocellulose, Soil Microflora, Metagenomic Analysis

ABSTRACT

The application of oil palm biomass such as felled oil palm trunk (OPT) as a nutrient source for oil palm replantation is in line with sustainable agricultural practice. Long term decomposition of OPT fiber residues by soil microorganisms can liberate carbon and nutrients from them and increase soil fertility. Hence, understanding the effects of OPT fibers on plant growth and soil microorganisms that constitute a large proportion of total biodiversity will enable responsible management of OPT waste, which is crucial to ensuring the sustainability of oil palm plantations. In this study, we investigated the enrichment of soil with OPT fibers and other lignocellulosic biomass that differ in cellulose/hemicellulose content and composition, namely bagasse and cellulose. Plants grown on lignocellulose-enriched soil, particularly using OPT fibers, exhibited reduced height, chlorophyll content and overall biomass in comparison with those grown on untreated soil. These results suggest possible changes in the soil microbial community and activity contributing to the consumption of these compounds. Metagenomic analysis revealed differences in the microflora of untreated soil relative to soil mixed with OPT fibers, bagasse and cellulose. Further studies are therefore necessary to improve understanding on the nutrient requirements of oil palms to enable efficient application of felled OPT for optimal supplementation of nutrients, in order to ensure healthy plant growth and good economic yields.

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INFLUENCE OF SEA WATER TREATMENT ON MECHANICAL AND DYNAMIC MECHANICAL PROPERTIES OF THE FLAX AND SUGAR PALM FIBRE BASED HYBRID COMPOSITES

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Keywords: Flax, Sugar Palm, Sea water, DMA, Mechanical properties

ABSTRACT

Natural fibres have proven to be a potential reinforcement for the polymer composites that has applications in the semi-structural and non-structural materials. These biocomposites are susceptible to degradation from the moisture, humidity and temperature effects in the atmosphere during their service life. Fibres from the plants and trees have natural affinity to moisture and the moisture uptake can vary from fibre to fibre. Thus, using two or more natural fibres in the laminate can significantly influence their physical, morphological, thermal and mechanical properties as well as the degradation characteristics of the hybrid composites. In this article, the influence of sea water treatment as well as the stacking sequence on the mechanical and dynamic mechanical properties of the flax and sugar palm (SP) based hybrid composites is investigated. The composites were fabricated by the compression molding technique and the composite specimens were immersed in sea water for 720 hours. Hybrid composites with the flax and SP fibre in the core and outer layer of the stacking sequence and vice versa exposed to sea water treatment was subjected to tensile, flexural, impact and viscoelastic characterization through DMA. The degradation in strength and stiffness under various mechanical loads for the hybrid composites were evaluated and compared with the composites reinforced with individual fibres. The changes in morphological characteristics due to the sea water treatment were also examined using the microstructural images from the scanning electron microscope.

GLUING OIL PALM WOOD FOR COMPOSITES

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Keywords: Adhesives, OPT, Oil Palm Wood, Penetration, Panels, Boards

ABSTRACT

Various panels and boards of different compositions and properties can be produced from Oil Palm Trunk (OPT), using either pure OPT or mixed build-ups with other materials, such as hardwood or veneers. This allows for customised composites depending on the type of application and use of end products. Lamellas sawn from oilpalm wood are side-glued to form blockboards. Several layers are laminated together to create multilayer panels. Materials of different densities can be combined to obtain lightweight panels with very light core layers and durable/heavier or visually appealing face layers. Different types of adhesives, such as water-borne dispersions, EPI, hotmelts, reactive hotmelts or PU prepolymer systems have been evaluated and compared. Performance and bond strength were tested on OPT test specimens of different density classes. Intensive investigations were carried out to clarify the penetration behaviour using microscopy images of microtome-produced cross-sections of coloured bonded joints. It is shown how different adhesives either penetrate the soft parenchyma or use the hard vascular bundles to be transported deep into the OPT. The oil palm wood structure can be significantly strengthened by using certain special adhesive combinations/ pretreatments-increasing the overall performance of the glued substrates. Pilot production of multi-layer panels of OPT is shown for both, manual manufacture and automated adhesive application using a large industrial roller coater line. Edge banding of OPT materials has been tested with different adhesives and performance was measured with T-peel tests. The work presented here was carried out within the framework of the PalmwoodNet research activities to develop a comprehensive technology approach for OPT usage.

PHYSICO-MECHANICAL PROPERTIES AND WEATHERING PERFORMANCE OF COCONUT HUSK FIBRE-REINFORCED COMPOSITE ROOFING TILES PRODUCED WITH SELECTED CEMENT ADMIXTURES

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Keywords: Coconut husk, Cement admixtures, Roofing tiles, Weathering test

ABSTRACT

Roofing constitutes a major cost item in building construction. The relatively high cost of conventional roofing materials is a factor militating against affordable housing provision in sub-Saharan Africa. This study examined the physico-mechanical properties and weathering performance of coconut husk fibre-reinforced composite roofing tiles produced with selected cement admixtures. Corrugated (40x30x0.6cm^3) and flat (16x30x0.6cm^3) roofing tiles were produced using Rice Husk Ash (ASH), Chicken Eggshell Ash (CESA) and Calcium Carbide Waste (CCW) as partial replacement for Portland Limestone Cement (PLC). Fibre content was 4% of cement mass; cement: water mass ratio was 0.4, cement: sand ratio was 1:2. Cement admixtures were 90%PLC+10%RHA; 90%PLC+ 10%CESA; and 95%PLC+5%CCW. Composites were demoulded after 24 h, immersed in CO_2-injected water inside a controlled chamber for 4 min at 5.5MPa and damp cured for 21days. Three replicate samples were tested for density, Water Absorption (WA), Thickness Swelling (TS), Modulus of Elasticity (MOE), and Modulus of Rupture (MOR). Corrugated and flat tiles were installed on a pitched roof structure and exposed to natural tropical weathering conditions for 24 months in Ibadan, Nigeria. Weather data were collected and triplicate samples of the installed roofing tiles were tested for density, WA and TS at 90-day intervals. Composite density (1.9 – 2.0 g/cm^3), WA (7.5 – 8.7%) and TS (7.8-11.1%) were relatively high. Partial replacement of cement with RHA, CCW and CESA slightly reduced the density and TS but significantly increased the WA ($p \leq 0.05$). The MOE (1.5 – 2.8 GPa) and MOR (1.4 – 5.0 MPa) were relatively low. However, RHA and CCW significantly increased MOE and MOR. Temperature, relative humidity and rainfall values for the weathering test duration were 28.8- 33.4^{o}C, 13.0-88.5% and 5.1-16.4 mm respectively. All installed tiles exhibited minimal reduction in density (<0.6g/cm^3), WA (3.0-4.6%) and TS (approximately 3%). Flat roofing tiles containing 10%RHA gave the best overall performance.

EFFECTS OF PARTIAL REPLACEMENT OF CEMENT WITH SELECTED POLYMERS ON SORPTION AND MECHANICAL PROPERTIES OF RATTAN CANE FIBRE-REINFORCED COMPOSITE ROOFING TILES

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Keywords: Rattan fibres, Polymer-cement, Cissus populnea, Roofing tiles

ABSTRACT

Environmental concerns about CO_2 emissions during Portland cement manufacture have drawn attention to the need to minimise cement consumption. Mixing cement with relatively cheap and readily available polymers is one way of addressing the challenge. This study, therefore, investigated the effects of polymer-cement admixtures on selected properties of rattan cane fibre-reinforced roofing tiles. Mature rattan (*Laccosperma secundiflorum*) canes were sun-dried and hammer-milled. The fibres were treated with dilute NaOH (10% w/v). Three polymeric materials were used in polymer-cement admixtures- Natural Rubber Latex (NRL); *Cissus populnea* Gel (CPG) extracted from the stem of cissus plant; and Acrylic Emulsion Latex (AEL), a synthetic paint. Triplicate samples of 160 x 50 x 6 mm composite tiles were produced with 3% fibre content using 0.5 cement/water ratio. Based on preliminary studies, cement was partially replaced (w/w) with 5,7.5, 10% NRL;10, 20%, 30% AEL; and 10,20,30% CPG in different composite samples cured under wet conditions for 28 days. The density, Water Absorption (WA), Thickness Swelling (TS), Apparent Porosity (AP), Modulus of Elasticity (MOE), and Modulus of Rupture (MOR) of the samples were determined using standard methods. Composite densities ranged between 0.86 and 1.23gc/m^3. All the three polymers, particularly NRL, significantly reduced the density ($p \leq 0.05$). WA ranged between 0.62 and 1.66%. Though CPG significantly increased WA, the values still fell within acceptable limits. TS (0.54-2.76%) was relatively low. AP (11.6-28.5%) was also relatively low except in samples containing AEL. The MOE (930-4649N/mm^2) and MOR (1.12-4.58N/mm^2) were within acceptable limits. However, NRL had negative, while CPG had positive effects on both strength properties with CPG increasing the MOE and MOR by approximately 100% of the control sample values. It was concluded that relatively strong and dimensionally stable rattan fibre-reinforced roofing tiles can be produced with CPG-Cement admixtures at cement replacement levels of up to 30%.

EFFECTS OF SELECTED CEMENT ADMIXTURES AND ACCELERATED CURING ON PHYSICO-MECHANICAL PROPERTIES OF COCONUT HUSK FIBRE-REINFORCED COMPOSITE ROOFING TILES

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Keywords: Coconut husk, Rice husk ash, Eggshell Ash, Carbide waste, Roofing tiles

ABSTRACT

The ban on asbestos-cement roofing sheets in many countries has contributed to the search for more environmentally friendly roofing materials. This study examined the effects of different cement admixtures and accelerated curing on physico-mechanical properties of coconut husk fibre-reinforced composite roofing tiles. Incineration temperatures were 800^{o}C for Rice husk Ash (RHA), 500^{o}C for Chicken Eggshell Ash Type 1(CESA1) and 900^{o}C for Chicken Eggshell Ash Type 2 (CESA2) which was also hydrolysed before use. For CESA1-based composite manufacture, fibre content was 4% of cement volume; cement: water mass ratio was 0.4, cement: sand ratio was 1:2. A super plasticizer, 0.3% of cement volume was added. Cement admixtures were 70% OPC+15%RHA+15%CESA1; 70%OPC+ 15%CCW+15%CESA1; and 70% OPC+7.5% RHA+ 7.5% CCW+ 15% CESA1. For CESA2-based composites, fibre content was increased to 6%. Other parameters remained constant. Control specimens were thermally cured at 60^{o}C for 5 days. The CO_2- cured specimens were exposed to 15% CO_2 at 60^{o}C, 60% RH and 0.34MPa for 12 hours. Six, 160 x 40 x 6 mm^3 replicate samples were tested to determine composite density, Water Absorption (WA), porosity, Modulus of Elasticity (MOE), Modulus of Rupture (MOR), and Flexural Toughness (FT). Micrographs of specimens were obtained using Scanning Electron Microscope (SEM). Composite density (1.77 – 2.14 g/cm^3) and WA (6.9 – 16.1%) were relatively high. Partial replacement of cement with RHA, CCW and CESA reduced the density and increased the WA, particularly the thermally cured CESA1-based samples. Porosity values ranged from 14.7 to 28.8%. Accelerated curing resulted in significant reduction in porosity ($p \leq 0.05$). The MOE (25.8 – 32.8 GPa) and MOR (9.2 – 12.9 MPa) of the CO_2-cured CESA2 samples were higher than CESA1 samples and the control. However, CO_2- cured CESA1 samples had the highest FT (107.2 - 185J/m^2). Micrographs showed acceptable fibre-matrix interaction in all tested samples.

