Newsletter
e-Science Putra
Issue 9
May - August 2022
Agriculture | Innovation | Life

HIGHLIGHTS
- Genic simple sequence repeat markers
- Electromagnetic interferance
- Attacking RSA cryptosystem
- Hierarchical assembled mesoporous metal
- Unsteady stagnation point flow of hybrid nanofluid
- Hybrid hyrogel

Welcome to the Newsletter e-Science Putra. This issue present research activities from May to August 2022 which highlights the latest research findings and activities by the faculty members.

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Genic Simple Sequence Repeat Markers associated with genes of important agronomic traits in *Stevia rebaudiana*

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Stevia rebaudiana Bertoni (Figure 1), commonly known as sweet herb or candy leaf, is a wild herb from the Asteraceae family. The natural sweet taste in *Stevia rebaudiana* is contributed by a group of natural compounds known as diterpenoid Steviol glycosides (SGs). SGs are 200-350 times sweeter than sugar, prompting its application as natural sweetener in the food and beverages industries in recent years. Genetic markers related to loci of agronomic traits is important for molecular breeding such as marker assisted selection (MAS) to produce varieties with desirable traits in *Stevia reabudiana*. MAS can accelerate plant breeding by improving the selection criteria from phenotypes to genes. Genic-SSR markers have high possibilities associated to the loci of agronomic traits and are advantageous for MAS, which can be incorporated into the genetic improvement program of *S. rebaudiana*.

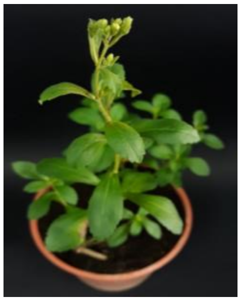

Figure 1: *Stevia rebaudiana*

A total of 8,789 genic-SSR markers were identified in the leaf and stem tissue transcriptomes of *Stevia rebaudiana*, many of which are associated to loci of agronomic traits. Among them, 117 genic-SSR markers were associated with genes involved in the plant defense responses to biotic and abiotic stresses. These plant defense genes were mapped to a multitude of pathways, including the phenylpropanoid, Jasmonic acid biosynthesis and glycolysis pathways. While 14 genic-SSR markers associated with six SG genes mapped to the Methylerithritol-4 phosphate pathway, Ent-kaurenoic acid biosynthesis pathway and the steviol glycosides biosynthesis pathway were also identified (Figure 2). Cross-amplification of selected markers also demonstrated a high potential (70%) of genic-SSR transferability between different varieties of *Stevia rebaudiana*. Thus, it is postulated that out of the 8,789 genic-SSR identified in this study, approximately 6,000 are possibly transferable across varieties. The genic-SSRs associated with functional genes identified in this study serve as an excellent baseline data to develop SSR panels, which could be further explored and applied in MAS and QTL analysis for genetic improvement program of *S. rebaudiana*.

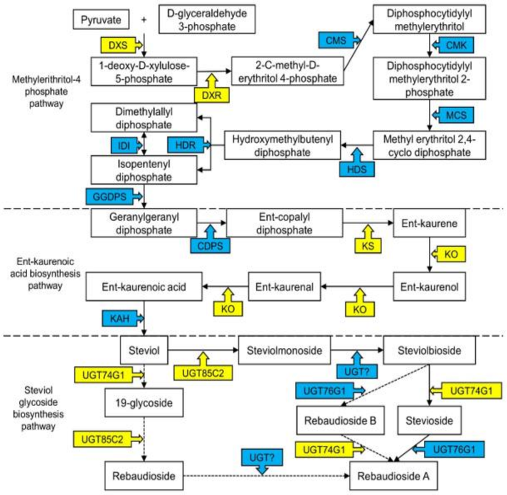
Pyruvate
+
D-glyceraldehyde 3-phosphate
DXS
1-deoxy-D-xylulose-5-phosphate
DXR
2-C-methyl-D-erythritol 4-phosphate
CMS
Diphosphocytidylyl methylerythritol
CMK
Diphosphocytidylyl methylerythritol 2-phosphate
MCS
Methyl erythritol 2,4-cyclo diphosphate
HDS
Hydroxymethylbutenyl diphosphate
HDR
Dimethylallyl diphosphate
IDI
Isopentenyl diphosphate
GGDPS
Methylerithritol-4 phosphate pathway
Geranylgeranyl diphosphate
CDPS
Ent-copalyl diphosphate
KS
Ent-kaurene
KO
Ent-kaurenol
KO
Ent-kaurenal
KO
Ent-kaurenoic acid
Ent-kaurenoic acid biosynthesis pathway
KAH
Steviol
UGT85C2
Steviolmonoside
UGT?
Steviolbioside
UGT74G1
19-glycoside
UGT85C2
Rebaudioside
UGT?
UGT76G1
UGT74G1
Rebaudioside B
Stevioside
UGT74G1
UGT76G1
Rebaudioside A
Steviol glycoside biosynthesis pathway

