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NEWSLETTER
e-Science Putra
Agriculture . Innovation . Life
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Faculty of Science is pleased to present the third issue of thrice-yearly e-Science Putra Newsletter. This e-newsletter intended to disseminate and highlight the latest research findings, activities, and contribution to the community by the Faculty members. We hope that you enjoy reading this newsletter.

HIGHLIGHTS

Nanotechnology-Based Detection of *Ganoderma boninense* in Oil Palm

The oil palm, *Elaeis guineensis* has been a significant contributor to Malaysia's economy in agricultural sector. However, the greatest current threat to the production of palm oil is the basal stem rot (BSR) diseases caused by *Ganoderma boninense*. Since there is no effective treatment for BSR disease, early detection is a proactive measure to avoid it. Therefore, this project focused on the development of nanotechnology derived chip-based DNA/RNA detection platform that is applicable to be used in Malaysian agricultural setting. This project was funded by the Newton fund led by two main principal researchers from different universities; Dr. Shahrul Ainliah Alang Ahmad (UPM) and Dr. Lu Shin Wong (University of Manchester, UK) and research partners from MARDI (Dr. Muhammad Zamharir Muhammad and Mrs. Siti Akhtar Mohshim).

Figure 1: An image of *Ganoderma boninense* fruiting bodies

The research activities involved the development of nanoparticle assay with local biological materials and fabrication of arrays by using polymer pen lithography. The research attachment by Malaysia co-applicant to the UK and *vice versa* was completed (in June 2017 and December 2018) where training and transfer knowledge were carried out. The results of DNA conjugation of AuNPs and optimisation of assays are promising for detection of *Ganoderma boninense* by observing color change. A sandwich assay format with DNA-conjugated gold nanoparticles was able to generate a visually observable result in the presence of the target DNA as low as 0.3 ng of target.

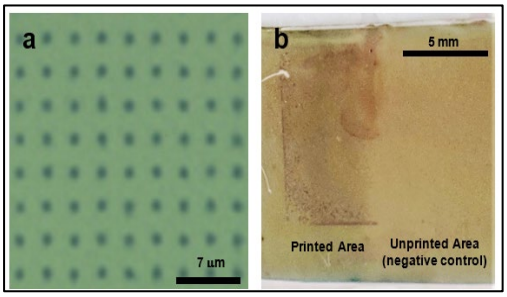

Figure 2: (a) Optical image for immobilisation experiments on arrays with capture DNA-AuNPs and genomic DNA extracted from *G. boninense* mycelia. (b) Photographic image of glass slide post hybridisation (10 pM of target ssDNA). Reprinted from Polymer Pen Lithography-Fabricated DNA Arrays for Highly Sensitive and Selective Detection of Unamplified Ganoderma Boninense DNA, by Ekta Rani et al. *Polymers* 2019, *11*, 561.

Report by: Shahrul Ainliah Alang Ahmad, Department of Chemistry, Faculty of Science, Universiti Putra Malaysia.

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Fusarium species: Parasitic and Saprophytic Fungi

Fusarium (Link ex Grey) species are interesting fungal genus, which are diverse and worldwide distributed. They are hyaline filamentous fungi belonging to the family Nectriaceae of the order Hypocreales within the fungal phylum Ascomycota. Based on morphological, biological and phylogenetic diagnostic concepts, the genus *Fusarium* comprises more than 100 species. *Fusarium* spp. produce woolly to cottony, flat, spreading colonies and various pigmentations. They can be isolated from air, insects, plants, soils, organic substrates and water, besides able to be transported in vegetable tissues. They can be found in diverse ecosystems and in normal microflora of commodities such as saprophytes, endophytes or pathogens. Some species of *Fusarium* can cause disease in a wide range of host plants.

Figure 1: Samples of plants infected by *Fusarium* and other microfungi.

They can also cause diseases to animals by producing toxins and allergies. Plant diseases caused by *Fusarium* are getting more severe especially in monoculture systems such as banana, corn, rice, sugar cane, and other important crops. For instance, *Fusarium* wilt disease of banana has become an outbreak with the collapse of banana plantations since there is no prevention and effective procedure to cure the disease. Not only in the field, *Fusarium* species such as *F. proliferatum*, *F. verticillioides*, *F. oxysporum* and *F. solani* can also cause post-harvest rot disease to commercial fruits. Fruit rot can affect the quality of the fruits and reduce marketable percentage of fruit.