BRAZILIAN COCONUT (*COCOS NUCIFERA*) HUSK FIBER AS POTENTIAL TEXTILE RAW MATERIAL

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Keywords: Coconut fiber, Brazil, Textile, Sustainability.

ABSTRACT

The coconut (*Cocos nucifera*) palm plays an important economic and social role in the Brazilian agroindustry. It is the 5th largest fruit producer in the world, generating huge amounts of husks residues. The inadequate end destination causes contamination and socio-environmental risks. The demand for natural fibers in textile sector has heightened the need for new sustainable materials. The issue has grown in importance in light of coconut fiber from residual husks. This research aims the analysis of coconut fibers as potential textile raw material in Brazil. A systematic review of the literature and creation of a bibliometric analysis network, based on the concepts of industrial ecology were carried out. Many researches have been developed in Brazil, such as: bio sorbent for textile dyes; handicrafts; green composites and copolymers. Thus, there is a great potential scope for expanding technological research in Brazil, including new sustainable materials for circularity.

COLLAPSE OF OIL PALM WOOD UNDER SEVERE AND MILD DRYING CONDITIONS

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Keywords: Oil palm wood, Wood drying, Collapse, Drying condition

ABSTRACT

An effective kiln drying of oil palm wood (OPW) lumber has been difficult to achieve because of the large variation of moisture content and density within the oil palm trunk. OPW is prone to drying defects such as collapse, twist and check. To investigate the underlying mechanisms of the OPW collapse, the lumbers were kiln-dried at various levels of relative humidity (RH) from severe to mild conditions at a constant drying temperature. Many quantitative assessments were employed at various stages of drying to determine moisture profile, cross-sectional area strain together with strains in the thickness and width directions and internal void fraction. The results reveal that higher RH condition produces slower moisture loss and slower strain development. All the strain and internal void quantities developed under various RH conditions were found to strongly correlate with a fraction of moisture loss. Thickness strain in the direction of liquid migration was observed to be greater than that in the direction of width. Stress reversal during drying commonly observed in hardwood and softwood was also detected in OPW. Analysis of the moisture and strain profiles across the thickness reveals the main role of the evaporation front on the collapse behavior of the wood cells during kiln-drying.

PROSPECTIVE LCA-BASED EMERGY EVALUATION FOR PULP PRODUCTION FROM EFB

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Keywords: Emergy, LCA, EFB

ABSTRACT

The oil palm plantation biomass wastes, such as empty fruit bunches (EFB), are the prospectus candidate for pulp production in Indonesia. EFB is the main biomass waste of the palm mill. It is potentially becoming a complement to wood for increasing sustainability. It can be assessed by the trade-off between human benefits and environmental impacts. The prospective life cycle assessment (LCA)-based emergy analysis will provide insight into the evaluated system in terms of environmental inputs from nature and benefits from outputs. The emergy analysis provides a more comprehensive view of sustainability than other methods. In recent years, many studies have combined emergy analysis with LCA to provide a broader perspective. The investigation of sustainability was based on emergy yield ratio (EYR), environmental loading ratio (ELR) and emergy sustainability index (ESI). In the proposed EFB-based pulp production, soda cooking and elemental chlorine-free (ECF) bleaching processes were used for producing the pulps. Natural resources are separated into renewable resources (R) and non-renewable resources (N). The renewable resources in this research are solar radiation and rain, while the non-renewable resources include soil loss and fossil fuels. In addition, the purchase resources (F) were also included in the emergy analysis. EYR, ELR and ESI for the proposed simulated process are 5.63, 0.62 and 9.07, respectively. The ESI value is higher than biodiesel production from palm oil on an industrial scale that is already calculated by other researchers. The system improvements are necessary to reduce the value of ESI, such as minimizing the use of non-renewable resources, reducing the imported chemical use and the increment in the process efficiency.

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SINGLE FIBER TEST BEHAVIOR OF LIGNOCELLULOSE SUGAR PALM FIBERS: EFFECT OF TREATMENTS

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Keywords: Single fiber test, Sugar palm fiber, Seawater treatment, Alkaline treatment

ABSTRACT

This paper evaluates the influence of two types of treatments on the tensile related properties of SPF by using a single fiber test. Natural fibers are one of the vital reinforcing materials in polymer composites due to their positive properties. Sugar palm fiber (SPF) is a kind of lignocellulose fibers that can be a good potential filler material in fibers/polymer composites for many utilize. A Scanning electronic microscope was used to evaluate morphological analyses. Seawater and alkaline solution treatments were used to treat the fiber before the test. The properties of palm sugar fibers improved significantly, as the effect of alkaline concentration by 0.5% (AF-0.5) and 0.25% (AF-0.25) improved the tensile properties of a single fiber by 10% and 176%, respectively compared to the untreated fiber. While the highest effect on palm sugar fibers was the fibers treated by seawater for 30days (SF-30) by 273%. Morphologic analyses showed that the treatment plays a big role to clean the surface of the fibers and remove the undesirable impurities. Overall, the results depict that the treatments improve the tensile properties of the single SPF.

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NEXT GENERATION NADES-BASED PULPING OF PALM FOR PULP AND PAPER MANUFACTURING

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Keywords: Palm, lignin, cellulose, NDES, biomass, ligno-cellulosic

ABSTRACT

The present day a revolutionary transition is needed in use of greener solvents in pulp and paper industry for a more sustainable pulp production. This requires a new approach, which will reduce the raw material, energy of manufacturing processes and minimize/eliminate the dispersion of harmful chemicals in the environment. Natural Deep Eutectic Solvents (NADES) are recently developed as one of these types of new solvents considered as bio-based Deep Eutectic Solvents (DES). During the fractionation process, a significant amount of hemicelluloses and lignin were dissolved from the palm using a natural deep eutectic solvent (NADES) that consisted of a mixture of choline chloride and lactic acid with the molar ratio of 1:9. In this fractionation process generated differently delignified pulp (celluloses). The delignified palm pulp was used for paper making with acceptable properties. The chemical composition and pulp properties were analysed to evaluate the efficacy of pulping process. The study shows that NDESs are effective at selectively dissolving lignin in biomass fractionation. In addition, lignin-derived NDESs were characterized and tested for lignin extraction, showing promising performance; meanwhile the solid cellulose-rich fraction was proved suitable for paper making. Further detailed investigation on these research areas will provide the versatile uses of NDESs for significantly lower cost and eco-friendly processes.

CHARACTERISTICS OF LIQUEFIED ADHESIVE MADE OF OIL-PALM STEM AND THEIR APPLICATION FOR PARTICLEBOARD'S BINDING

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Keywords: Liquefied adhesive, Oil-palm stem, Properties, Particleboard

ABSTRACT

Liquefied adhesive made of oil-palm stem was produced according to bio-refinery concept[1]. In this context, oil-palm stem was converted into 20-60 mesh powder and it was liquefied through liquefaction process involving thermo-chemical reaction and resulting in pre-polymer like phenol-formaldehyde (PF)[2]. The characteristics were determined based on Indonesian Standard SNI 06-4567-1998 for PF resin. The pre-polymer then was used for binding of three composition types of particleboards, namely 100% oil-palm particle, 50:50 mixture of oil-palm and jabon wood particles, and 100% jabon wood particle. Evaluation of the board was carried out based on Japanese Industrial Standard JIS A 5908-2003 for particleboard. Results of this study showed properties of the pre-polymer generally met the SNI except its viscosity was too high. For overcoming this, the pre-polymer was then diluted in solvent until it was appropriate to be placed in spray gun and passed the nozzle for further use as binder. Physical properties of the board showed moisture content and density fulfilled JIS standard however thickness swelling was up to limit. Mechanical properties of the board showed only modulus of elasticity (MoE) met the criteria of JIS standard while modulus of rupture (MoR) and internal bonding were below the target. Statistically, both parameters of moisture content and MoE within the board were different among the boards. For sum up, making adhesive from oil-palm stem using bio-refinery method was feasible and it can be applied for particleboard binding.

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UTILIZATION OF OIL-PALM LEAVES FOR MAKING INNOVATIVE PRODUCTS

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Keywords: Oil-Palm Leaves, Innovative Products, Board, Eco-printing

ABSTRACT

Traditionally, oil-palm leaves have been only utilized as cattle feed[1]. In this study, five innovative products made of oil-palm leaves have been presented, namely (i) particleboard; (ii) sheathing products; (iii) comply board; (iv) insulation board; and (v) eco-printing products. Particleboard has been made from oil-palm leaves using 10% urea-formaldehyde (UF) resin based on dry leaves with two different amount of hardeners, namely 1% and 3% ammonium chloride[2]. Sheathing products were similar to particleboard with some enhancement of raw material, for instances increasing of hardener amount up to 9% if still using UF resin; replacing UF with exterior type adhesive like isocyanate; layering thin veneer on both surface of the board; and mixing oil-palm leaves with recycle paper as the raw material[3]. Comply board has performance similar to plywood because of its face/back layers using thicker wood veneer. Further, comply can be used as structural application. Insulation board made of oil-palm leaves was able to absorb sound. Testing of its capability involved acoustical property. Eco-printing on paper and fabrics using oil-palm leaves only leaved pattern without any colors. Eco-printing is direct dyeing using any parts of plants without any extraction[4].

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STUDY OF EXTRACTION FIBERS OF DATE PALM FRUIT BUNCH BRANCH

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Keywords: Composites, Date palm fibres, Tow fibres, Extraction Under-product, Traction

ABSTRACT

The increasing demand for more sustainable and renewable materials has increased the interest in natural fibers. Natural fibers are not only environmentally-friendly, but they also have high specific properties, due to their light weight. The date palm tree is considered one of the sources of natural fibers. Fibers could be extracted from different parts of the date palm, namely, the midribs, spadix stems, leaflets, and mesh. The high population of date palm results in huge quantities of by-products of annual pruning, which makes it one of the most available sources of natural fibers.[1] Natural fibers are generally hydrophilic in nature, as they are in fact derived from lignocellulose, which contains strongly polarized hydroxyl groups .During the last few decades, cellulose has been one of the most abundant, inexpensive, non-toxic, and renewable bio macromolecules in nature and has been widely applied in diverse fields. Cellulose has a wide range of industrial applications in composites, textile, paper, food, additives and pharmaceutical industries. It is the most promising plant components to substitute synthetic polymers due to its low cost, nontoxic, and biodegradable properties. [2]

In this study, we choose to optimize the extraction process from date palm cluster arm in order to obtain fibers with minimum rate lignin, minimum degradation, a high yield and degree of whiteness[3] . As well as the mechanical characterization quasi static tensile chemically treated fibers by NaOH solution [4], compared to Tow fibers. The results show that the mechanical tensile strength of palm fibers was higher than that of Tow fibres. Finally for characterization these fibers by infrared spectroscopy (IR), XRD and SEM were used.

