

Harnessing Sarawak's Indigenous resources: innovations in product development

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Article history:

Received: 24 April 2024

Received in revised form: 16 December 2024

Accepted: 27 December 2024

Available Online: 22

February 2025

Keywords:

Sarawak's Indigenous resources, Biodiversity, Innovations, Product development, Economic potential

DOI:

[https://doi.org/10.26656/fr.2017.8\(S8\).6](https://doi.org/10.26656/fr.2017.8(S8).6)

Abstract

Sarawak's tropical rainforests have a rich heritage of diverse flora and fauna, supporting some of the world's most abundant plant species. Within this biodiversity, over 100 indigenous fruits, vegetables, herbs, and spices have long been used as food sources, offering supplementary income to rural communities. These rich plant resources possess vast untapped economic potential that can be promoted for wider use, domestication, and commercialization. Among these potential indigenous resources are dabai, terung asam, and wild pepper. Through extensive research and development, MARDI Sarawak has harnessed these resources to create value-added Sarawak-based products. Our goal is to foster sustainable growth and drive economic progress in Sarawak's agri-food sector by strategically developing products and leveraging our plentiful resources for a prosperous future. This paper aimed to disseminate information about the untapped potential of Sarawak's indigenous resources while showcasing MARDI's innovations and achievements in product development, including herbal drinks, condiments, and premixed powders. Developing countries are encouraged to diversify their food exports by exploring the development of indigenous crop-based products that have not been fully explored. By engaging in strategic product development, Sarawak can unlock its immense economic potential and forge a path toward a prosperous and sustainable future.

1. Introduction

Borneo, the world's third-largest island, is renowned for its remarkable plant diversity. Situated centrally in Maritime Southeast Asia, the island is politically divided among Malaysia, Indonesia, and Brunei. Malaysia's portion of Borneo, known as 'East Malaysia' or 'Malaysian Borneo,' comprises two states, Sarawak and Sabah. Notably, Borneo has gained recognition as one of the most crucial centres of plant diversity on the planet. The botanical richness of Borneo is exemplified by an estimated 12,000 - 15,000 species of vascular plants, representing approximately 5 - 6% of the world's total. An impressive 40 - 50% of these species are unique to the island, with the majority of the endemic plants concentrated in Sarawak and Sabah. Recent research by the World Wildlife Fund (WWF) has unveiled the discovery of over 360 new species on Borneo since 1994, underscoring its ongoing significance as a botanical hotspot (Alamgir *et al.*, 2020).

Sarawak boasts a rich legacy of diverse flora and

fauna. Among these resources are more than 100 types of indigenous fruits, vegetables, herbs, and spices, which serve not only as essential food sources but also contribute to the livelihoods of rural communities. These indigenous crops have garnered attention due to their adaptability and suitability for local cultivation, setting them apart from introduced crop varieties. Several of these indigenous crops have even earned Geographical Indication (GI) status, recognized as the authentic products of Sarawak by the Intellectual Property Corporation of Malaysia (MyIPO).

Through diversifying food exports and actively promoting the domestication and commercialization of indigenous crops, the region has a significant opportunity to bolster its economic growth while simultaneously preserving its unparalleled biodiversity. Among the various botanical treasures found in this region, three principal categories of plants emerge as particularly promising: (1) edible fruits and vegetables, (2) medicinal herbs and spices, and (3) ornamental plants. This article

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highlights the potential of harnessing Borneo's indigenous plant resources, particularly in Sarawak, for sustainable development.

The Malaysian Agricultural Research and Development Institute (MARDI) Sarawak has played a pivotal role in advancing research on the quality enhancement and value addition of Sarawak-based plant products. Notable among these indigenous resources are dabai, terung asam, and wild pepper, which have been successfully commercialized into innovative products. This review aimed to explore the potential of these unique resources, showcasing their nutritional and functional properties, the innovations achieved in their value-added product development, and their contributions to sustainable economic growth and biodiversity conservation in Sarawak. By emphasizing these success stories, the review seeks to inspire further research and commercialization efforts to unlock the full potential of Sarawak's indigenous plant resources.