Figure 2: Three interrelated pathways responsible for the biosynthesis of steviol glycosides. Steviol glycoside genes (highlighted in yellow) linked to genic-SSR markers (Azrul-Murad et al., 2022).

Reference:
Afiq A. Azrul-Murad, Christina S. Y. Yong, Yoeng L. Tan and Nurul I. Ab Ghani. (2022) Identification and characterization of genic simple sequence repeats from the leaf and stem transcriptomes of *Stevia rebaudiana* Bertoni. *Scientia Horticulturae*. 300 (2022) 111067.

Electromagnetic Interference Shielding Polymer

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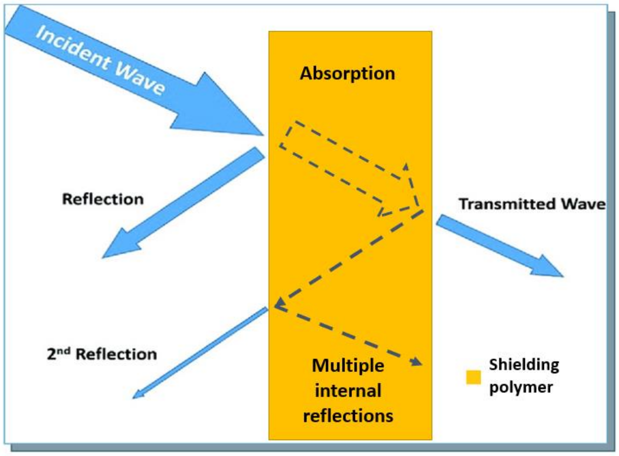

Figure 1: EMI shielding mechanisms of a shielding polymer

Not all signal is a good signal! Electromagnetic interference (EMI) is an unwanted electromagnetic signal that often causes problems when it interferes with other electronic equipment. EMI is one of the many challenges in the rapid growth of smart electronic devices that often are placed in plastic cases. The plastic cases provide little to no protection, making it easy for EMI to pass through and cause device malfunctions. To protect against the EMI, EMI shielding was used.

Conventionally EMI shielding uses solid or mesh metal gaskets. However, works on polymers to replace the conventional methods have been on the rise due to the lightweight and flexibility that polymers offer, making it useful in personal electronic devices and the aerospace industry, in which weight, size, and high EMI shielding are essential. EMI shielding comprises two mechanisms: shielding efficiency due to reflection (SE_R) and shielding efficiency due to absorption (SE_A) (figure1). Polymers with high conduction offer higher SE_R and can be attained by utilizing either ionic conductivity, electron conductivity, or both. The SE_A of a polymer can be improved by altering the dielectric and magnetic properties of the polymer. The adjustment to the polymer can be made by chemical modification of the polymer chain or by a mechanical process of inserting selected material as filler into the polymer matrix.

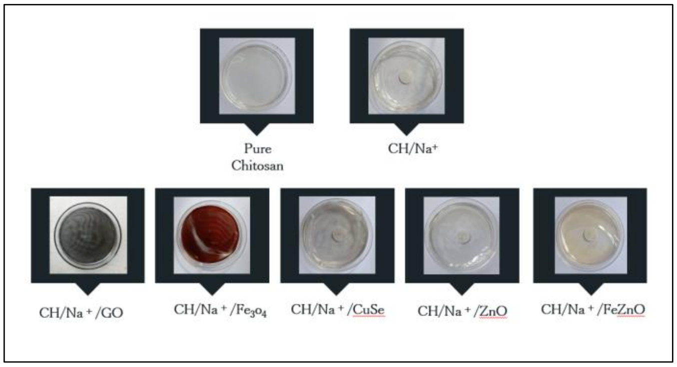

Figure 2: EMI shielding polymer with various fillers

Our current work aims to produce free-standing, flexible and transparent high shielding efficiency polymer. This includes works utilizing various filler ranging from metal ions, carbon, oxide, ferroelectric, magnetic and many more (figure2). The possibility of using hybrid material to increase shielding efficiency further has also been examined. This includes work on a single layer and sandwich polymer. To date, shielding efficiency ranging from 1.5 dB to 34 dB has been recorded from various fillers, correspondence to 29 % to 99.95 % EM energy shield [1-2]. We are working to achieve the industrial standard of 40 dB (99.99 % EM energy shield) requirement.