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SYNERGISM OF SILAGE PRODUCTION WITH PROBIOTIC REINFORCEMENT OF RECYCLED *L. LACTIS* IO-1 FROM LACTIC ACID FERMENTATION USING SAGO FROND

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Keywords: Sago frond sap, silage, L-lactic acid, LAB

ABSTRACT

The major restriction of sago palm plantation is the long maturation period for the sago palm to be harvestable for starch extraction. As such, sago farmers need to have a different source of income from sago. Sago frond was discovered to have numerous advantages as an alternative to be developed as a substrate to produce lactic acid and animal feed. Sago frond sap (SFSp) extracted from sago rachis using a roller press machine contain glucose, xylose and starch. Fermentation of formulated SFSp used as media to produce L-lactic acid generates optimum concentration of biomass of *L. lactis* IO-1 (14.53 g/L). The cells then recycled as inoculant for silage production using mixtures of residual sago fibre (RSF) and leaves (SL). The mixture of 1:1 RSF/SL was identified as the best formulation for silage production considering the five ideal characteristics (DM, ADF, TWSS, minimum pH and protein content). Amendment with *L. lactis* IO-1 definitely improves efficiency of ensiling by accelerating the acidification process, hence refining preservation of the protein content (23.49%) in the sago frond silage (inoSFSil). Addition of *L. lactis* IO-1 ends up with a silage containing high concentration of acetic acid (27.7 g/g) which maintains viability of the LAB and improve aerobic stability of the silage to suppress secondary contamination from yeast and mould. The growth performance of the animal model was reflected by the average daily gain (ADG) of the sheep fed with inoSFSil was comparable with commercial pallet at 74.12 g/day and 97.67 g/day, respectively. Even so, inoSFSil exhibit better feed efficiency with -125.35 g/day residual feed intake (RFI) and 6.46 feed conversion ratio (FCR) compare to commercial at 81.48 g/day and 12.93 g/day, respectively. Therefore, feed cost to produce a sheep using inoSFSil was projected around RM 280.00 compare to RM 540.00 by using commercial pallet.

IMPACT & BLAST RESISTANCE BEHAVIOUR OF OIL PALM SHELL CONCRETE & COMPARISON WITH NORMAL WEIGHT CONCRETE

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Keywords: Oil palm shell, lightweight aggregate, aggregate impact value, ductility, impact resistance, oil palm shell concrete, blast load, blast resistance.

ABSTRACT

Oil palm shells (OPS), once considered as pollutant and waste material in Malaysia and other palm oil producing nations; today, it is one of the commercial products and despite its nature as a biodegradable material, it has been shown that OPS could be used as coarse aggregate as a replacement for the conventional crushed granite aggregates. In this research, the use of OPS as ductile and blast resistant characteristics have been investigated and reported. This is the first time an organic material has been tested to prove its effectiveness as ductile and blast resistant material. A series of blast tests was conducted on reinforced concrete slabs made with conventional crushed granite aggregates (NWC) and compared with slabs made with OPS concrete (OPSC) of similar grade of concrete. The instrumentation includes linear variable displacement transducers, pressure transducers and accelerometers to record data of response of the slabs subjected to blast loads of 1, 5 and 10 kg TNT. The recorded data were then analyzed and compared, and conclusions were made on the effectiveness of OPS as a coarse aggregate. It has been found that OPSC outperformed NWC slab when subjected to 10 kg TNT as the ductile OPSC panel was intact and had no shrapnel. The ductility behaviour of OPSC was evident through multiple cracks and the impact resistance of OPS through its energy absorption due to fibrous content within OPS itself was visible. Despite being organic nature, OPS exhibited resistance to blast waves as the huge fire ball created due to blast hasn't damaged the OPSC panels compared to NWC panels. Overall, the behaviour of OPSC in blast resistance characteristics is significant and further tests are required to envisage the use of appropriate content in OPSC.

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MICROALGAE BASED PALM OIL MILL EFFLUENT (POME) TREATMENT AND BIOFUEL PRODUCTION: A BIOTECHNOLOGICAL APPROACH TOWARDS SUSTAINABILITY AND ENVIRONMENTAL PROTECTION

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Keywords: POME, nutrients, bioremediation, biofuel, sustainability

ABSTRACT

Malaysia is one of the major palm oil exporters, thus generating tremendous volume of Palm oil mill effluent (POME) on daily basis. POME is defined as the wastewater generated during the overall production process of palm oil. Approximately 6 tonnes of fresh water is consumed to produce 1 tonne of crude palm oil, however 50% of this amount is turned into wastewater [1]. POME if discharged not complying with the standards may cause deleterious impact on environment. Therefore, it should be treated efficiently before discharging to the environment. There are various conventional methods for the treatment of POME like physicochemical, aerobic, anaerobic and membrane technologies. To overcome the limitations of these processes and to provide sustainable solution researchers are working extensively on the microalgae-based treatment of POME. POME contains all the necessary nutrients (N, P, K, Mg, Fe, Zn, Ca) required for the cultivation of microalgae [2]. The aerobic bacterial oxidation of organic matter is advocated by microalgae producing photosynthetic oxygen, which catalyzes POME treatment especially in terms of high BOD and COD. Microalgae also has the potential to detoxify, transform and volatilize the heavy metals present in POME. The removal efficiency of Characium sp. and Chlorella vulgaris for nitrogen and phosphorus are 80%; 89.9% and 86%; 78% respectively [3]. Microalgae thus cultivated can be further utilized to produce biofuels, since the microalgae is having high biomass yield and lipid content, It was revealed in a study that the biomass and lipid yield of chlorella vulgaris and chlorella sorokiniana when cultivated in POME was higher as compared to other synthetic mediums. The biomass produced can also be further processed to achieve various value added bioproducts. This puts microalgae-based POME treatment in a win-win situation. This paper provides an acumen of the microalgae-based treatment of POME integrated with biofuel production, in a systematic and critical manner.

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COMPARATIVE STUDY OF DATE PALM MIDRIB AND SPADIX FIBERS WITH OTHER LEAF FIBERS AND THEIR COMPOSITES

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Keywords: Date palm fiber, Midribs, Spadix stem, Leaf fiber, Natural fiber composites

ABSTRACT

Due to the lack of biodiversity in natural fibers and their poor distribution worldwide, there was a need to find new sources of natural fibers that could be widely available and have acceptable properties. Recently date palm has been emerging as a rich source of vegetable fibers due to its wide availability and its large production of byproducts that are suitable for fiber extraction. However, the literature lacks a comprehensive study that benchmarks and compares the extracted textile fibers from date palm and other commonly used natural fibers. Therefore, the aim of this research is to conduct a comparative study between textile fibers extracted from the date palm midribs and spadix stems to other commonly used leaf fibers including sisal, abaca, and banana fibers and their composites. Three types of date palm fibers were used in this work; date palm midrib (DPM) core and skin fibers in addition to date palm (DP) spadix fibers. The comparison includes morphological, physical, chemical, mechanical and thermal properties in addition to comparing the tensile and flexural properties of their nonwoven polypropylene composites. The composites are made from 50% fiber weight fraction using compression molding process. The results showed that the six tested fibers had cellulose wt.% ranging between 60 % and 80 % and hemicellulose and lignin wt.% values less than 25% and 13% respectively. The thermogravimetric analysis showed that the fibers are thermally stable nearly till over 200 °C. The composites mechanical properties showed that DP composites had tensile and bending strength of 20 – 22 MPa and 32 – 34 MPa respectively. This research will help in identifying the position of date palm midrib and spadix stems fibers among the other leaf fibers. Additionally, it will open the doors for date palm textile fibers to be used in various applications and consequently increase the biodiversity of natural fiber sources.

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PHYSICAL AND MECHANICAL PROPERTIES OF WOOD FROM DATE PALMS RELATED TO STRUCTURE

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Keywords: Palm, Pith, MOE, Modeling

ABSTRACT

Date palms are a family of Arecaceae with several species. In the current study density and compression strength of the wood from two date palm trunks (Phoenix dactylifera) and their relation to wood structure as well as strength properties of vascular bundles were investigated. Results showed that – different to most other palms - there is no significant difference in density across the trunk diameter and along the trunk length. Wood compression strength (MOR) parallel to fiber direction correlates significant with wood density but it does not correlate with share of vascular bundles on the sample cross section. The reason is the weak parenchyma which allows buckling of the vascular bundles and shear failures along the interface parenchyma and vascular bundle. MOE and MOR of single vascular bundles are much higher compared to the overall wood. But this reinforcement has its limits due to the much weaker parenchyma. The results contribute to the development of a mechanical model to describe material characteristics based on structure and density of the palm wood.

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DATE PALM FIBRILIUM WASTES AS A NOVEL SOURCE OF NATURAL COLORANT FOR TEXTILE MATERIALS

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Keywords: Date palm Fibrilium, Wool, Multi-fibres fabric, natural dyes, dyeing,

ABSTRACT

In textile field, natural colorants are more likely to be used as an alternative to substitute the synthetic colorants because of the allergenic and toxic risks from synthetic colorants [1,2]. This study proposes to test the affinity of the dyestuff extracted from the date fibrillium and to use as dye for multi-fibers fabric (acetate, cotton, nylon, polyester, acrylic, and wool). This choice was made in order to test the affinity of the extracted dye into different kinds of textile fibres. It was shown that the different types of fibres were well dyed. The darkest dyes were obtained especially with wool and nylon fabrics. Based on these results, wool and nylon fibres were selected to develop a research on dyeing based from dyes from date palm. The effect of the main operating conditions such as temperature, pH and duration on the dyeing quality resulted has been studied. K/S and CIELab values were used to evaluate the dyeing properties. The use of sustainable chemical and bio-mordants before and after dyeing has not only given new shades but also improved the fastness ratings. It is can be concluded that date fibrillium has excellent potential for coloration of wool and nylon fabrics, where the application of low amount of bio-mordants has made process more ecological, economical and sustainable.

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A NEW APPROACH FOR STUDYING THE DYEABILITY OF DATE PALM RESIDUES FABRIC WITH SUSTAINABLE NATURAL DYES

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Keywords: Natural dyeing; handicrafts; date palm leaves;

ABSTRACT

Date palm (*Phoenix Dactylifera*), which is mostly found in the north Africa, the middle east, and the United States (California) that play a significant role in the economical as well as the environmental condition in those areas. In addition to them bring into the high food nutrition value, the date palm offers a wide range of renewable and abundantly available agricultural by-products. Palm tree provides eight kinds of residues namely: Petiole, Rachis, Leaflets, Fibrillium, Bunch, Pedicels, Spathe, and thorns, which it can be collected from the seasonal pruning process. In Tunisia, date palm tree acquires great importance historically, socially and economically. The pruning, especially the leaves, are utilized in many traditional industries and construction by the cultivators and craftsmen. Actually, craftsmen used synthetic dyes to dye their products. This paper devoted to develop a dyeing process of handicrafts products with natural dyes. The color yielding plant materials obtained from natural dyes extracted from date palm was compared to the dyes extracted from various sources such as: henna (*Lawsonia inermis*) leaves, madder (*Rubia tinctoria*) roots and turmeric (*Curcuma Longla L.*) rhizome. It can be concluded that the dyes extracted from date palm with using different mordants can be offer a large color palette of shades of varied hue and tone. The effect of various metal salts (ferrous sulphate, and alum) as mordants on color and fastness properties of dyed samples were comparatively evaluated. The dyed samples color was investigated in terms of CIELab (L*, a* and b*) and K/S values. The results seem to be very interesting and encouraging to explore at industrial scale.