Fusarium spp. are also soil inhabitants, persisting in soils and have good competitive saprophytic abilities. Their populations can increase after organic amendment. Several studies reported that saprophytic *F. oxysporum* can increase the survival of plants. Application of *F. oxysporum* with arbuscular mycorrhizal fungi increased shoot dry matter, N and P concentrations of plants, as well as the level of arbuscular mycorrhizal colonization attained by indigenous or introduced arbuscular mycorrhizal fungi.

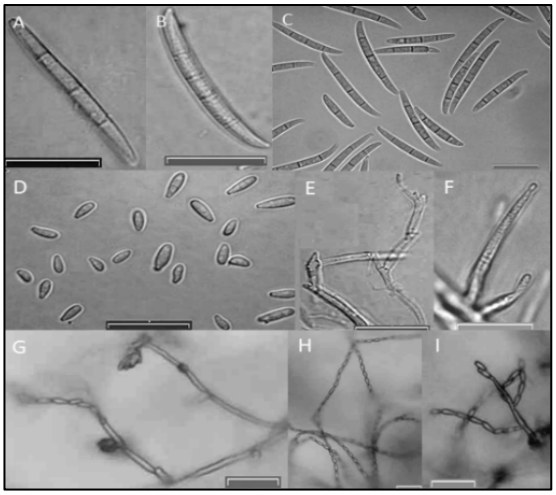

Figure 2: Morphological characteristics of *F. proliferatum*; A - C) various shapes and sizes of macroconidia; D) obovoid with flattened base of microconidia; E) polyphialides; F) monophialide; G) microconidia borne in short chains and false heads *in situ* on CLA; H) long chain of microconidia; I) microconidia in short chains. Scale bar A - I: 20 µm

Unfortunately, the basic knowledge in taxonomy, pathogenicity and toxigenicity of such important genus is very confusing. Correct identification of the species is deemed necessary to formulate quick actions for controlling and avoiding legal

complications. Realizing their importance, since 2003, Laboratory of Mycology at the Department of Biology has continuously studied the species diversity of *Fusarium* together with other fungi focusing on plant pathogens. We perform species identification based on morphological, biological, and molecular characteristics. On top of that, the distribution, and species diversity as well as genetic variations of fungi are also studied. From the research project conducted, we are able to update information on distribution of *Fusarium* species and other Ascomycetes fungi such as genus *Aspergillus*, *Bipolaris*, *Curvularia*, *Lasiodiplodia*, *Penicilium*, *Trichoderma* and *Setospheria* species throughout Malaysia.

Report by: Nur Ain Izzati Mohd Zainuddin, Department of Biology, Faculty of Science, Universiti Putra Malaysia.

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JCR TOP 10% JOURNAL PUBLICATIONS

Publications:

1. Ibrahim I., **Lim H.N.***, Huang N.M., Jiang Z.T. and Altarawneh M. Selective and sensitive visible-light-prompt photoelectrochemical sensor of Cu^{2+} based on CdS nanorods modified with Au and graphene quantum dots. **Journal of Hazardous Materials**. 2020. 391: 122248.

2. Lee X.J., **Lim H.N.***, Gowthaman N.S.K., Rahman M.B.A., Abdullah C.A.C. and Muthoosamy K. *In-situ* surface functionalization of superparamagnetic reduced graphene oxide–Fe_3O_4 nanocomposite via *Ganoderma lucidum* extract for targeted cancer therapy application. **Applied Surface Science**. 2020. 512. 145738.

Graphene comprises a single layer of carbon atoms in a honeycomb structure. There are distinctive derivatives of graphene such as graphene oxide, graphene nanoplatelets and graphene quantum dots, making it savvy for various applications. Graphene can be used as an additive for polymer to increase the tensile strength, automotive to enhance lubricity and power output, electronics to improve detection and thermal and electrical conductivity, and agriculture and pharmaceutical for sustained release formulations. An article published in the **Journal of Hazardous Materials** reported that graphene, when combined with cadmium sulfide nanoparticles and gold nanorods, was able to increase the photocurrent of a sensor, making it more sensitive and selective to heavy metal copper detection[1]. Another article published in **Applied Surface Science** reported on utilizing graphene as a scaffold for targeted drug delivery application. The graphene was decorated with magnetite nanoparticles to guide the drugs, *Ganoderma lucidum* and quercetin, to a specific site of interest using a guided external magnetic field[2].

Prof. Dr. Janet Lim Hong Ngee
Department of Chemistry, Faculty of Science, Universiti Putra Malaysia.

