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2ND INTERNATIONAL SCIENCE,
ENGINEERING AND TECHNOLOGY
COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A
SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

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Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

EXPLORING BAMBOO CULM EXTRACTS AS A SOURCE OF FUNCTIONAL FEED ADDITIVES

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Abstract: Aquaculture faces increasing challenges related to fish health, growth, and environmental sustainability. Functional feed additives have emerged as a promising solution, particularly plant-based additives that offer natural bioactive compounds. This study investigates the potential of *Bambusa vulgaris* (bamboo) culm as a source of functional feed additives through ethanolic extraction. Bamboo is known to contain phytochemical compounds such as flavonoids and phenols, which possess antibacterial, antioxidant, and immune-boosting properties. The research aimed to (i) extract bioactive compounds from bamboo culms using ethanol, (ii) analyze and compare functional groups using FTIR and ATR spectroscopy in crude bamboo culm, bamboo charcoal powder, ethanolic extract, and ethanol-treated charcoal, and (iii) conduct phytochemical screening for flavonoids and phenols. Results revealed positive presence of phenolic compounds, particularly in ethanolic extracts, while flavonoids were weakly detected. FTIR analysis identified common functional groups such as O-H, C-O, and C-N, except in untreated bamboo charcoal due to its hydrocarbon nature. Bamboo-based fish pellets showed potential for environmental benefits, including water purification through activated charcoal. However, adjustments are needed to improve pellet buoyancy and pH balance. This study highlights the untapped potential of bamboo culms as sustainable and eco-friendly functional feed additives. Future research should explore their direct impact on fish growth, health, and immunity in aquaculture settings.

Keywords: *Bambusa vulgaris, FTIR, phytochemical screening test, functional feed additives, physical properties*

INTRODUCTION

In aquaculture, functional feed additives are compounds that are added to fish and shrimp diets to enhance growth, boost health, and strengthen disease resistance, which improves sustainability and productivity. Traditional fish feed diets frequently do not improve health, immunity and feed efficiently. Over time, traditional fish feed's composition has evolved to create a product with better qualities, and fish feed enriches needs to be further enhanced. In 1990, fish feed was primarily composed of fishmeal and fish oil, whereas by 2020, plant-based ingredients such as plant proteins and oils had become the dominant components. This is because plant resources are more cost-effective, sustainable, and efficient (Zlaugotne et al., 2022). In response, the introduction of functional feed additives into fish pellets has attracted significant attention among researchers and aquaculture practitioners. Some common functional feed additives in aquaculture are probiotics, prebiotics, phytochemical, microalgae, yeasts, enzymes, organic acids, mycotoxin binders, seaweed, or mushrooms (Onomu & Okuthe, 2024; Bharathi et al., 2019). Bamboos are widely found in Malaysia, a fast-growing plant that contains phytochemical bioactive compounds such as phenol, flavonoid and phytosterols. According to studies, these compounds exhibit antibacterial, antioxidants and enhancing immunity systems to combat various disease properties (Mt Yusuf et al., 2024; Gagliano et al., 2021). These properties are applicable in aquaculture. However, the utilization of extraction of phytochemical bioactive compounds from bamboo for functional feed additives remains largely unexplored. This study aimed to (i) extract the bioactive compounds from bamboo culm using ethanolic extraction (ii) to compare functional groups in bamboo culm crude, bamboo charcoal powder, ethanolic extract of bamboo culm crude and ethanol-treated bamboo charcoal powder by using Fourier-Transform Infrared spectroscopy and Attenuated Total Reflectance and (iii) to analyze phytochemical screening of bamboo's bioactive compounds from ethanolic extraction of bamboo culm crude.