BONDING PROPERTIES OF COMMERSIAL SCALE WOVEN OIL PALM SANDWICH COMPOSITE MADE OF UREA FORMALDEHYDE & PHENOL FORMALDEHYDE RESIN

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Keywords: Internal bonding, Woven composite, Oil Palm, Resin

ABSTRACT

The main objective of this study was to determine the internal bonding of woven oil palm sandwich composite when different type of resin and spread rate was applied. In this study, two types of resin (urea formaldehyde and phenol formaldehyde) at two different spread rate (300 g/m^2 and 500g/m^2) were used. To produce woven oil palm sandwich composite, the oil palm trunk was trimmed, weaved, soaked and dried before the resins were spread. Internal bonding test were done on the woven oil palm sandwich composite. The results showed that lay-up of non-woven outer trunk gives higher internal bonding reading compared to lay-up of woven outer trunk. Generally, urea formaldehyde results in better wood mechanical properties than phenol formaldehyde. Further studies of other adhesive as bonding agent are needed to find out the best type of adhesive to utilize the oil palm sources as substitute of timber as raw material.

IMPROVEMENT OF UNLOADING EFFICIENCY FOR CRUDE PALM KERNEL OIL (CPKO): A PIPELINE TRANSFER IS BETTER TRANSPORTATION MEDIUM COMPARED TO TANKER

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Keywords: Supply Chain; Crude Palm Kernel Oil (CPKO); Unloading process; Logistic

ABSTRACT

World palm oil consumption has significantly increased over the years. The southeast Asian country is a trusted supplier of sustainable palm oil, producing 35 percent of the world's palm oil. Indonesia has scored a significant achievement on oil palm development by becoming the biggest palm-oil producing country in the world and Malaysia is the second largest producer after Indonesia. The palm oil industry has been earmarked by the Malaysian Government as a critical player in its aspiration of becoming an industrialized nation towards Vision 2020. Concurrent to achieve the vision the supply chain model a part of create the value to create the delivery system which is more responsive to cater the high demand. One of the elements in supply chain that will highlight in this paper is a logistics efficiency. Logistic consists in two big component which are loading and unloading condition. This paper will highlight logistic operation which is unloading handling for incoming raw material. The unloading process will highpoint the raw materials are Crude Palm Oil (CPO) and Crude Palm Kernel Oil (CPKO). The role of transportation is a significant component of supply chain. Such a focus leads to decision that lower transportation cost need to meet customer requirement at the same time. Selecting a transportation mode is both a planning and an operational decision in a supply chain. The logistic improvement for unloading operational will give new angle for increasing the productivity and good time management for company. Throughout the pipeline transfer, the most significance highlighted in terms of cost saving, time saving which are involved travel time and tanker turnover time. Besides, the spillage case improved also significance element in this study.

EFFECT OF FIBER ARCHITECTURE AND TREATMENT ON DATE PALM MIDRIB FIBER COMPOSITE

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Keywords: Date palm fiber; fiber architecture; nonwoven; unidirectional; comingled

ABSTRACT

Date Palm fiber is emerging as a sustainable substitute to manmade reinforcements for composite materials. Yet, to harness the full potential of this fiber it has to be prepared in a suitable textile preform and surface treated. The objective of this research is to investigate the effect of fiber architecture and treatment on the mechanical properties of date palm - polypropylene composite. 8 composite samples were prepared with different architecture (non-woven, commingled and core-wrapped unidirectional), and different weight fractions (40%, 50% and 60%) and different treatments (untreated and Maleic Anhydride treated). The tensile and flexural composite properties showed significant difference when changing the fiber reinforcement architecture. The core-wrapped unidirectional, commingled unidirectional and non-woven exhibited (40 MPa,748 MPa), (33 MPa, 670 MPa) and (14 MPa, 309 MPa) for the composite tensile strength and modulus respectively. For the flexural properties, the core-wrapped flexural strength was 58 MPa, 47 MPa for the commingled and 27 MPa for the non-woven. For the different non-woven fiber weight fraction, 50% fiber composite (50 DP, 50 PP) showed the optimum results for both tensile and flexural properties. Surprisingly, the fiber treatment with maleic anhydride has negatively affected the mechanical properties when compared with the non-treated samples. The impact properties of the 8 samples will still be measured and the fracture behavior will be studied.

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DATE PALM SURFACE FIBERS AS A GREEN THERMAL INSULATOR

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Keywords: Date palm surface fibers, green insulation, waste management, thermal conductivity

ABSTRACT

High performance thermal insulation in the building structures is necessary for energy efficiency. The installation of thermal insulation becomes more cost effective and environmentally friendly when insulations are made from renewable materials. Here, high performance green insulation material using date palm surface fibers were prepared in simple process without utilizing any toxic materials. Polyvinyl alcohol has been used as a binding material to prepare four insulation samples with different densities. The fabricated green insulators showed promising thermal insulation properties with thermal conductivity and thermal diffusivity values in a range of 0.038-0.051 W/(m.K) and 0.137-0.147 mm2/s, respectively. Thermogravimetric analysis showed that the insulating sample has high thermal stability with a very high initial degradation temperature between 260-280 ºC where it losses only 10 wt.% of its original weight. Differential scanning calorimetry analysis showed a very high melting point value of 225 ºC for insulating sample which closely corresponds to the binder melting point. FT-IR analysis confirmed that the fiber-based insulation material retains its organic nature. The insulation material has a reasonable ultimate tensile range of 6.9-10 MPa. Results of this work show that development of insulation materials from lignocellulosic waste materials is a promising strategy to develop green and cheap substitutes for petroleum-based high cost and toxic insulation materials.

DATE PALM FIBER COMPOSITES: PROCESSING, PROPERTIES & APPLICATIONS

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Keywords: Date palm fiber, composite, book, Springer

ABSTRACT

Date Palm (Phoenix dactylifera) is one of the most populous members of the palmae family and one of the main elements of flora in the Middle East and North Africa. Date palm is a very rich source of cellulosic fibers, fibers can be obtained from the byproducts of annual pruning such as the sheath, spadix stems, midribs, leaflets and even the trunk at the end of the palm life. The renewed interest in sustainable resources and biobased materials has given a surge to rediscovering those agriculture byproducts in new applications with higher added value. The focus of this book is on the emergence of date palm fiber as a new source of cellulosic fibers that can be used in the reinforcement of polymer composites. The significant features of date palm fiber are abundance, relatively low price, and competitive mechanical, physical, and chemical properties, which makes it, stand out as an alternative to other fibers currently used in the natural fiber composites market.

Date Palm Fiber Composites: Processing, Properties and Applications is the first published book title on date palm fiber and its composites. The book acts as a body-of-knowledge or handbook for researchers and industrialists interested in this field. It covers the different aspects of date palm fiber composites with focus on their processing, properties and applications. Includes up to date information on research carried out on date palm fiber composites covering versatile topics such as, history of utilization, extraction, treatment, preform formation, composite fabrication, nanofibers, design and modelling, characterization and properties. In addition to, real life applications in construction and building, wood substitutes, automotive, and other potential future applications.

The book can be ordered from Springer https://www.springer.com/gp/book/9789811593383

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THE USE OF FRONDS WASTE AS BIOMASS IN SAUDI ARABIA, MEDINA REGION CASE STUDY

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Keywords: Biomass, palm waste, power generation, environment, alternative power sources

ABSTRACT

Even though dates are produced in large scales in Saudi Arabia, it is not the only product palm trees can offer. Transformative products of palm trees that can be beneficial for the community are intense. For instance, using fronds waste as a biomass to generate power at remote areas or central cities where palm trees population is intense might be a transformative product of palm trees. Using natural waste as a supplement source of electricity at the communities living near palm farms will have a profound effect on the environment and economy. This paper discusses the use of palm trees' fronds as a biomass in Saudi Arabia. It complies with the kingdom's strategic power plan where alternative power sources are encouraged in the vision 2030. This paper briefly illustrates the opportunity of using biomass, statistics of palm trees in Saudi and the use of biomass as a feedstock to generate electricity in Medina region as a case study.

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UTILIZATION OF COCONUT-TRUNKS – MAKING MORE AND BETTER PRODUCTS

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Keywords: Coconut palm, palm trunk, coco-wood availability, processing, products

ABSTRACT

Coconut Palms (cocos nucifera L.) grow in all tropical regions around the world. Often they are planted in rows along the fields but mostly within fields in pure palm stands or as part of agricultural systems. The total area worldwide is estimated at 10 million ha with a total of some 1000 million palms. The average palm age at felling/replacement is 70-80 years, resulting annually in 12-15 million palms available for felling with a total of 10-13 million m³ of trunks. Due to the scattered distribution throughout agricultural areas the processing of the trunks into different products is mainly locally with transportable sawmills or in local small operations. Quality of processing, yield of products, costs and quality (uniformity) of products is crucial. Efforts to process “coco-wood” in larger mills equipped with advanced machines and tools have often failed. Coco-wood products are rarely competitive in high-end markets, but coco-wood finds its way into arts and household articles. As with most palms machining of coconut is difficult due to generally high density, structure (vascular bundles and parenchyma), and a high percentage of silica cells around the vascular bundles. The achievements with processing of oil-palm-trunks could positively influence coco-wood processing, in particular in terms of processing, output, product range and quality. Well designed and manufactured products for building purposes (load and non-load bearing), interior decoration and furniture, including hybrid designed products with other palm material or conventional timber could have a chance to enter higher value consumer markets.

COCONUT WOOD: PROPERTIES, PROCESSING AND PRODUCTS

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Keywords: Coconut palms, trunks, palm-wood properties, advanced processing, market products

ABSTRACT

Coconut Palms are replaced when 70-80 years old. Trunks are up to 20 m in length and up to 40 cm (base) and 25 cm (top) in diameter. The wood density varies within the trunk between 0.25 and 0.80 g/cm³ and the fresh wood shows a high initial moisture content. Properties and processing of the wood is influenced by the wood structure with parenchyma cells as ground tissue (low density and low strength) and vascular bundles as reinforcing material (high density, very hard and high strength). Mechanical properties mainly depend on density and position within the trunk. Trunk density oriented sawmilling and (NDT) timber grading leads to different grades of material (density and strength) for different uses. Many properties of coconut-wood are comparable with those of many common timber species. Material adopted product design and advanced processing technology could produce competitive products for many different markets. Projects in the past often developed and manufactured products with different success, mainly because of limited technology for processing and unbalanced matching of material properties with product requirements. A former project between Germany and Indonesia (1) showed that modern industrial technology can lead to high quality, high performance and competitive products on various markets like flooring (one layer and multi-layer), solid wood based panels (one layer and multi-layer) furniture, shop decoration, building purposes, window and door frames (3-layer) and general uses. Quality and costs of the products were good but sufficient supply with rough sawn timber i.e. to European markets were unfeasible. The implementation of modern technology in countries of origin like South East Asia or Central America requires a certain mill production capacity, which need investment capital, entrepreneurs, and optimism in the future.