Biogenetic Synthesis of Zinc Oxide Nanoparticles using Hystrix for Environmental Applications

Nanobiophysics is an interdisciplinary research in the Faculty of Science. Their research uniqueness lies on the utilization of various Malaysian tropical plants. This is in line with UPM objective to be the leading institution of higher education and research in agriculture. To date, many material scientists focus on green nanotechnology by utilizing eco-friendly and non-toxic nanomaterials for environmental and health applications. In addition, green nanomaterials in agriculture offer reduction in the needs of costly fertilization and the greenhouse emissions. A group of researchers led by Assoc. Prof. Dr. Che Azurahanim Che Abdullah and her team (Siti Huzaimah Ribut and Assoc. Prof. Dr. Muskhazli Mustafa) in collaboration with researcher from UiTM Pulau Pinang (Dr. Muhd Zaki Yusoff) carried out research focused on the development of metal oxide nanoparticles using local plant, Citrus Hystrix.

Dr. Azura and team attending MTSF Prize Ceremony and the copyright received for the development of biogenic ZNONPs using Citrus Hystrix.

Their studies focus on the structural, morphology, and the antibacterial properties of ZnO nanoparticles (ZnONPs) prepared using Citrus Hystrix extract for potential wastewater treatment. The biogenic ZnONPs from Citrus was identified as wurtzite structure and the particle size form is around 24.40 – 59.56 nm (Figure 1B). The band gap energy calculated is range between 3.29 - 3.36 eV (Figure 1C). Biogenic ZnONPs were successfully inhibited the bacteria growth (Figure 1D). The project was selected and funded by Malaysian Toray Science Foundation (MTSF) in 2018.

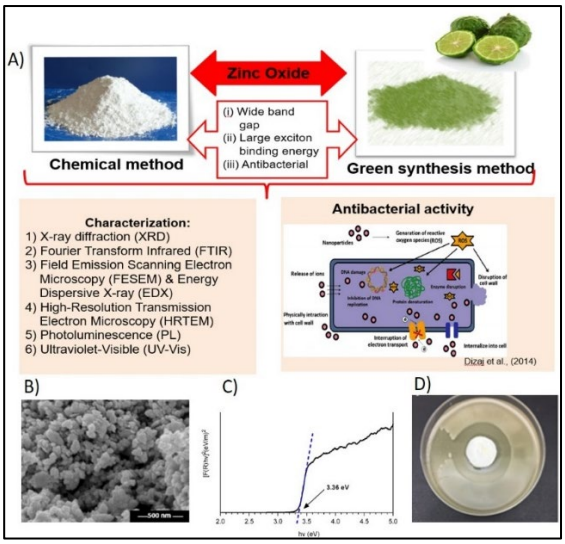

Figure 1: A) showing the strategy of producing ZNONPs using chemical and green synthesis methods. B) The size of biogenic ZNONPs using green approach evaluated using scanning electron microscope C) The energy band gap calculated using Photoluminescence spectroscopy and the inhibition of bacterial growth.

The plant-mediated green synthesis of nanomaterials as important branch of nanotechnology. It has significantly developed and gained importance due to its eco environmental, low cost, biocompatible and avoiding the use of toxic chemical. This allows for positive impact of nanomaterials on modern agriculture where the human health and environment is the main concern in addition to food and nutritional security.

Report by: Che Azurahanim Che Abdullah, Department of Physics, Faculty of Science, Universiti Putra Malaysia.

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Modified Residuals for Model Adequacy of the Log Logistic Distribution

The study of model adequacy using residual analysis is often used in statistical modelling to decide if the model in hand fits the data well. The Cox-Snell residuals, $rci = -log\ \hat{S}_i(t_i)$, where $\hat{S}_i(t_i)$ is the estimated survivor function for the ith individual at time t_i, is widely used for assessing model fit in survival analysis. Several modifications of the Cox-Snell residual were suggested for censored survival data to make it more suitable for model assessment. The modifications are of the form:

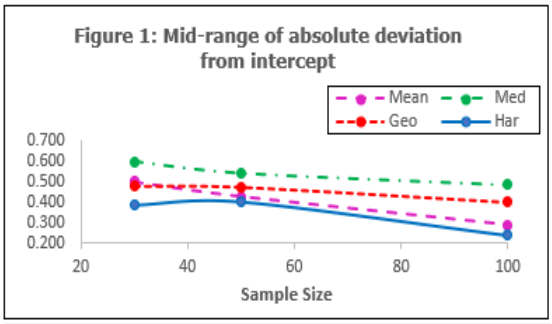
$$Mrci = \begin{cases} rci & if\ data\ is\ uncensored \\ rci + \Delta & if\ data\ is\ censored \end{cases}$$