LITERATURE REVIEW

Aquaculture plays a vital role in lifespan of aquatic animals, however this industry is constantly facing challenges related to fish health, growth and lifespan in terms of food security. One of the main problems that caused this is due to production of fish feeds that promotes ammonia growth rapidly in water and affects the fishes (Ruben et al., 2025). This attention has led to production of feed formulation using plant-based formulas which use bioactive compounds in plants to replace the synthetic additives to promote growth, health and enhancing immune system in fish. Not only focusing on fish but also producing a feed formulation that is environmentally friendly, economical and nutritious to all consumers. Bioactive compounds in aquaculture feed have gained attention due to their potential in enhancing fish health, growth and disease resistance. The essence of extraction of bioactive compounds from bamboo into fish feed formulations is presented as a natural and alternative to synthetic fish additives. Common bioactive compounds in bamboo are flavonoids, phytosterols and phenols that can contribute to overall fish well-being and offers a possible renewable functional fish feed (Nirmala et al., 2018). Studies show that flavonoids play a vital role in providing therapeutic properties such as reducing oxidative stress in fish, antimicrobial effect in fighting fish pathogens, and anti-inflammatory activity while phenolic acids links to enhancing the digestion and metabolism in aquatic species (Gunathilake et al., 2022). Phenolic compounds are present in both free and bound forms within the lignocellulosic matrix in bamboo culm (Knott et al., 2017). The outer layer of bamboo typically has a high presence of phenol due to more exposure to the environment. Therefore, the presence of phenolic influenced by the level of mature bamboo for 3 to 4 years of growth. Flavonoid is also a compound that is widely found in plants and known for their strong antioxidant, anti-inflammatory and UV protection. Although flavonoids are mostly found in bamboo leaves and shoots, some research has confirmed the presence of phenol even with lower concentration (Nuzul et al., 2022). Even in lower concentration, flavonoid in bamboo culm still can give value to the waste of bamboo in sustainable plants.

MATERIALS AND METHODS

Sample Preparation

Young *Bambusa vulgaris* culms were harvested and cut into small pieces using a machete. It then dried under between 10.00 am to 5.00 pm the shade for 14 days continuously. The culms were ground using a mechanical grinding and stored in a chiller at 5°C till needed (Nuzul et al., 2022). To prepare the bamboo's culm crude, the course culms were further oven-dried at 60°C and ground into fine powder using a mortar and pestle.

Ethanolic Extraction Method to Obtain Bamboo Culms Extraction

50g of powdered young bamboo culms were soaked in 300ml of 96% ethanol for 3 days at room temperature. Then, the mixture was extracted through a vacuum filter. After soaking the rough bamboo powder with 96% ethanol solvents for 3 days, the mixture was then filtered through suction by vacuum pump. The precipitate is then washed using 20ml of 70% ethyl acetate and allowing the liquid to pass through the rough powder slowly, within the vacuum. The extracted was concentrated using a rotary evaporator (adapted from Nuzul et al., 2022 with slight modification).

Ethanol-treated Bamboo Charcoal Powder

A food-grade bamboo charcoal powder (an activated charcoal) was purchased. 0.05g of bamboo charcoal powder and 10ml of 70% ethanol were added together into a conical flask to remove organic impurities and residual tar. This mixture was placed into an ultrasonic bath for the sonication process. The temperature and duration for the sonication process was set to 40°C and 12 minutes (Isa et al., 2017).

Analysis Sample Using FTIR and ATR for Bioactive Compound's Functional Groups

The samples: (1) bamboo's culm crude (2) bamboo culms ethanolic extract (3) bamboo charcoal powder and (4) ethanol-treated bamboo charcoal powder was mixed with potassium bromide powder each with a ratio of 1:8 using a spatula into a mortar. The mixtures were then pressed using a pestle to produce a fine powder. Next, the mixtures were transferred into a die set and compressed into a 3mm diameter salt-disc. Then, the die set was placed into a hydraulic gauge, and a thin film disk was produced. The background analysis was done first before inserting the disk into the

FTIR machine. The region for ATR was set from 400 cm^{-1} to 4000 cm^{-1} . The disc was kept in a sample holder and FTIR analysis was carried out.

Phytochemical Screening for Flavonoids and Phenols

(1) Flavonoids: 2 ml of the ethanolic extraction of bamboo culms was transferred into a clean test tube. 1 to 5 drops of concentrated hydrochloric acid (HCl) solution was added. The presence of flavonoids was determined by immediate development of red color. (2) Phenols: 2 ml of ethanolic extraction of bamboo culms was transferred into a clean test tube along with an additional 1 ml of distilled water. 1 to 2 drops of 0.1M Iron (III) chloride solution was added into the test tube. A blue, green, red or purple color appears indicating the presence of phenols (Rao, 2016).