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ECO-FRIENDLY DYEING OF BICOMPONENT (PET/PTT) FILAMENTS WITH NATURAL DYE EXTRACTED FROM DATE PALM PITS POWDERS (*PHOENIX DACTYLIFERA*)

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Keywords: Bicomponent polyesters filaments, Date palm pits, Natural dye, color, fastness

ABSTRACT

Bicomponent polyesters filaments (PET/PTT) are known for their excellent elastic recovery[1], good elasticity[2], soft touch[3] and good thermal comfort[4]. All these properties make them suitable for use in sportswear. These clothes are too close to the body. So, their dyeing with synthetic dyes presents a great danger to human health. In fact,traces of residual dyes or auxiliaries when mixed with the sweat could generate allergenic and carcinogenic products[5]. In this context, this study investigates the feasibility of dyeing bicomponent polyester filaments with a natural dye extracted from a very abundant raw material in the Tunisian south, date palm pits.The characterization of the aqueous extract from the point of view of chemical composition (content of polyphenols, tannins and flavonoids) and antioxidant activity were carried out. Knits made from 100% bicomponent polyester filaments were used for dyeing. Knitted samples were characterized by analyzing their morphology, mechanical and thermal properties. The main dyeing conditions effect on the color yield (K/S) and the color coordinates of the dyed samples were investigated. Many parameters such as the dye bath pH, temperature and duration of dyeing were established. The experimental design was carried out to be able to analyze the main effects of each parameter, to detect interactions between these parameters and to deduce the optimum conditions for dyeing process. The fastness properties of dyed samples were also evaluated. The obtained results indicate interesting washing and rubbing fastness in the range of 4-5. These good values are due to metal and mineral contents in date pits.

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INVESTIGATING THE AGING OF NITRILE RUBBER REINFORCED WITH DATE PALM FIBER

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Keywords: Date palm fibers; Nitrile rubber; alkali treatment; Silane treatment; Mechanical properties; thermal properties; aging.

ABSTRACT

In light of governmental regulations and environmental awareness, its emphasis on environmental and sustainable sources of material, coupled with a new socio-economic awareness, scientists are making tremendous efforts to find new environmentally friendly materials. Presently, Industries which widely use polymer are seeking sustainable and environmentally friendly materials to comply with governmental regulations.

This research investigated the aging of nitrile rubber (NBR)/ Date palm fiber base composites. The date palm fibers were prepared through grinding, sieving, and treating the date palm fibers. the fibers were treated with NaOH 5% and with a silane coupling agent (Si69). Standard samples of NBR with different loadings of fiber were mixed and standard test samples were cured using compression molding. The mechanical, thermal, morphological, and aging tests of the composites were carried out at different conditions.

The mechanical properties of the composites containing date palm fibers were decreased slightly in comparison to the unfilled or carbon black compounds. However, the treatment resulted in a noticeable increase in mechanical properties of the composites as compared to the composites containing untreated fibers. The date palm fibers loading preserved the mechanical properties when they were subjected to hot air or ozone, whereas its resistance to oil dropped slightly due to swelling. Dynamic Mechanical Analysis (DMA) results showed that the treatment of the date palm fibers improved the interaction between the fibers and the nitrile rubber, which is supported by Scanning Electron Microscopy (SEM). Moreover, thermal studies showed that the fibers did not obstruct the rubber chain movement and the treatment enhanced the thermal stability of the fibers. It was concluded that the fibers could be added to the nitrile rubber to be used in applications where elongation is not a critical property, and where no contact with oil is involved. Using such compounds will enhance the economic use of date palms, reduce waste to the environment and create a circular economy for the country.

BIOREFINERY CONCEPT OF FIBER EXTRACTION AND BIOGAS PRODUCTION USING COMMON DATE CULTIVAR BIOMASS (*PHOENIX DACTYLIFERA L.*)

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Keywords: Common date, biorefinery, fibers extract, biogas

ABSTRACT

Date production is usually associated to a considerable loss either in common cultivars or in fruit picking and storage stages. This discarded biomass is not very well valued up to now especially in bioenergy production. The Tunisian second-grade cultivar 'Kenta' was biochemically characterized in the present study. 'Kenta' discarded flesh is rich in soluble sugars (79.5 %VS ± 0.8%VS) and fibers (7.4 %± 0.5%VS). The crude fibers were recovered after soluble sugars extraction. The biochemical composition analysis showed that this by-product contains mainly carbohydrates (33.2 % VS± 0.7%VS) and proteins (8.8% VS ± 0.1% VS) making it a suitable substrate for biogas production. A biorefinery concept was therefore developed based on soluble sugars (date-syrup) aqueous extraction and biogas production via anaerobic digestion of the residual fibers. The proposed concept showed interesting results since it permitted the co-production of date syrup, as high-added value product, with 0.6 g sugars/gVS and biogas with maximum methane yield of 225 mL CH4/gVS fibers. This study presents a proof of a sustainable processing approach allowing an almost bioconversion of undervalued secondary date variety.

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CHEMO-MECHANICALLY ISOLATED CELLULOSE NANOCRYSTALS FROM DIFFERENT PARTS OF OIL PALM FRONDS

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Keywords: Cellulose nanocrystals, Acid Hydrolysis, Thermal properties, Morphology

ABSTRACT

Since Malaysia has the second largest oil palm plantation area in the world, it subsequently produces huge amount of oil palm biomasses such as the trunks, fronds, empty fruit bunches, mesocarp fibres, kernel shells and etc. These biomasses could be utilised in replacement of natural fibre for various wood-based products which simultaneously could reduce the dependency on the log. Therefore, this study was conducted to explore the potential of oil palm frond (OPF) for the isolation of cellulose nanocrystals (CNC) by using chemo-mechanical treatment. It is important to denote that the anatomical structures of oil palm biomass have some impacts on its properties mainly attributing to the distribution of parenchyma cells and vascular bundles. This work investigates the properties of CNC isolated from top, middle and bottom part of OPF by using acid hydrolysis followed by mechanical treatment. Sulphuric acid was used with a concentration of 64% and the hydrolysis was done for 1 hour. The CNC were characterised for their thermal properties, morphology, crystallinity and zeta potential analysis. The transmission electron microscopy (TEM) images displayed size reduction and good dispersion of the CNC with the highest aspect ratio possessed by the CNC from top part of OPF. The CNC from top part of OPF also had the highest crystallinity index of 63% and the best thermal properties compared to the middle and bottom parts. The results obtained from this study has proven that this under-utilised biomass has good potential to be exploited as a new raw material for CNC production.

OIL PALM FROND PRETREATMENT BOX BEHNKEN DESIGN OPTIMIZATION STRATEGY USING (EMIM)AC AS IONIC LIQUID FOR BIOENERGY POTENTIALS

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Keywords: 1-ethyl-3-methylimidazolium acetate, Box Behnken, Pretreatment, Oil Palm Frond, Ionic Liquid, Response Surface Methodology

ABSTRACT

Cellulosic Oil palm frond (OPF) as abundantly generated in Malaysia has been investigated for future bioenergy potentials for like biofuel. 1-ethyl-3-methylimidazolium (EMIM)Ac ionic liquid (IL) has high capability of cellulosic dissolution for liquid biofuel. Thus, in this project, (EMIM)Ac has been investigated for the pretreatment of OPF in a batch isothermal reactor for the optimization strategy, simulating the investigated microscale reaction using BioShake iQ. These (EMIM)Ac IL pre-trials using simulated lignocellulosic biomass, microcrystalline cellulose (MCC), with various (EMIM)Ac concentration percentage of 0, 10, 30, 50, 70, 80, 90 and 100 % (v/v) were conducted in a 2-mL microtube at 1800 rpm, 99°C and for 3 hours. The resulted crystallinity index (CrI) values from X-Ray Diffraction (XRD) analysis, indicated positive pretreatment effectiveness. Theoretically, the distorted pretreated MCC chains indicated a transformation of a less ordered structures, is predicted to increase the effectiveness during hydrolysis/fermentation for biofuel production. A slight larger scale of a batch reactor with a working liquid volume of 70-mL was then approached. The pretreatment optimization strategy on OPF was conducted using IL concentration percentage (CP) of 20, 40 and 60% (v/v) of (EMIM)Ac, with solid loading (SL) of 5, 10 and 15% (w/v) of OPF-(EMIM) Ac as well as at reactor temperature of 90, 110 and 130°C. The conducted 15 sets of pretreatment on OPF, gathering sets of CrI, were investigated using Box Behnken method in Response Surface Methodology which proposed optimized pretreatment strategy of approximately 48% (v/v) (EMIM)Ac with 12% (v/v) OPF-(EMIM) Ac and at the temperature of 92°C. The optimized pretreatment strategy is predicted to moderately balance between CP and temperature to SL per volume basis. With this, the challenge in utilizing highly efficient IL but costly during pretreatment of OPF can be decreased gradually towards the realization of OPF biofuel market.

EFFECT OF NANOSILICA MODIFIED EPOXY ON TENSILE PROPERTIES OF *ARENGA PINNATA* POLYMER COMPOSITE

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Keywords: Arenga Pinnata, Sugar Palm, Nanomaterials, Tensile properties, Nanosilica

ABSTRACT

This paper presents a study on the effect of nanosilica content on tensile properties of *Arenga Pinnata* fibre reinforced epoxy composite (APREC). The composite plates were produced using *Arenga Pinnata* fibre as the reinforcement material and epoxy resin modified with nanosilica as the matrix. Three types of specimens using nanosilica modified APREC were produced with different nanosilica content. The specimens were label as B4 for *Arenga Pinnata* fibre reinforced 5wt% nanosilica modified epoxy composite, B5 for *Arenga Pinnata* fibre reinforced 13wt% nanosilica modified epoxy composite, and B6 for *Arenga Pinnata* fibre reinforced 25wt% nanosilica modified epoxy composite. The main concern of using nanosilica as nanomodified epoxy is agglomeration. To counter that problem, the epoxy and nanosilica were mixed using magnetic stirrer machine that was set to 4000 rpm at temperature of 80ºC for 1 hour. Specimens B4, B5, and B6 then underwent tensile test using ASTM D3039[1]. Tensile properties show that specimen B4 which has 5wt% nanosilica content has the highest tensile strength 71.206MPa and tensile modulus 4.110GPa, followed by specimen B5 which has 13wt% nanosilica content with tensile strength 64.496MPa and tensile modulus 3.756GPa, and the lowest of all was specimen B6 with 25wt% nanosilica content with tensile strength 39.707MPa and tensile modulus 3.205GPa. As conclusion, the optimum amount of nanosilica in APREC is 5wt% for this composite system.

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NON-DESTRUCTIVE TEST (NDT) APPROACH FOR EVALUATING HIGH STRENGTH CONCRETE INCOPORATING WITH PALM OIL FUEL ASH (POFA)

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Keywords: POFA, NDT, rebound hammer, UPV, cracking, bending

ABSTRACT

Concrete is the main and popular construction materials in Malaysia. Cost effective and durable are the main factors that make it the best and affordable materials in Malaysia. This paper presents the non-destructive approach for high strength concrete with the inclusion of POFA. In addition, crack monitoring of high strength concrete with POFA inclusion is also conducted. High strength concrete is design for Grade 60 and the utilisation of POFA acts as additive from 2.5%, 5% and 7.5% from cement weight. All specimens underwent water curing and were tested on 7 and 28 days. All samples were evaluated for NDT testing using rebound hammer and UPV. After that, all NDT samples were undergone bending test using universal testing machine to evaluate the flexural behaviour and crack pattern. From this report, NDT testing shows a similar result to the destructive test. In addition, the utilisation of POFA at every level of addition in concrete also enhanced the cracking behaviour of concrete. As a conclusion, the utilisation of POFA was proven to enhance the concrete performance especially mechanical properties. Apart from that, NDT approach can be used as an alternative technique to the destructive test for evaluating the mechanical properties of concrete material.