References:

1. Osman, N.H.; Mazu, N.N.; Ying Chyi Liew, J.; Ramli, M.M.; Sandu, A.V.; Nabiałek, M.; Abdull Majid, M.A.H.M.; Mazlan, H.I. “Sodium-Based Chitosan Polymer Embedded with Copper Selenide (CuSe) Flexible Film for High Electromagnetic Interference (EMI) Shielding Efficiency”. Magnetochemistry 2021, 7, 102.
2. N. N. Mazu, M. A. H. M. A. Majid, N. H. Osman, J. Y. C. Liew and M. M. Ramli, "Shielding Efficiency Study of Sodium Based Chitosan Polymer with Different Types of Filler," 2020 IEEE International RF and Microwave Conference (RFM), 2020, pp. 1-4.

Attacking RSA Cryptosystem by Knowing Some Least Significant Bits of RSA Secret Keys

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Asymmetric key cryptography plays a pivotal role in securing our daily digital communication. It ensures the process of transmitting a symmetric key – later used to encrypt and decrypt data – achieves all cryptography goals, namely (a) confidentiality; (b) authenticity; (c) data integrity; and (d) non-repudiation. The classic example of an asymmetric key cryptosystem is Rivest-Shamir-Adleman or usually known as RSA. Its simple mathematical design makes it compelling to be used in the early days of digital technologies until today. Since it is still regarded as the most widely used asymmetric key cryptosystem, the necessity to analyze the mathematical structures embedded in its parameters is always welcomed. This cryptanalysis (or 'attack') guarantees the security of RSA is maintained at the highest level possible.

One of the methods to conduct an attack against RSA is known as a partial key exposure attack. This attack assumes that the adversary has limited capabilities in knowing some information on the bits of the RSA secret parameter. It must be understood first that the secret parameter is defined as a long string of bits that when can be translated by a digital device to a decimal number (today, RSA will use about 300 digits of a decimal number). Given $N = pq$ as a valid RSA public key and suppose there exist unknown a_0 and b_0 where

$$p = (2^{l_1} \cdot a_0)^m + r_p \qquad (1)$$

and

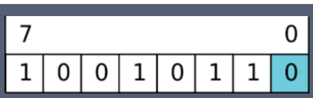
$$q = (2^{l_2} \cdot b_0)^m + r_q \qquad (2)$$

are two different prime numbers and l_1, l_2, and m are some unknown integers. In our work, we assume that the adversary knows the values of r_p and r_q where

$$r_p \equiv p \ (mod\ 2^{l_1 m})$$

and

$$r_q \equiv q (mod\ 2^{l_2 m}).$$



7							0
1	0	0	1	0	1	1	0

Figure 1: The least significant bits (LSBs) are the low-positioned bits in a binary string. However, we can extend it to k-th LSBs above figure, the LSB is 0 and the 3-th LSBs is 110.

In short, the adversary knows some of the least significant bits (LSBs) of primes p and q.

Primes that satisfy Equations (1) and (2) must have the bits arrangements for a^m and b^m as shown in Figure 2.

$$a^m = \underbrace{r_{p_1} r_{p_2} \cdots r_{p_{(n-k)}}}_{n-k \text{ many bits of 1 and 0's}} \overbrace{r_{p_{(n-k+1)}} \cdots r_{p_n}}^{k \text{ many bits of 0's}}$$

$$b^m = \underbrace{r_{q_1} r_{q_2} \cdots r_{q_{(n-k)}}}_{n-k \text{ many bits of 1 and 0's}} \overbrace{r_{q_{(n-k+1)}} \cdots r_{q_n}}^{k \text{ many bits of 0's}}$$

Figure 2: Bits position for a^m and b^m to identify primes that satisfy Equations (1) and (2). Their LSBs must have k many consecutive 0's while the remaining bits will be the combination of bits 1 and 0's.