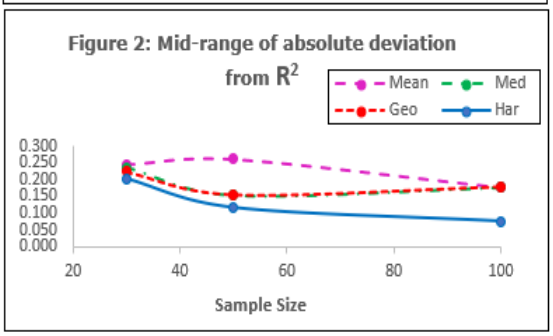
Two existing modifications of rci take Δ as the mean and median of the unit exponential distribution which is 1 and 0.693 respectively. In our current research we proposed taking Δ as either the geometric or the harmonic mean of the data instead. These modifications are suggested because survival data are usually skewed and the geometric or the harmonic mean may be more appropriate to make up for the excess residual.

Table 1: Mid-range of absolute deviation from slope

n	*cp*	Mean	Med	Geo	Har
0.1	30	0.5451	0.4519	0.4484	0.4449
	50	0.4516	0.3796	0.3820	0.3705
	100	0.3085	0.2073	0.2085	0.2303
0.2	30	0.5610	1.2925	0.7354	0.4710
	50	0.4786	0.4405	0.4425	0.4030
	100	0.3720	0.3488	0.3653	0.3615
0.3	30	0.6102	1.2939	1.3053	0.5300
	50	0.6457	0.5652	0.6000	0.5660
	100	0.3852	0.4266	0.4258	0.4409

A cumulative hazard plot of the residual is obtained by plotting the estimated cumulative hazard function against the Cox-Snell residual. If the proposed model fits the data well then, this plot should exhibit a linear trend through the origin with a unit slope. A simulation study was conducted at various sample sizes (n) and censoring proportions (cp) to investigate the performance of the proposed residuals on the widely used log logistic survival model.





The survivor function for this model is $S(t, x, \beta, \sigma) = [1 + exp\ (z)]^{-1}$ where $z = \frac{y-\beta_0-\beta_1 x}{\sigma}$, $y = In(T)$, x is the covariate and β_0, β_0 and σ are the parameters. The results are shown in Table 1, Figure 1 and Figure 2. The mid-range is the arithmetic mean of the maximum and minimum of absolute deviation of the estimates from the desired intercept, slope and R^2. Figures 1, 2 and Table 1 clearly shows that the method with Δ as the harmonic mean has outperformed all other residuals by having the maximum number of lowest mid-range of absolute deviation from all the three parameters at different combinations of cp and n. Thus, it might be a very good alternative to the existing residuals.

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The Behaviour of Captive Malayan Tapir: Implications for Ex-situ Management and Conservation

Malayan tapirs (*Tapirus indicus*) received considerable attention recently from government, NGOs and the media as their population numbers have halved in the past three decades due to multiple factors including loss of habitat and human disturbance that elevated their conservation status from "vulnerable" to "endangered" (IUCN 2016). Often during in search for a new habitat, food or mating partner, tapirs are also victimised to traffic accidents when the roads are cutting through their habitats. Present Malayan tapir worldwide population is estimated to be only around 2000-2500 individuals, with 1000-1700 residing in Peninsular Malaysia forest.

Figure 1: The recording of Malayan tapir behaviour at Zoo Negara, Ampang

Local extinction or population declines of tapirs can disrupt some key ecological processes such as seed dispersal and nutrient recycling, and eventually compromise the integrity and biodiversity of the forest ecosystem. Therefore, as an initiative measure to sustain the population, *ex-situ* conservation was established. However, the ability of captive management to maintain and breed endangered species has been proved challenging. While many other wild animals under captivity showed changes in their natural behaviours that resulted in stress, breeding difficulties, poor health, and repetitive stereotypic behaviours, information on Malayan tapir is still lacking.