FAILURE EVALUATION OF ARENGA PINNATA/NANOSILICA EPOXY COMPOSITE LAMINATE UNDER UNIAXIAL TENSION AND COMPRESSION USING ANSYS

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Keywords: Arenga Pinnata, Polymer Composite, ANSYS, Uniaxial Tension, compression

ABSTRACT

Nowadays, natural fibres extracted from plants are becoming more popular among researchers as a reinforcement material in polymer matrix composites due to their environmentally friendly and good mechanical characteristics. Fibre reinforced polymer (FRP) composites have been developed and become a trend in maintenance and repairing industry to replace the commercially available metallic materials due to their capability to tailor the base or substrate material properties. In this study 3 different compositions of nanosilica were introduced to epoxy composite and reinforced with Arenga Pinnata natural fiber. The effect of nanosilica inclusion and weight fraction on maximum stress properties of Arenga Pinnata FRP composite laminates were evaluated. The purpose of this paper is to analyse and simulate the failure behaviour, deformation behaviour, and mechanism of failure of composite laminate using ANSYS and maximum stress criterion. Finite element modelling and analysis of symmetric and anti-symmetric Arenga Pinnata/nanosilica Epoxy laminates were conducted. The effect of fibre orientation angle on tensile and compressive properties of arenga pinnata FRP composite laminates was determined. Maximum Stress Theory has been implemented to predict the failure load with failure index equals or approximate to a value of 1. Numerical validation and convergence analysis were performed simultaneously. From finite Element analysis the maximum stress and deflection of composite were generated using ANSYS software. Results show that the value of stress and deformation decreased with increasing amount of nanosilica content in the arenga pinnata FRP composite laminate.

WORKABILITY AND PERFORMANCE OF HIGH-PERFORMANCE CONCRETE USING PALM OIL FUEL ASH AS A CEMENT REPLACEMENT MATERIAL

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Keywords: POFA, workability, compressive, flexural

ABSTRACT

Malaysia as the world's largest exporter of palm oil has been facing problem in disposing palm oil fuel ash, a by-product of palm oil mill, since many years ago. Through public concerns and research efforts, the agriculture waste by-product materials have potential to be utilized as construction material by replacing the conventional ordinary Portland cement (OPC). In this research, the effectiveness of agro-waste ash by-product namely palm oil fuel ash (POFA), as alternative material to replace the OPC, was evaluated. POFA cement-based concrete is a concrete produced by integrating POFA as a pozzolan in concrete. The quality of POFA was improved by secondary treatment until the size were 212 microns. The refined POFA were used to replace OPC by 0%, 2.5%, 5.0% and 7.5% by weight of cement binder. The workability test, covering slump test and flow table test, was carried out to determine the workability of fresh concrete. The results revealed that the slump value was increased as the percentage of POFA in the sample increases, but the results from flow table show a contradict effect. Besides that, the compressive and flexural strength of POFA-concretes due to 1, 3, 7 and 28 days of curing ages were also investigated. The results revealed that the mechanical properties of POFA-concretes were enhanced as compared to the control specimen and 5% POFA was recorded as the optimum replacement level when compared to the other samples. It is revealed that POFA fineness is an excellent pozzolanic material and can be used as an alternative cement replacement in concrete. It is recommended that the optimum replacement levels of OPC by POFA are 5.0% as mixture for a good strength in compressive test and 2.5% mixture for a good strength in flexural test.

EFFECT OF ANGLE PLY ON TENSILE STRENGTH OF UNIDIRECTIONAL GLASS/EPOXY AND ARENGA PINNATA/EPOXY HYBRID COMPOSITE LAMINATE

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Keywords: ANSYS software, Off-axis ply, Arenga Pinnata , Polymer Composite, Uniaxial Tension

ABSTRACT

Over the last few decades, researchers have aggressively been investigating natural fibre reinforced polymer composites for replacing conventional synthetic polymeric materials in a variety of applications, including automotive, medical, agricultural, thermal management, and building insulation. The usage of synthetic fibre in industry is exacerbating and challenging on recycling of non-biodegradable and costly materials. In this study, modelling and simulation technique is used to predict the tensile properties of Unidirectional Glass/Epoxy and Arenga Pinnata/Epoxy Hybrid Composite Laminate. The effect of off-axis ply on tensile strength of both FRP composites was evaluated using ANSYS software based on maximum stress failure criteria. A symmetric finite element modelling and analysis of $[0/\theta/-\theta]_{4s}$ Glass/Epoxy and hybrid with Arenga Pinnata/epoxy natural fiber laminates that is subjected to uniaxial tension is simulated. The stress of the hybrid laminate composite of natural fibre from Arenga Pinnata yields a moderate stress value, indicating that the composite is reliable. The maximum tensile stress of fibre laminates with orientation of 0°, 15°, 30°, 45°, 60°, 75°, and 90° degrees was evaluated. The highest value of maximum stress was observed for 0° laminate layup, whereas the lowest value was observed for 90° fiber orientation. This study contributes to a new knowledge on predicting the tensile strength value using modelling and simulation techniques. The predicted simulation values of the hybrid composite performance could be used for natural fibre composite product designing and performance evaluation purposes.

EXPERIMENTAL PERFORMANCE EVALUATION OF *ARENGA PINNATA* REINFORCED NANOSILICA-MODIFIED EPOXY COMPOSITE LOADED IN COMPRESSION

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Keywords: Compression, Arenga Pinnata, Sugar Palm, Nanomaterials, Nanosilica

ABSTRACT

Compressive behaviour and properties of fibre reinforced polymer (FRP) composites materials are important in designing structures and mechanical components. In this study, plant-based fibre namely arenga pinnata is used to fabricate light weight FRP composites. The objective of this study is to evaluate the effect of nanosilica content on compressive stress-strain response and properties of *Arenga Pinnata* FRP composite. Three different nanosilica contents were incorporated into the epoxy polymer matrix for the fabrication of *Arenga Pinnata* FRP composites. The specimens were label as 5wt% nanosilica modified APFRP composite, 13wt% nanosilica modified APFRP composite, and 25wt% nanosilica modified APFRP composite. The nanosilica modified epoxy resin was prepared using magnetic stirrer machine that was set to 4000rpm at temperature of 80ºC for 1 hour. Compressive test was conducted based on ASTM D3410 [1]. The compressive stress-strain graphs show that the 5wt% nanosilica modified APFRP composite curve has the highest stress and strain at failure values indicates the lowest values when compared to 13wt% and 25wt% nanosilica in the APFRP samples. This shows that the addition of 5wt% nanosilica produces high compressive modulus and strength properties. Based on the graphs, 25wt% nanosilica modified APFRP composite sample has compressive strength of 70.786MPa and compressive modulus of 1.874GPa. The addition of 13wt% nanosilica in APFRP composite produces sample with compressive strength and modulus properties of 93.336MPa and 1.945GPa, respectively. It was found that, 5wt% nanosilica modified APFRP composite sample has the highest compressive strength and compressive modulus with values 102.053MPa and 2.142GPa, respectively. This research contributes to a new knowledge on the effect of nanosilica addition to the properties of *Arenga Pinnata* FRP composite.

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PROCESSING AND ALKALI TREATMENT IMPACT TOWARDS OIL PALM FROND FIBERS BULK DENSITY AND WOOD-PLASTIC COMPOSITE PERFORMANCE

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Keywords: Alkali treatment, Bulk density, Oil palm frond, Wood-plastic-composite

ABSTRACT

The oil palm biomass is challenging in term of its mass utilization and its compatibility to various processing. The use of alkali treatment on wood particles could modify the surface making it suitable for processing with polypropylene. This work analyses the impact of alkali treatment on the bulk density and its impact on the mechanical properties of wood-plastic composite (WPC). Fibers used were treated at 3 concentration level of NaOH (1, 2 and 4 %) and compared to control (no treatment). Two fiber loading 10 and 50% were blended representing high matrix and high fiber environment respectively. The materials were melted and blended at 195°C with pressure of 1000psi for 6 min. Test samples were prepared and tested in accordance to relevant ASTM procedure. Bulk density of fibers indicated an inversely proportional relation to concentration of alkali. Mechanical and physical properties showed better performance after alkali treatment and the impact is varies according to the loading factor of the composite. While tensile and flexural modulus of rupture plus elongation is at higher value for 10% fiber loading, the composite with 50% fibers exhibit higher modulus of elasticity and impact performance. The trend of 10% loading is either V shaped or inverted V shaped for mechanical properties indicating the impact at 2% modification being strongest. The 50% fiber loaded WPC have either upward trend throughout the mechanical properties proportional to the alkali content. Capillary action of fiber in void created in higher loaded composite explained the lower thickness for 10% loaded WPC. Composites using treated fiber are a good option for future development as it could be further optimized using varying processing parameters such as temperature, pressure, time, loading factor and coupling agent addition.

EFFECTS OF DENSITY AND RESIN CONTENT ON PARTICLEBOARDS FROM OIL PALM FRONDS

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Keywords: Dimensional Stability, Flaker, Urea Formaldehyde

ABSTRACT

Oil palm frond (OPF) biomass can act as an alternative source for wood-based industry. OPF was an agricultural waste and its producing millions of tons of biomass every year. The oil palm frond was obtained from oil palm plantation UiTM Pahang. The frond part of the oil palm was separated for further processes. The OPF was converted into a flake using a ring flaker to produce the particles. The urea-formaldehyde resin was used as a binder. The particleboard samples were then tested for their mechanical and dimensional stability of OPF by using different resin content and board density. The tests on the mechanical properties include Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) and Internal Bonding (IB). The dimensional stability tests are thickness swelling and water absorption. The results showed that the higher density board and resin content seem to have a better result in mechanical properties and physical properties. Statistical analysis indicated significant differences between boards made from different densities except for thickness swelling, but highly significant differences were observed in the resin content. Boards with a density of 700 kgm-3 and 12% of resin content achieved the minimum requirement based on the JIS A5908:2003 standard. The particleboard from oil palm fronds has the potential to be used as an alternative resource to overcome the shortage of raw material in the wood industry.