2. Approaches in product development

The development of indigenous resource-based products can be structured around three innovative approaches: (i) refining the processing parameters of existing conventional or traditional products, (ii) devising new formulations by substituting local plant-based materials for the less nutritious constituents in current existing food products, and (iii) integrating with other novel processing technologies. Several illustrative examples are presented in Table 1.

In order to establish a niche in the food markets, Malaysia can embark on product development grounded in indigenous knowledge encompassing aspects such as product formulation, form, and application (Aziz et al., 2005). Indigenous resources like dabai, terung asam and wild pepper offer significant potential for the innovation of value-added products that can benefit local economies and find success in wider markets.

2.1 Dabai

Canarium, a large fruit tree genus in the Burseraceae family, encompasses about 100 species found

predominantly in Asia, Africa, and the Pacific Islands. In Malaysia, four *Canarium* species are identified, with *C. odontophyllum* being popular. Known as dabai, *C. odontophyllum* (Figure 1) is a seasonal fruit unique to Borneo, especially Sarawak, resembling olives but botanically distinct. Dabai's growth is upright, reaching 20 m; mature trees yield up to 300 kg of fruit per season. It has two peak seasons: May-June and December-January. Dabai, oblong (3-4 cm), with dark skin, has yellowish flesh (4-7 mm thick) around a hard seed. Quality fruit is sizeable, with a nutty aroma and creamy texture (Chua et al., 2015).

Traditionally soaked and consumed with salt or soy sauce, dabai is rich in energy (339 kcal), protein (3.8%), fat (26.2%), minerals (potassium 810 mg, phosphorus 65 mg, calcium 200 mg, magnesium 106 mg), and vitamin E (257 ppm). The fatty acid composition resembles palm oil: palmitic acid (41.8%), linoleic acid (35.0%), and linolenic acid (11.0%). Dabai shows potential for healthy oil and nutraceuticals.

MARDI has conducted a study on dabai product development and storage techniques, which has resulted in the creation of innovative semi-processed products like pickled dabai and frozen dabai puree. These products aim to reduce wastage and extend dabai availability. This progress has also served as inspiration for the development of additional dabai-based products, including dabai dipping sauce, cooking paste, juice drinks, and even mayonnaise (Figure 1). These developments are in alignment with Sarawak's economic projections, promising a prosperous future for the dabai industry.

2.2 Terung asam

Terung asam (*Solanum lasiocarpum*), commonly referred to as terung Dayak or sour eggplant, stands as one of Sarawak's prominent indigenous crops. Over time, it has gradually gained substantial commercial significance, particularly in East Malaysia (Ting and Ding, 2021).

Maintaining a healthy weight can be tedious and challenging for many of us. Given the current situation

Table 1. Approaches and examples.

Approaches	Refining the processing parameters of existing conventional or traditional products	Devising new formulations by substituting local plant-based materials for the less nutritious constituents in current existing food products.	Integrating with other novel processing technologies.
Examples	Enhancement of Malaysian satay paste through the infusion of herbs with thermogenic properties to boost metabolism and promote fat burning, or the inclusion of herbs with cancer prevention attributes.	Development of granola bars featuring herbal additives like stevia to substitute for sugar, along with herbal antioxidants to replace butylated hydroxytoluene (BHT).	Transformation of local fruit juices into popping boba utilizing molecular gastronomy techniques such as spherification.



Figure 1. Dabai fruit and its value-added products: (a) dipping sauce, (b) juice drink, (c) cooking paste, and (d) mayonnaise.

involving a rapidly growing obese population in Malaysia, MARDI has developed an innovative solution, TERUNGOLD™ beverage (Figure 2), based on terung asam. This beverage efficiently helps people reduce and control their body weight. Scientific research has demonstrated the effectiveness of the product's primary constituent, hydroxycinnamic acid, in combating obesity. An analysis of the product revealed that the extract contains high concentrations of hydroxycinnamic acid group metabolites (0.42 mg/mg dried extract), including derivatives such as caffeic acid (0.15 mg/mg dried extract), 1-caffeoylquinic acid (0.09 mg/mg dried extract), along with other metabolites like gallic acid monohydrate, rutin, and quercetin acetyl glucoside (Zuraida *et al.*, 2022).