A team of researchers from Faculty of Science, UPM, co-leaded by Assoc. Prof. Dr. Geetha Annavi and Ms. Kalai Arasi Arumugam (including Assoc. Prof. Dr. Marina Mohd. Top and Dr. Wan Norhamidah Wan Ibrahim) in collaboration with PERHILITAN and University of Oxford investigated the effects of captive enclosure conditions, weather (temperature and humidity) and the number of visitors on a range of behaviours to determine their role as potential stressors in male and female captive Malayan tapirs. The study revealed that unsuitable enclosure conditions of extreme dryness (which resulted in more frequent snout licking, a type of oral behaviour; Arumugam et al., 2019; http://www.ijramr.com/sites/default/files/issues-pdf/2499.pdf licking, a type of oral behaviour; Arumugam et al., 2019; http://www.ijramr.com/sites/default/files/issues-pdf/2499.pdf) and an increased number of visitors, prone to be potential stressors that lower the activity pattern which possibly alter the natural behaviors of Malayan tapir in captivity (Arumugam et al., 2018; http://dx.doi.org/10.29322/IJSRP.8.7.2018.p7906). Their findings also showed that, the social and reproductive activity patterns of captive Malayan tapirs depend mainly on the female's maternal experience and environmental conditions (Arumugam et al., 2020; https://doi.org/10.1038/s41598-020-60429-0).

Non-pregnant female exhibited a high frequency of initiation behaviour towards her social male compared to pregnant females. A large enclosure was associated with the advancement of initiation behaviors or so-called consortship into breeding behaviors. This study has contributed information for the understanding of Malayan tapirs' basic needs in captivity and the design and management of captive breeding facilities, thus improving the welfare and conservation effort of the Malayan tapir.

Report by: Geetha Annavi, Department of Biology, Faculty of Science, Universiti Putra Malaysia.

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Impact of Carbon Nanotube (CNT) and Carbon Nanofiber (CNF) Addition on Transport and Superconducting Properties of $YBa_2Cu_3O_{7-\delta}$ Ceramics

In order to fight the enormous challenge of climate change and annual depletion of fossil fuels, renewable energy is our alternative solution. Unlike oil and gas, renewable energies are generated by natural sources such as sunlight and wind which are constantly replenish. However, reducing our dependence on oil and gas is only part of the solution. We need to conserve energy and improve the energy efficiency of our electrical system. Despite the growing demand for electrical energy, the electrical system we have today is incredibly inefficient especially during the transport of electricity from one source to another. Although copper are good conductors for electrical wiring, approximately 60 to 80 percent of the energy that goes into the system is lost and wasted mostly to heat and sound during the transportation.

Research Team Members at Superconductor Magnetic Levitation (SCMAGLEV) Park, Japan.

Thus, further investment, research and development are required to find better material that has better efficiency to meet the ever-increasing energy demand. The observation of superconductivity in the high-temperature superconductor compound $YBa_2Cu_3O_{7-\delta}$ (Y-123) is widely referred since 1986 by Paul Chu. Y-123 superconductor gave huge impacts to the market penetration for power applications due to its high, critical temperature T_c. However, the weak flux pinning and granularity of bulk Y-123 especially at temperatures above 20–30 K seems to have low critical current density, J_c, which limited its usage in superconductors' technological applications.

A variety of research has been done focussing on improving the superconducting properties of Y-123 ceramic by altering the techniques with which it can be synthesised and adding impurities that act as artificial pinning centres in the sample. The addition of CNT's and CNF's on Y-123 are expected to introduce pinning centres based carbon nanomaterials that may enhance current carrying capability of superconductors. The effect of addition of several weight percentages (wt.%) of CNTs and CNFs on the transport properties, critical temperature and microstructure of Y-123 ceramics synthesized via coprecipitation process were investigated.

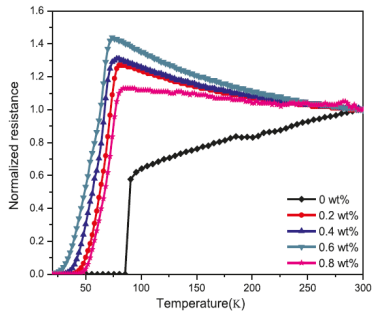

Figure 1: Different weight percentage of CNT addition at x = 0, 0.2, 0.4, 0.6 and 0.8 wt.%.

The sample added with CNTs showed higher J_c compared to pure sample. The CNTs may be converted to carbon-based nanomaterials that act as artificial pinning centers and contribute to the enhancement of J_c of the added samples. This study shows experimentally that the addition of nanoparticles CNTs and CNFs can significantly enhance the critical current density, J_c of bulk $YBa_2Cu_3O_{7-\delta}$. Thanks to STFL Team (Auni Khalid, Nabilah Yusuf, Chen Soo Kien, Halim Shaari, Lim Kean Pah, Nabilah Abdullah, Nik Afida Azahari). This work partly supported by Sakura Science Program (aPBL), Shibaura Institute of Technology (SIT) under the Top Global University Project, Designed by Ministry of Education, Culture, Sports, Science and Technology in Japan.