MODELLING AND SIMULATION OF QUASISTATIC INDENTATION AND IMPACT RESISTANCE OF ARENGA PINNATA/NANOSILICA EPOXY COMPOSITE

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Keywords: Quasistatic indentation, Impact, Arenga Pinnata, Polymer Composite, ANSYS

ABSTRACT

Deformation and failure behaviour are important characteristics that need to be analysed for future improvement in quality, reliability, and safety, especially for synthetic and natural fiber reinforced polymer (FRP) composites. In this study, the impact response, maximum deformation and maximum stress of Arenga Pinnata FRP composites are determined using finite element modelling and simulation technique. The quasi-static indentation behaviour and impact resistance properties of Arenga Pinnata FRP are then compared to those of synthetic glass FRP composite. ANSYS Software was used to simulate symmetric $[\theta/-\theta]_{2s}$ laminate sequence. The effect of nanosilica and fibre orientation of 0°, 15°, 30°, 45°, 60°, 75°, and 90°degrees on impact response and indentation behaviour were investigated. From this study, it was found that the off-axis laminates of 15°, 30°, 45°, 60° and 75°fibre orientation angles exhibit better resistance to sudden impact of 50m/s velocity and static indentation loading when compared to unidirectional 0° and transverse 90° composite laminates. 25 wt% nanosilica addition improves the impact properties and maximum indentation loading of the FRP laminates. It can be concluded that FRP composites made of Arenga pinnata plant based FRP composites has good impact and indentation properties. Arenga pinnata FRP composite has good potential to replace the synthetic glass fibre composites.

MAXIMUM BENDING STRESS ANALYSIS OF NANOSILICA FILLED ARENGA PINNATA/EPOXY AND CARBON/EPOXY POLYMER COMPOSITES

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Keywords: Bending, Flexural, Arenga Pinnata, Polymer Composite, ANSYS

ABSTRACT

Bending in applied mechanics characterizes the action of a slender structural structure subjected to an external load applied perpendicular to the element's longitudinal axis. Bending stress deformation behaviour and flexural properties of fibre reinforced polymer (FRP) composite materials are important data in designing structures and mechanical component. The bending or flexural properties of FRP composite materials depends on the type of fibre and the fibre sequence architecture. Therefore, in this study, bending stress and deformation analysis are determined using modelling and simulation technique. The dimension of the specimen is set up based on ASTM standard D7264. In addition, the effect of fibre types, i.e., Arenga Pinnata and Carbon, on flexural stress-strain behaviour, the effect of layer sequence on maximum bending stress and deformation properties and the effect of 25wt% nanosilica inclusion in the epoxy were simulated and calculated. ANSYS Software was used to simulate symmetric $[\theta/-\theta]_{2s}$ laminate sequence. The effect of nanosilica and fibre orientation of 0°, 15°, 30°, 45°, 60°, 75°, and 90° degrees on flexural behaviour were investigated. From this study, it was found that the 0° unidirectional laminate exhibits the highest flexural strength when compared to all off-axis laminates. The presence of 25 wt% nanosilica improves the bending properties of both Arenga Pinnata and Carbon FRP polymer composites. It can be concluded that FRP composites made of Arenga pinnata plant based FRP composites has low flexural properties when compared to conventional carbon FRP composites.

ACTIVATED CARBON FROM DATE PALM RACHIS FOR CONTINUOUS COLUMN ADSORPTION OF *O*-CRESOL

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Keywords: Activated carbon, date palm, chemical activation, fixed-bed column, breakthrough curve.

ABSTRACT

High surface area micro porous activated carbon has been prepared from date palm rachis by chemical activation with hydroxide sodium. The process has been conducted at different impregnation ratios (NaOH/precursor=0.5–3) and carbonization temperature (500, 600 and 700°C). The physical structure and chemical properties of obtained activated carbon were derived from Scanning Electron Microscope (SEM), N_2 adsorption/desorption isotherms, Fourier-transform infrared spectroscopy (FTIR), thermo gravimetric analysis (TGA), Boehm titration and pH zero point charge measurement (pH_{PZC}). Activated carbon was used as an adsorbent for the removal of *o*-Cresol from aqueous solutions in continuous mode. The four most popular breakthrough models, namely, Adams–Bohart, Thomas, Yoon–Nelson and Yan were used for the correlation of breakthrough curve data along with the evaluation of model parameters.

EVALUATING THE POTENTIAL OF EMPTY FRUIT BUNCHES MIXTURES AS COCOPEAT REPLACEMENT IN FERTIGATION SYSTEM

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Keywords: Oil palm; Empty fruit bunches; Cocopeat; Fertigation

ABSTRACT

The purpose of this study is to evaluate the potential of Empty Fruit Bunches (EFB) mixtures as cocopeat replacement in fertigation. The mechanical and chemical properties of EFB fibre mixtures were analysed experimentally and compared against the properties of cocopeat used in fertigation. The properties considered were Bulk Density (BD), Total Porosity (TP), Aeration Porosity (AP), pH value and Electrical Conductivity (EC). EFB fibre used was obtained from local palm oil mill and was treated based on similar manufacturing process of cocopeat. Experiments were designed to measure the five properties of EFB mixtures with different compositions of EFB and cocopeat, as well as EFB mixtures with different compositions of EFB, cocopeat and peatmoss. The results indicated that changes in these properties were minor for EFB mixtures with high cocopeat composition and the disparity increase with the decrement of cocopeat composition in the mixture. The most feasible composition found for EFB mixture as cocopeat replacement was the one of 80% cocopeat, 20% EFB fibre and 80% cocopeat, 10% EFB, 10% peat moss for EFB mixture with 2 and 3 components respectively. The study concluded that EFB fibre is feasible to partly replace the use of cocopeat as fertigation medium in term of mechanical and chemical properties. However, further study on biological properties and the effects of actual planting application are required for detail evaluation.

IOI PALMWOOD – THE COMMERCIALISATION OF A SUSTAINABLE AND CIRCULAR BUSINESS MODEL

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Keywords: Oil palm trunk, Palmwood, Sustainability

ABSTRACT

IOI Palmwood is a joint venture between IOI Corporation and Peter Fitch. IOI is one of the preeminent plantations and property developer in Malaysia and Peter Fitch is a seasoned entrepreneur in the timber and composite panel industry. The purpose of the JV company is to explore the commercial potential of utilizing the biomass generated from the cultivation of Oil Palm. Our initial project is to produce lumber core from OPT and to convert this material into engineered panels such as blockboard and three layered panels. The Core of our Vision is to create high performance materials from Oil Palm residues in a Sustainable, Circular and Inclusive Way.

MECHANICAL PROPERTIES OF BUNCH DATE PALM FIBERS AND PLASTER REINFORCED WITH ITS FIBERS IN HOT-DRY CLIMATE

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Keywords: Nanomaterials, Processing, Microstructure, Microfluidics

ABSTRACT

North African and Middle East Oasis are known by dates as the main product of palms largely cultivated in its vast palm groves. However, the seasonal pruning process produces enormous quantities of date palm byproducts as wastes which are thrown away or burned. These Oasis are located in desert areas that are characterized by a very hot climate in summer and a very cold in winter. In these regions, the widely used building materials are concrete and mortar cement bricks. Their bad mechanical and thermal properties cause a significant increase in cooling and heating costs. The present study exposes some methods to extract the fibers from the bunch date palm and examines their mechanical properties alone in addition of the plaster bricks reinforced by these fibers. The objective of this work is to improve the mechanical and thermal performances of building materials in the hot and dry zones, and to offer an ecological and sustainable solution for the valorization of date palm byproducts.

UTILIZATION OF DATE (PHOENIX DACTYLIFERA L.) PITS AS A SOURCE OF BIOACTIVE COMPONENTS

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Keywords: Date pits, Bioactive components, phenolic compounds, antioxidants

ABSTRACT

Date (Phoenix dactylifera L.) pits are a valuable and abundant by-product with various potential food applications and a source of functional and bioactive components. In this research, date pits from siwae variety cultivated in the Aswan Governorate (south of Egypt) were analyzed for their chemical and phytochemical compositions, antioxidant capacities. The crude fiber content of date pits was found to be 20.8 %, ash (2.09%), crude fat (7.2%), protein (5.56%), and total carbohydrate (87.2%). Total phenolic compounds (584 ppm), total flavonoids (100 ppm), anthocyanins (5.26ppm). date pits also showed significant antioxidant activity as evidenced by the results of 2,2-diphenyl-1- picrylhydrazyl (DPPH), 2,2'-azino-bis (3-ethylbenzothiazoline 6 sulphonicacid) (ABTS) and Ferric Reducing Antioxidant Power (FRAP) assays. The results indicate that date pits are a very rich source of bioactive compounds, thus constituting strong candidates for functional food additives and nutraceuticals.

DATE PALM PIT POLYPHENOLS LOADED GUM ARABIC MICROPARTICLES: INFLUENCE OF EGG YOLK PROTEINS ON THE PHYSICAL PROPERTIES

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Keywords: Microparticles, Date palm pit, egg yolk, Microfluidics

ABSTRACT

Date palm pit extract represents an interesting source of polyphenols that provide antioxidant, anti-inflammatory, anti-bacterial and anti-viral functions. In addition, egg yolk is a valuable source of lipids, but its protein fraction (the granular fraction) is underused and shows different functional properties than the lipidic one. In this sense, the development of new applications for egg yolk proteins (EYP) could increase the commercial value of the egg yolk. In this work, we aimed to preserve the bioactivities of the date pits polyphenols by means of their encapsulation using gum arabic (GA). Furthermore, the effect of the EYP on the properties of these microparticles was also tested. For that purpose, date pits polyphenols were encapsulated by freeze-drying using different ratios of GA and EYP as wall materials. The microparticles solubility, color, microstructure, Fourier transform infrared spectroscopy (FTIR), thermo-gravimetric analyses (TGA), encapsulation efficiency, antioxidant activity and their behavior into a food matrix (cheese) were assessed.

The progressive incorporation of EYP to the wall material produced a decrease in the water solubility of these microparticles, which enables their addition into a food matrix with a high-water content. The EYP increased the antioxidant activity of the microparticles, in addition to the antioxidant activity of the date pit polyphenols themselves. TGA revealed that the microcapsules containing higher amount of EYP had a better thermal stability. FTIR confirmed the interactions between the date pits polyphenols and the coating materials. The herein formulation cheese “composite” product maintained its textural properties when the microparticles were incorporated, and the microparticles with a high EYP content remained undissolved in the food piece.

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VALUATION OF PALM FIBERS IN THE FORMULATION OF PREFABRICATED CONCRETE IN SOUTHERN ALGERIA

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Keywords: Palm fibers, Cement composites, Precast concrete, Mechanical properties

ABSTRACT

Algeria has known various models of construction. The general observation is the failure of the construction models used for not only their failure to meet the growing demand for housing, but also for the destruction of the architectural and urban landscape. Today, the housing policy is oriented towards prefabrication. The preservation of non-renewable resources has made it necessary to use natural fibers of plant origin as an ecological replacement for their synthetic counterparts in building materials. Considering the capacity of natural fibers of plant origin to improve the mechanical properties of concrete, at their relatively low cost, of a renewable and permanently available resource. In this work, the feasibility of using date palm fibers in cement composites to replace synthetic fibers is studied in southern Algeria. This study reported on the production, types and comparison between the physico-chemical and mechanical properties of date palm fibers and synthetic fibers for prefabrication in southern Algeria.