Fish Pellet Production

(1) Fish pellet using crude bamboo culms (27% protein ratio): 2.4g of fish meal (local store), 7.8g of soybean (local store), 5.5g of yellow corn (local store), 3.5g of rice bran (local store), 2.4g of wheat flour (Cap Sauh, Johor Bahru Flour Mill Sdn Bhd), 2.4g of corn starch (cap bintang, THC Sdn Bhd), 1.0g of crude bamboo culms fine powder and 10ml of fish oil (Green Bait, Ideal Fishing Tackles) were added into a bowl and mixed. (2) Fish pellet using bamboo crude (30% protein ratio): 2.9g of fish meal, 9.2g of soybean, 4.0g of yellow corn powder, 2.6g of rice bran, 2.2g of wheat flour, 3.2g of corn starch, 1.0g of crude bamboo culms fine powder and 12ml of fish oil were added in a bowl and were mixed. (3) Fish pellet with crude bamboo charcoal powder: 2.4g of fish meal, 7.8g of soybean powder, 5.5g of yellow corn powder, 3.2g of rice bran powder, 2.2g of wheat flour, 2.4g of corn starch, 0.5g of crude bamboo charcoal powder and 10ml of fish oil were added all together into a bowl and were mixed. 1 - 3 ml of distilled water was added into each mixture respectively and shaped into spheres with a weight of approximately 0.35g each. The pellets produced were dried in an oven at $40\text{ }^{\circ}\text{C}$ for 5 hours (adapted from Bahnasawy, 2014 with slight modification).

Physical Properties of Fish Pellets

All types of fish pellets produced were tested by taking one pellet from each type and were put in a 250ml beaker containing 150ml of water at room temperature. The hardness, floating properties, pH of water, color changes on water and time taken for the pellets to dissolve in water were recorded.

RESULTS

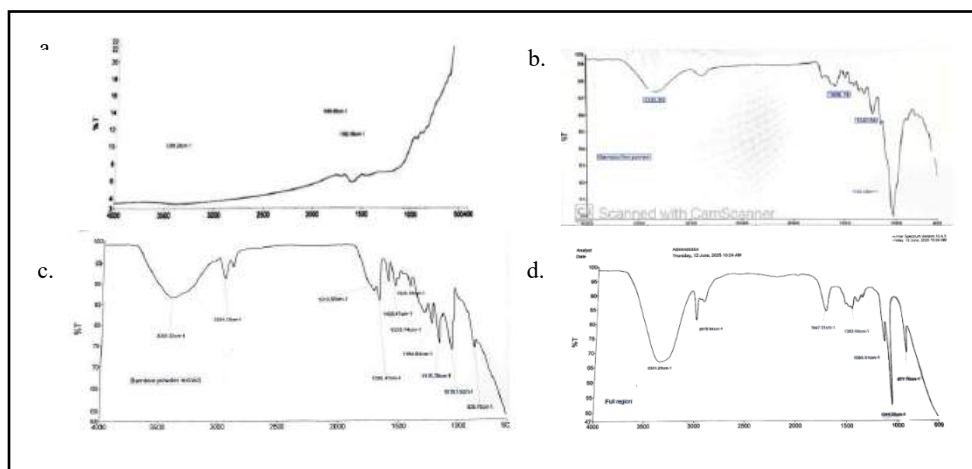


Figure 1. FTIR graph analysis from (a.) Crude bamboo charcoal powder (b.) Crude bamboo culms powder (c.) Bamboo culms ethanolic extract (d.) Ethanol-treated bamboo charcoal powder

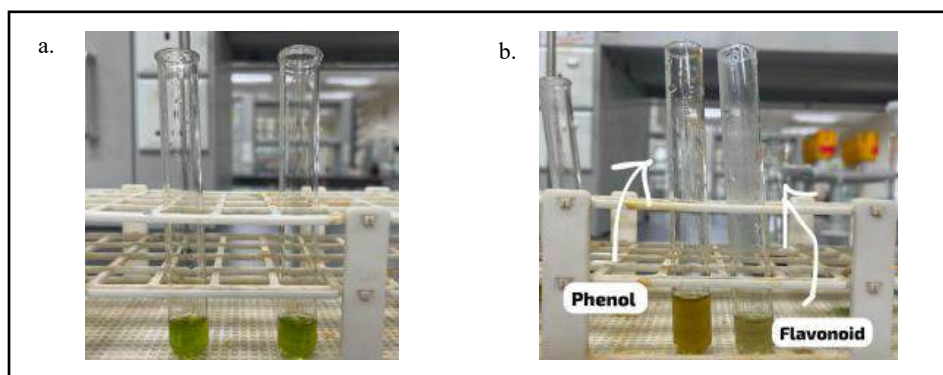


Figure 2. Phytochemical screening test for bamboo culms ethanolic extract (a.) Initial color (b.) Final color