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Collagen Hydrolysate from Local Jellyfish (*Rhopilema hispidum*) as an Alternative for Anti-Tyrosinase Agent

Collagen has been a crucial biomaterial used in different industries, extended from sausage-making in the food sector to drug delivery in the biomedical sector. However, the source of collagen is mainly from bovine and porcine. The safety issue of bovine collagen has been raised over the last decades due to the outbreak of a disease known as bovine spongiform encephalopathy (BSE) that can be transmitted to humans, leading to development for an alternative. Therefore, our initiative to search alternative collagen derived from marine organisms like edible, local jellyfish is preferred to solve these issues.

Figure 1: Jellyfish sampling at Jeti Kampung Nelayan, Kukup, Johor

A study was conducted with collaborated with Prof. Dr. Nazamid Saari from Faculty of Food Science and Technology, and Prof. Dr. Fatimah Md. Yusoff from the Department of Aquaculture, Faculty of Agriculture, UPM, to produce and generate collagen hydrolysate (CH) from Malaysian jellyfish (*R. hispidum*) through enzymatic hydrolysis using papain enzyme.

The molecular weight of CH was found < 10kD consisting of mainly Gly (19.219%), Glu (10.428%), and Arg (8.848%). A preliminary study of anti-tyrosinase was evaluated. CH was found to exhibit tyrosinase inhibitory activity up to 64 % after 8 h of the hydrolysis process. It also exhibits good antioxidant with no toxicity toward normal fibroblast cells. Thus, it can potentially be used as active ingredients in cosmetics and serve as a good alternative source for collagen.

Table 1. Amino acid composition of jellyfish collagen hydrolysate.

Amino acids	Amount of amino acid	
	g/100 g sample	% (*w/w*)
Glycine (Gly)	2.086	19.219
Glutamic acid (Glu)	1.132	10.428
Arginine (Arg)	0.960	8.848
Proline (Pro)	0.753	6.935
Aspartic acid (Asp)	0.737	6.787
Alanine (Ala)	0.664	6.115
Hydroxyproline (Hyp)	0.634	5.843
Cysteine (Cys)	0.529	4.874
Threonine (Thr)	0.467	4.300
Leucine (Leu)	0.412	3.796
Serine (Ser)	0.373	3.437
Histidine (His)	0.356	3.283
Valine (Val)	0.351	3.238
Lysine (Lys)	0.350	3.220
Isoleucine (Ile)	0.324	2.986
Methionine (Met)	0.305	2.809
Phenylalanine (Phe)	0.235	2.164
Tyrosine (Tyr)	0.186	1.718
Tryptophan (Trp)	n.d.	n.d.
Σ_{AA}	10.854	100.000
Σ_{HAA}	5.316	48.980

Note: Data are expressed as mean of triplicates g/100 g of dry powder and as percentage of total amino acids. Σ_{AA}: total amino acids; Σ_{HAA}: sum of hydrophobic amino acids; n.d.: not detected.

Figure (a) shows that the tyrosinase inhibition activity was increased throughout 8 h of hydrolysis, which highly correlated with the hydrolysis time with an R^2 value of 0.9795.

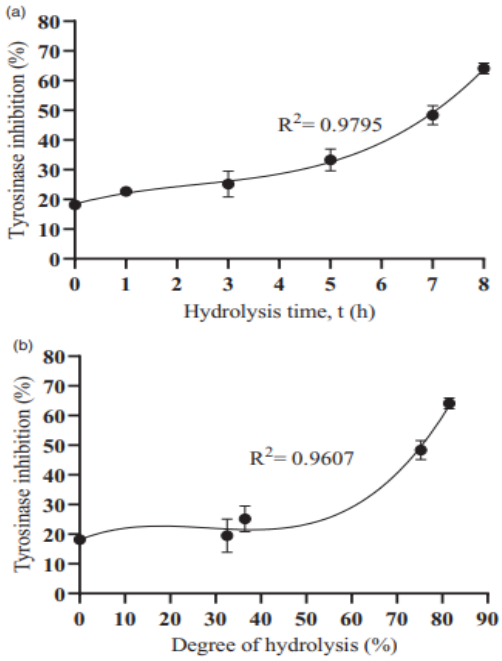

Figure (b) shows that tyrosinase inhibitory activity was correlated to the DH with R^2 value of 0.9607.

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It is a way of THINKING.