By establishing this arrangement of positions of LSBs for r_p and r_q, our research shows if

$$p = a^m + r_p$$

and

$$q = b^m + r_q$$

for a, b are positive integers and $m \geq 2$ then we can solve the factorization of $N = pq$ in a feasible time using current computing technology. This will lead to an insecure RSA cryptosystem that can lead to a catastrophe for any online services using these weak parameters. Hence, our research also proposes an early intervention during the RSA key generation process to prevent the attack as shown in Figure 3.

Given N, p and q, if

$$\lceil N^{1/2} - \lfloor p^{1/2} \rfloor \cdot \lfloor q^{1/2} \rfloor \rfloor$$

is a sufficiently small integer as defined in Definition 2, then RSA key generator must find new p or q.

Figure 3: The proposed countermeasure of the attack during the RSA key generation process

References:

Abd Ghafar, A.H.; Kamel Ariffin, M.R.; Asbullah, M.A. A New LSB Attack on Special-Structured RSA Primes. *Symmetry* **2020**, *12*,838. https://doi.org/10.3390/sym12050838

Hinek, M. Jason. Cryptanalysis of RSA and its variants. Chapman and Hall/CRC, 2009.

Hierarchical Assembled Mesoporous Metal Incoporated ZnO Nano-heterostructure for Wastewater Treatment

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Crystalline phase transition metal oxide with controllable mesoporous architecture plays a dominant role in enhancing the performance of energy conversion and storage device. Solution based self-assembling routes for the fabrication of an orderly mesoporous heterostructure have increased the accessible morphology space as well as structural dimension. Our group has been focusing on designing various types of metal nanostructures incorporated ZnO hierarchical heterostructures by combining liquid deposition technique and hydrothermal method. Various morphologies of the secondary metal nanostructures including nanoparticle (NPs), nanotubes (NTs) and nano-flowers (NFs) has been synthesised.

The beautiful of the crystal growth involving crystal twinning and lattice matching between Pt/Ag/Ti and ZnO crystal facet was found beneficial as a catalyst in wastewater treatment. The design heterostructures shows a significant enhancement in the degradation of the organic pollutant and water splitting under the illumination of solar simulator, as compared to the primary bare ZnO nanorods. The synthetic methodology described herein promises to be an effective approach for shape-selective synthesis and assembly of metal nanoparticle with a novel structure. The nano-heterostructure materials with peculiar intrinsic properties exhibit considerable potential to address the environmental and energy issues via degradation of pollutant and water splitting applications. This work has published in several peer reviewed International Journal [1-3] and received a recognition in International Workshop of Advanced Materials (IWAM).

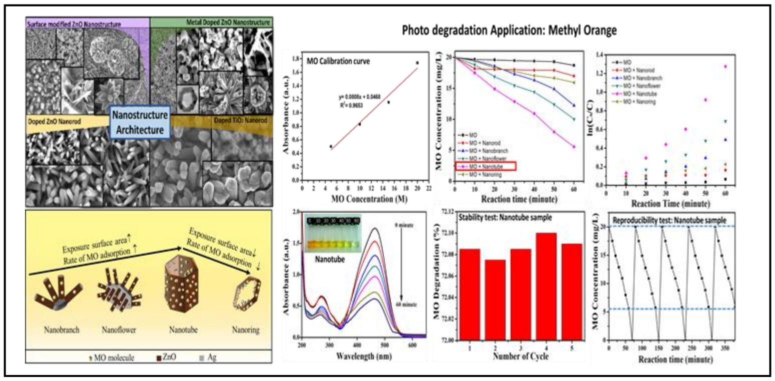

Figure 1. Metal Incorporated ZnO Nano-heterostructure and its applications in azo-dye degradation. [1]

Figure 2. His Highness Sheikh Saud bin Saqr Al Qasimi (Crown Prince of the Emirate of Ras Al Khaimah), Dr. Sin Tee (first from the right) and her collaborators during the exhibition in International Workshop of Advanced Materials (IWAM).

References:

Tan, Sin Tee, et al. "Rational design of ordered Bi/ZnO nanorod arrays: surface modification, optical energy band alteration and switchable wettability study." *Journal of Materials Research and Technology* 15 (2021): 5213-5220.

Tan, Sin Tee, et al. "Ag–ZnO nanoreactor grown on FTO substrate exhibiting high heterogeneous photocatalytic efficiency." *ACS combinatorial science* 16.7 (2014): 314-320.