Table 1. FTIR and ATR results from samples and validation via Phytochemical screening test

Samples	Wave number (cm ⁻¹)	Types of Bond(s)/Compound(s)	Phytochemical screening test*		Related to Flavonoid/Phenol
			Flavonoids	Phenols	
Crude bamboo charcoal powder	-	-	-	+	-
Crude bamboo culms powder	1240.64	C-O/Carboxylic acid	-	+	Yes, related because having (O-H), (C=C) and (C-O)
	3346.80	O-H/Phenol			
	1036.29	C-N/Amines			
	1600.74	C=C/Aromatic Rings			
Bamboo culms ethanolic extract	3385.52	O-H/Alcohol	-	+	Yes, related and strong evidence of phenol and flavonoid compounds because of (O-H) and (C-O) bands
	2924.58	C-H/Alkanes			
	1220.74	C-O/Carboxylic acid			
	1115.38	C-N/Amines			
	1326.68	C-O/Alcohol			
Ethanol-treated bamboo charcoal powder	3351.23	O-H/Alcohol	-	+	Yes, related because of the presence of O-H and C=C but though possibly less intense.
	1044.30	C-N/Amines			
	1383.99	C-O/Alcohol			
	1647.31	C=C/Alkenes			

*+ indicates the presence of bioactive compounds and – indicates the absence of bioactive compounds

Table 2. Summary of physical properties of fish pellets produced

Physical properties	Types of pellets		
	27% protein ratio	30% protein ratio	Crude bamboo charcoal powder
Floating /Sinking	Sinking	Sinking	Sinking
Time taken to dissolve in water	21 minutes 30 seconds	21 minutes 42 seconds	21 minutes 21 seconds
pH of water	5	5	5
Hardness	Hard	Hard	Hard
Observation	Water changed from clear to cloudy appearance	Water changed from clear to cloudy appearance	Water changed into very slightly cloudy appearance

Based on Figure 1 and Table 1, there are very weak or unclear peaks in the FTIR spectrum of crude bamboo charcoal. The full region of crude bamboo culms powder indicates 4 peaks. The first peak is 3346.80 cm^{-1} which is O-H broad, and this indicates strong hydroxyl group such as in water, alcohol or phenol. The next peak is 1600.74 cm^{-1} , which indicates C=C stretch. This is commonly in lignin which is an aromatic biopolymer that is mostly found in plants. The C-O peak is 1240.64 cm^{-1} represents carboxylic acid. While the C-N peak 1036.29 cm^{-1} indicates the presence of amines. The full region of ethanol-treated bamboo charcoal powder indicates 4 peaks. The ethanol-treated bamboo charcoal powder peaks shown are O-H at 3351.23 cm^{-1} , indicates a hydroxyl group or can be assumed as alcohol. Followed by C-O at peak 1383.99 cm^{-1} which corresponds to alcohol. Next is C-N peaks at 1115.38 cm^{-1} which are amines. Lastly the C=C, with peaks at 1647.31 cm^{-1} , indicates alkenes. There are 5 peaks shown for bamboo culms ethanolic extract. The first peak O-H is at 3385.52 cm^{-1} , indicating a hydroxyl group or alcohol. Next C=C and the wavenumber at 2924.58 cm^{-1} that shows the presence of alkenes. After that, the C-O peaks at 1326.68 cm^{-1} that corresponds to alcohol and the C-O peaks at 1220.74 cm^{-1} indicates carboxylic acid. Lastly is C-N with wavenumber 1115.38 cm^{-1} which shows the presence of amines. In phenol test, the solution color change from green to yellowish brown after added 1 to 2 drops of FeCl_3 which is indicating it as positive reaction. In a flavonoid test, the solution decolorized after adding 1 to 2 drops of HCl that concentrated which indicated a weak result in confirming the presence of flavonoid.