BIO-BASED HYBRID COMPOSITES FROM WASTE COIR RESIDUES: FIBERS AND SHELL PARTICLES

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Keywords: Bio-composites, Polypropylene; Coir; Hybrid composites; Mechanical properties

ABSTRACT

Due to depleting natural resources, new environmental regulations and economic considerations, there is a constantly growing interest in using renewable resources [1, 2]. Our investigation has focused on the possibility to expand the use of Coir residues (fibers and shells) as agriculture by-products by turning them into new eco–composites and to investigate their structural, morphological, and thermo-mechanical. This work provides an overview of a method to develop hybrid bio-composites based on polypropylene (PP) reinforced with coir fibers and coir shells particles at a total weight content of 20%. In order to increase the adhesion, it is proposed here to first treat the coir fillers (fibers and shells particles) were chemically treated with NaOH, and then the compounds were compatibilized with the addition of a coupling agent (SEBS-g-MA) at 8 wt.%. The effects of coupling agent and fillers (fibers and particles) loading on the thermal, tensile and rheological properties of the hybrid composites is reported. Form the results obtained, the Tsai-Pagano model was used to determine the mechanical properties of coir shells particles reinforced PP.

The thermal, mechanical and rheological properties of the bio-composites were mostly enhanced with the addition of bio-fillers and coupling agent compared to the neat polymer matrix. The combination of coir fibers and particles has a positive effect on the Young's modulus values, the hybrids composites show an intermediary value compared to non-hybrid composites (a gain between 50.5 % and 35 %). The study of modeling the mechanical behavior of manufactured composites by prediction of physical models results (Voigt, Reuss, and Tsai-Pagano models) and experimental one show that the mechanical rigidity of coir shell particles was 5000MPa. This study represents a new opportunity to valorize biomass residues into green materials, which could reduce domestic dependence on petroleum-based thermoplastics.

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IMPROVEMENT OF THE HYDROPHOBIC AND MECHANICAL PROPERTIES OF EPOXY HYBRID-COMPOSITES BASED ON PALM FELT BY THE USE OF FUNCTIONALIZED GRAPHENE OXIDE

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Keywords: palm felt, graphene oxide, silane molecules, bio-composites thermoset

ABSTRACT

The substitution of synthetic fibers (glass fibers, carbon fibers, aramid fibers) in the automotive industry, e.g., interior equipment, cowls by plant fibers may produce an eco-friendly product with high biodegradability, lightweight, low wear forming tools, and reduced undesirable environmental impact. However, the use of natural fibers in these semi-structural applications necessitates a high mechanical property which is the problem of the bio-composites thermoset. So, in order to dissolve this challenge, the hybridization of resin by nano-charge will be used. In this work, palm-felt composites with high mechanical properties were performed by carding the palm fibers and their impregnation in the hybrid epoxy resin with functionalized graphene oxide. Finally, the composites were prepared by compression molding process of hybrid palm felt/epoxy resin at different graphene oxide contents from 0, to 3 wt.% with and without chemical modification using silane molecule (octyltriethoxysilane) as coupling agents. The results revealed that the use of graphene oxide as nano-charge showed the most promising improvement in terms of young's modulus however the modified graphene oxide by silane molecule presented high tensile strength. The hydrophobic properties of the palm felt/ epoxy composites have been enhanced by the use of functionalized graphene oxide that is confirmed by the result comparison of water droplet contact angle of the overall composites.

NOVEL PHOTOCATALYST BASED ON DATE PALM FIBERS FOR EFFICIENT DYES REMOVAL

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Keywords: Date palm fiber; TiO2, Polyisoprene; Highly porous block; Dyes adsorption; Photocatalysis

ABSTRACT

The combination of nanotechnology and green chemistry, based on the valorization of natural resources for environmental applications, has become a top priority for scientific researchers in the last few decades. Biomass with fascinating features, including abundance, an environmentally safe nature and low cost, can be easily manipulated as an infinite source for green and advanced sorbent materials design. In this study, date palm fibers, as one of the most plenty resources in Morocco was exploited to extract pure cellulosic fibers, which were combined with TiO2 nanoparticles in the form of highly porous blocks using a natural linker to be used as a green photocatalyst for both cationic and anionic dye photodegradation. Structural, morphological, thermal and textural properties of the resulting composites were determinate using X-ray diffraction (XRD), Fourier transform infrared spectrometry (FTIR), Scanning electron microscopy coupled to Energy dispersive X-ray spectroscopy (SEM & EDX), Thermogravimetric analysis (TGA) and nitrogen adsorption-desorption. The effect of environmental parameters on composite sorption performance, such as initial dye concentration, contact time, and initial pH solution, was consistently investigated. Under optimized conditions, the resulting blocks exhibited impressive adsorption capacity, greater photocatalytic efficiency for both methylene blue (MB) and congo red (CR) dyes and excellent regeneration after several cycles with easier separation.

BIOCHAR COMPOSITE DERIVED FROM DATE PALM FIBERS FOR POLLUTANTS REMOVAL FROM WASTEWATER

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Keywords: Date palm rachis, Metal–organic framework, Antibiotic, Adsorption, Wastewater treatment

ABSTRACT

The removal of hazardous materials such as pharmaceutical compounds from wastewater has emerged as a major global concern. The development of new materials with high efficiency, eco-friendly nature and low-cost to address such situation is, therefore, a vital environmental challenge. In this study, a novel composite based on biochar derived from date palm rachis and metal–organic framework has been successfully prepared and constructed using an uncomplicated and controllable microwave assisted approach. Structural and physicochemical properties of the resulting photocatalysts were explored through several characterization methods, namely, X–Ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), Energy dispersive spectroscopy (EDS), Thermogravimetric Analysis (TGA), Brunauer–Emmett–Teller (BET) and Zeta potential measurements. The adsorption ability of the resulting composite was investigated through the uptake of pharmaceutical compounds as persistent elements most found in the wastewater. The effect of environmental parameters such as initial antibiotic concentration, pH, temperature, contact time and ionic strength on the antibiotic adsorption were exploited for synthetic wastewater. Adsorption kinetics, isotherms and regeneration tests were addressed. The modified biochar with MOF with a pHPZC of 5.1, high surface area and abundant functional groups was powerful in a wide range of temperature and pH.

IMPACT RESPONSE OF COCONUT FIBREBOARDS WITH DIFFERENT FLOUR AS NATURAL BINDERS

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Keywords: Coconut Fiber, Natural Binder, Fiberboard, Impact Response

ABSTRACT

Coconut palm are mainly cultivated in coastal areas of tropical countries. The husk is abundantly available in many places as cheap residue from coconut processing, which is considered to produce coconut fiber. This coconut fiber is explored for new usage and adopted for various engineering applications. It is expected that this fiber would act as an excellent raw material for panel product such as fiberboard with value added. This paper investigates the impact response of fiberboard made from coconut fiber. Three types of natural binder were used which are corn starch (CS), tapioca starch (TS) and rice flour (RF). The coconut fiberboards were coded as CFBCS, CFBTS and CFBRF based natural binder used were prepared using hot compression machine with temperature of 150oC for 1 hour holding time. The impact behavior of coconut fiberboard was investigated using a drop-weight impact tower at three different energy level, which are 5J, 10J and 15J according to ASTM D7136. The Load - deflection curves were analyzed and used to measure the absorbed energy. The results showed that the CFBCS has higher energy absorbed followed by CFBRF and CFBTS at 5J impact energy. However, at 15J impact energy, the CFBRF resulted in higher impact response as compared to CFBCS and CFBTS. The optical analysis shows that the coconut fiberboard cracking and chirping during the impact test.

ACTIVATED CARBON FROM DATE PALM RACHIS FOR CONTINUOUS COLUMN ADSORPTION OF O-CRESOL

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Keywords: Activated carbon, date palm, chemical activation, fixed-bed column, breakthrough curve

ABSTRACT

High surface area micro porous activated carbon has been prepared from date palm rachis by chemical activation with hydroxide sodium. The process has been conducted at different impregnation ratios (NaOH/precursor=0.5–3) and carbonization temperature (500, 600 and 700°C). The physical structure and chemical properties of obtained activated carbon were derived from Scanning Electron Microscope (SEM), N2 adsorption/desorption isotherms, Fourier-transform infrared spectroscopy (FTIR), thermo gravimetric analysis (TGA), Boehm titration and pH zero point charge measurement (pHPZC). Activated carbon was used as an adsorbent for the removal of o-Cresol from aqueous solutions in continuous mode. The four most popular breakthrough models, namely, Adams–Bohart, Thomas, Yoon–Nelson and Yan were used for the correlation of breakthrough curve data along with the evaluation of model parameters.

THE EFFECT OF PROCESSING PARAMETERS ON THE PHYSICAL AND MECHANICAL PROPERTIES OF DATE PALM FIBRE REINFORCED COMPOSITE

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Keywords: Date palm fibre, Processing, Mechanical and physical properties, Microstructure analysis

ABSTRACT

In the last years, there is an increasing interest in utilizing biomass wastes as resources for developing sustainable composites as the environmental concerns increase. Natural fibres are considered as one of the most abundant resources that exist in nature. Date palm trees (DPT) accounts for approximately 2.6 – 2.8 million tons of waste annually, making it the most abundant agricultural crop producing agricultural biomass waste in the MENA region. Date palm fibre (DPF) extracted from DPT possesses great mechanical and physical characteristics which makes them superior compared to other natural fibres in the MENA region. To develop and achieve the DPF reinforced composite with ultimate properties and cost-effective, it is very important to understand the forming principles by studying the influence of the processing processes. Thus, this study investigates the effect of processing conditions which includes temperature, pressure and time on the mechanical and physical properties of DPF reinforced polyester composites. The composites are developed using hand-layup technique which is followed by compression moulding. Three different temperatures (90 oC, 100 oC, and 110 oC), three different pressure (5 MPa, 10 MPa, 15 MPa) are examined for three different durations, (3 min, 6 min, and 9 min). The mechanical properties are determined, including the impact strength, tensile strength and flexural strength. Meanwhile the moisture absorption and thickness swelling are investigated to understand the dimensional behaviour of the developed composites.

PRODUCTION OF BIO-PELLET FROM COCONUT CHOIR AS RENEWABLE ENERGY AND ITS APPLICATION TO LOW-EMISSION-STOVE BASED ON ROTARY AIR-FLOW PRESSURE

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Keywords: Biopellet, coconut-choir, lower-emission-stove, heat, thermal efficiency

ABSTRACT

One of the biomass that can be utilized as a biopellet namely waste coconut-choir. Each type of biopellet have different characteristics. Differences in the characteristics of the looks of the characteristics of the physical, chemical and combustion biopellet that can be caused by differences in the type and concentration of the adhesive.This study uses adhesive tapioca flour and molasses at a concentration of 10, 15 and 20% on any type of adhesive. The process of making biopellet includes material drying, size reduction, the manufacture of adhesives, mixing materials, printing biopellet and drying biopellet. The parameters observed are the physical and chemical characteristics which include: density, ash content, moisture content, volatile matter, moisture content fixed carbon and calorific value.This research was conducted to design, manufacture and test a biomass stove using bio-pellet fuel from waste coconut-choir, which focusing on increasing air intake, and rotating the air intake so that the heat wasted in the furnace can rotate in the furnace, and can produce efficiency high thermal emissions, and low emissions of harmful substances. The faster rotation resulting from the wind rotation can also provide air intake to the furnace, so that the biomass-pellet can burn completely. The results shows that a stove with a diameter of 26.5 cm, and a height of 37 cm by calculating the distance from the stove to the outside of the stove by 8 cm, so that the heat generated by burning the stove can be minimized. The speed of the blower can be adjusted according to its use using a dimmer. The results obtained from the stove's performance are the average thermal efficiency of the stove of 10.03%, and the average CO gas emissions of 3.25 ppm.

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