Lim, Fang Sheng, et al. "Tunable plasmon-induced charge transport and photon absorption of bimetallic Au–Ag nanoparticles on ZnO photoanode for photoelectrochemical enhancement under visible light." *The Journal of Physical Chemistry C* 124.26 (2020): 14105-14117.

Unsteady Stagnation Point Flow of Hybrid Nanofluid Past an Impermeable Disk

Report by: Prof. Dr. Norihan Md Arifin
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Project member: Dr Najiah Safwa Khashi'ie
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The theoretical studies of boundary layer flow subjected to static and moving surfaces were conducted by many researchers due to its potential applications in many industries such as automobile, friction drag of a ship and airfoil design of the airplanes. The main objective of this study is to to analyse the unsteady stagnation point flow of hybrid nanofluid due to a stretching/shrinking disk in the presence of radiation effect.

The combination of metal and metal oxides nanoparticles (Al_2O_3-Cu) with water (H_2O) as the base fluid is analysed numerically using the bvp4c solver. The physical model of stagnation point flow of Cu-Al_2O_3/H_2O hybrid nanofluid over a radially stretching/shrinking surface, as illustrated in Fig. 1, where (r, α, z) are the cylindrical coordinates and assume that the surface is at $z = 0$ with the flow in the region $z \geq\geq 0$. It is also assumed that the velocity of the stretching/shrinking sheet is $u_w(r,t)$ and the velocity distribution in the frictionless flow in the neighborhood of the stagnation point is given by $u_e(r,t)$. Moreover, it is assumed that the surface temperature T_w is constant, while T_∞ is the temperature of the ambient fluid.

The governing boundary layer equations in the cylindrical coordinate (see Khashi'ie et al., 2022) is simplified into a set of differentials (similarity) equations:

$$\frac{\mu_{hnf}/\mu_f}{\rho_{hnf}/\rho_f} f''' + 2ff'' + 1 - f'^2 + B\left(1 - f' - \frac{\eta}{2} f''\right) = 0,$$

$$\frac{1}{\Pr} \frac{1}{(\rho C_p)_{hnf}/(\rho C_p)_f} \left(\frac{k_{hnf}}{k_f} + \frac{4}{3} R\right) \theta'' + 2f\theta' - B\frac{\eta}{2}\theta' = 0,$$

subject to the boundary conditions:

$$f(0) = 0, f'(0) = \lambda, \theta(0) = 1, f'(\infty) \to 1, \theta(\infty) \to 0,$$

where $\Pr$ is the Prandtl number, R is the radiation parameter, B is the unsteadiness parameter and λ is the velocity ratio parameter of the sheet.

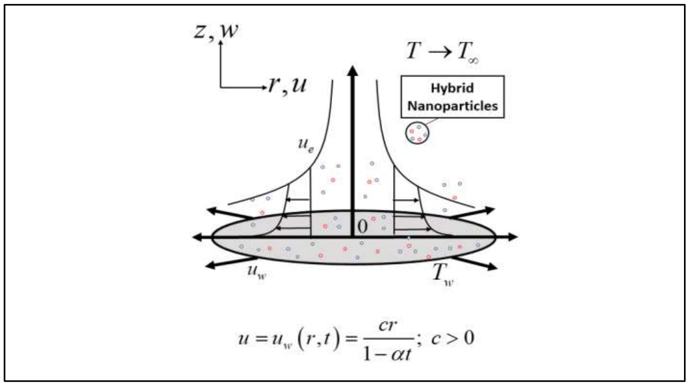


Figure 1: Coordinate system of unsteady hybrid nanofluid flow for stretching disk

The separation point is located at the decelerating flow region ($B < 0$) where beyond the separation point λ_c, the transition of laminar to turbulent flow occurs. Figs. 2 shows the critical values decrease as the values of B increase such that $\lambda_c = -0.6153\ (B = -1), \lambda_c = -0.5371\ (B = -1.3)$, and $\lambda_c = -0.4902\ (B = -1.5)$. Besides, the increase in B also reduces the skin friction coefficient $\left(0.5\mathrm{Re}_r^{1/2}\mathrm{C_f}\right)$ while sustains the heat transfer performance of Cu-Al_2O_3/H_2O hybrid nanofluid.