DISCUSSION/ANALYSIS

Although the drying process of bamboo culms can be done in an oven which is more effective and proper method that keeps from being contaminated, it is dried under the shades to avoid direct heat on the culms that might be resulting in damaging or reduced percentage of the desired bioactive compounds and more convenient as the samples are being exposed to the sunlight. Ethanol was chosen as the solvent to extract the bioactive compounds as ethanol extraction exhibits high extraction efficiency, facilitating the optimal recovery of target compounds from the plant material. This process maximizes the yield of bioactive compounds, making it a cost-effective and resource-efficient technique (Zhang et al., 2024). Methanol is not suitable to be used since it is more toxic than ethanol and can be hazardous if not handled properly (Plaskova & Mlcek, 2023). While, aqueous extract is not as efficient as organic solvents, especially in extracting bioactive compounds possessing antioxidant potential (Awad et al., 2021). Based on the result of crude bamboo charcoal, there were very weak or unclear peaks in the FTIR spectrum. It takes a lot of possible reasons for this to happen. Firstly, the sample is too thin. If the sample is too thin, the absorbance will be weaker in resulting peaks and the signal becomes saturated which means the IR light is leading to flattened or distorted peaks. Other than that, instrumental issues like resolution setting in FTIR can blur spaced peaks into broad or make the peaks indistinguishable. Detectors or optics problems such as dust, moisture or degraded mirror can attenuate IR beam, therefore some detectors are sensitive with certain ranges so if the detector it can miss the peaks (Drawell, 2025). However, to improve these unclear peaks, the samples need to be prepared properly according to their concentration and appropriate thickness. The instrument can be set to a resolution of 8 cm^{-1} instead of 2 cm^{-1} that causes overlap in complex samples. Dirty mirrors or mismatch detectors can reduce sensitivity and produce unclear results. Phytochemical screening test was conducted to detect the presence of phenol and flavonoid compounds in bamboo powder. These are common secondary metabolites that are found in plants, and this test involves the changes color as

indicator of the presence of phenol and flavonoid. In phenol test, the solution colour changes from green to yellowish-brown. This happens because phenol has an O-H group that is attached to an aromatic ring so it can form a complex with lone pair on oxygen. However, there are other methods that can be used such as pH testing or bromination, but the method takes longer or can be less specific compared to FeCl_3 (DeepakRajput, 2025). In a flavonoid test, however, there is another proper method to indicate strong results of flavonoid which is to use magnesium ribbon. This is because magnesium acts as reducing agent, donor electron to flavonoid. The use of HCl alone would not cause the necessary reduction, as it does not have the reducing power of magnesium (Asman et al., 2024). All types of fish pellets produced sank quickly. This sinking is due to low quantity of floating agents such as wheat flour and cornstarch. Another factor is due to the large mass which is 0.35g and large diameter of each pellet formed. To make it a floating pellet, the mass should be decreased to 0.1g and the pellet should be compressed into 1.0mm to 3mm diameter using a pellet extrusion machine (Bahnasawy, 2014). The pH of water after dissolving the pellets were in the acid range which is less suitable for feeding fish. This might be due to the number of plant-based materials such as soybean powder, rice bran powder and fish meals which are rich in organic acids. Table 2 shows, only crude bamboo charcoal fish pellets turned the water into a very slightly cloudy appearance compared to 27% protein ratio and 30% protein ratio fish pellets. According to a study, activated bamboo charcoal serves a great absorbent in purifying the water. Activated carbon is used since it is cheaper and recyclable and superior performance in dealing with organic and toxic waste (Isa et al., 2017).

CONCLUSIONS

Extracting bioactive compounds from bamboo using ethanolic extraction has been carried out successfully, as well as comparing functional groups in bamboo culm crude, bamboo charcoal powder, ethanolic extract of bamboo culm crude and ethanol-treated bamboo charcoal powder, where the similar functional groups present are O-H, C-N & C-O except for bamboo charcoal powder since it is a strict hydrocarbon hence, no peaks shown. Analyzing phytochemical screening of bamboo's bioactive compounds has also been achieved where phytochemical screening of flavonoid is tested negative and phenol is tested positive. Crude bamboo charcoal has the potential to be suitable for functional feed additives due to their properties as high adsorbent, making the need to change water can be minimized. For future investigation, research regarding the functional feed additives from bamboo culms should be tested on fish such as tilapia to test the effectiveness in aspects of the fish's growth and health thus strengthening the research.

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Tarikh : 20 Januari 2023



Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

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Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

27.1.2023

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