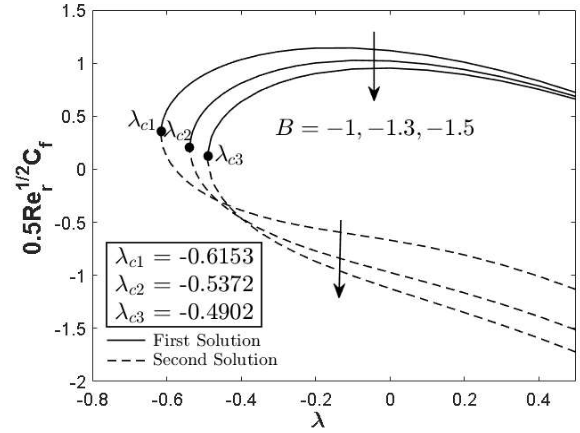
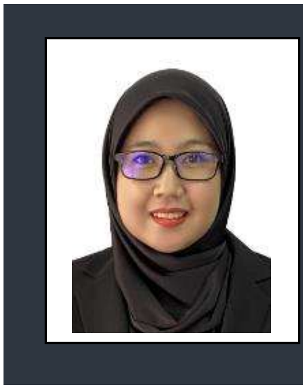


Figure 2: $0.5\mathrm{Re}_r^{1/2}\mathrm{C_f}$ towards λ with disparate values of B when $R = 0.1$ and $\phi_1 = \phi_2 = 0.01$.

References:

Khashi'ie, N.S., Arifin, N.M., Pop, I. (2022) Unsteady axisymmetric radiative Cu-Al_2O_3/H_2O flow over a radially stretching/shrinking surface, *Chinese Journal of Physics* 78, pp. 169-179



Hybrid Hydrogel as An Alternative Adsorbent for the Removal of Perfluorooctanesulfonate Acid (PFOS)

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Perfluorinated compounds (PFCs) are primarily one type of organic micropollutant that is widely found in the environment that contributes to severe environmental problems [1]. In that course, a group of researchers lead by Dr. Sazlinda Kamaruzaman and team members Dr. Norizah Abdul Rahman and Aiza Farhani Zakaria from the Faculty of Science, UPM have designed a new sustainable hybrid hydrogel based on eco-friendlier precursors such as sodium alginate, β-cyclodextrinand carbon nanotubes as an adsorption kit to efficiently remove perfluorooctanesulfonic acid (PFOS) from the aqueous environment.

Sodium alginate, β-cyclodextrin and carbon nanotubes have combined their specialities to enhance the adsorptivity performance due to abundant functional groups that can induce PFOS removal by creating many possible chemical interactions such as electrostatic attraction, hydrogen bonding and hydrophobic interaction [2]. The highly efficient removal of up to 91.6% with the influence of several optimum adsorption variables, which were: 1000 mg of adsorbent dosage, 10 mg/L of PFOS solution, pH 5, and a contact time of 45 min was reported in this research study. Therefore, based on the findings, the fabricated carbon-based hybrid hydrogel has promising capabilities with excellent mechanical properties and optimum productivity to solve PFOS contamination issues to conserve our water resources in the near future.

Dr. Sazlinda and team have participated in innovation carnival held by Universiti Malaysia Terengganu entitled “Amalan Inovasi Penyelidikan” and a conference entitled “The 3rd International Conference on Natural Sciences, Mathematics, Application, Research & Technology”. The team were sharing information related to this innovation and has awarded gold medal in research innovation category and won best presenter in the events, respectively.

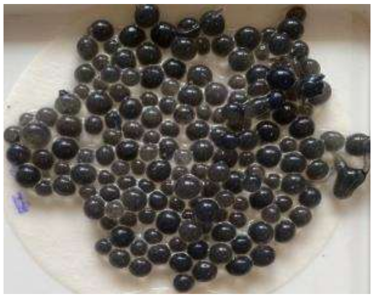

Figure 1: Carbon-based hybrid hydrogel

Figure 2: Gold medal award in Amalan Inovasi Penyelidikan

References:

[1] Franke, V., McCleaf, P., Lindegren, K., & Ahrens, L. (2019). Efficient removal of per- And polyfluoroalkyl substances (PFASs) in drinking water treatment: Nanofiltration combined with active carbon or anion exchange. Environmental Science: Water Research and Technology, 5(11), 1836–1843.

[2] Niu, B., Yang, S., Li, Y., Zang, K., Sun, C., Yu, M., Zheng, Y. (2020). Regenerable magnetic carbonized Calotropis gigantea fiber for hydrophobic-driven fast removal of perfluoroalkyl pollutants. Cellulose, 27(10), 5893–5905.

Science is much more than just a body of KNOWLEDGE.
It is a way of THINKING.

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