Figure 2. TERUNGOLD™ beverage.

Based on a 12-week preclinical investigation involving Sprague Dawley mice, TERUNGOLD™ beverage demonstrated anti-obesity effects when compared to a control group of animals fed a high-fat diet (HFD). Similar to the effects observed with Orlistat treatment, which served as a positive control, the beverage managed to reduce the weight gain of HFD-fed

mice by up to 29% (Figure 3). The product's effectiveness in combating obesity, preventing weight gain, and reducing excess weight has been clearly demonstrated (Zuraida *et al.*, 2022). The product is now ready for market distribution.

2.3 Wild pepper

Biodiversity prospecting of Sarawak's wild Piper species is of great importance, as many have long been known to possess numerous health-enhancing properties. Wild pepper (*Piper arborescens*) is one of the most commonly distributed species. The decoction is reputed to help treat rheumatism, gout, and other inflammatory disorders among local communities. Wild pepper root extract showed no noticeable gross toxicity in all treated Sprague-Dawley mice during sub-acute toxicity evaluation. The no-observed-adverse-effect-level (NOAEL) of wild pepper root extract exceeds 5 g/kg of body weight per day.

The PIPERIA Botanical Cubes (Figure 4), derived from wild pepper roots, exhibit natural anti-inflammatory activity. An anti-inflammatory study was conducted based on carrageenan-induced oedema in the hind paws of Sprague-Dawley rats. The results demonstrated robust anti-inflammatory activity in the drink, comparable to that of paracetamol (normalized values of 1.08 vs. 1.05) (Figure 5). PIPERIA can serve as an instant health beverage and sweetener for a wide range of food products. Its versatility and convenience make it an ideal botanical cube for multiple applications. Furthermore, PIPERIA has the potential to be introduced as a natural alternative, reducing over-dependence on synthetic anti-inflammatory drugs.

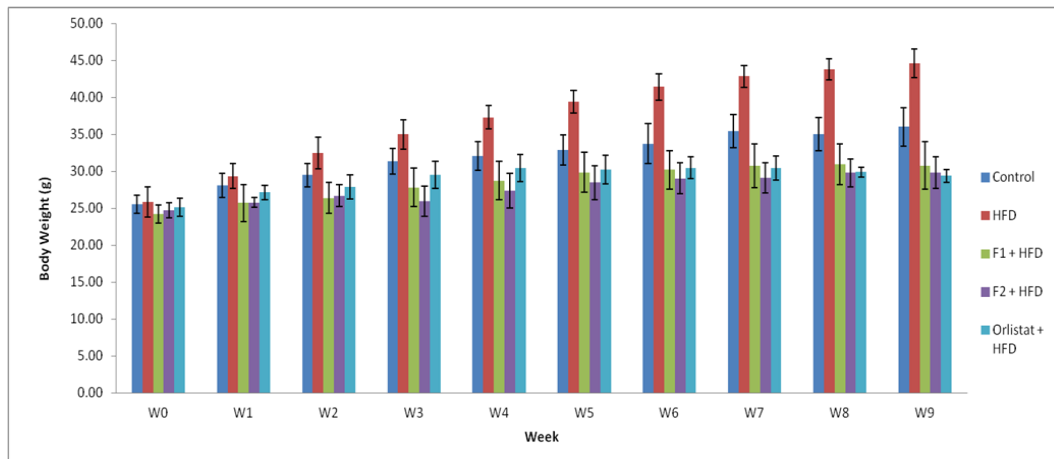


Figure 3. Weekly body weight measurement of control mouse, untreated HFD mouse, HFD mouse treated with F1, HFD mouse treated with F2 and HFD mouse treated with Orlistat for 9 weeks pre-clinical study.



Figure 4. Wild pepper roots (left) and PIPERIA Botanical Cubes (right).

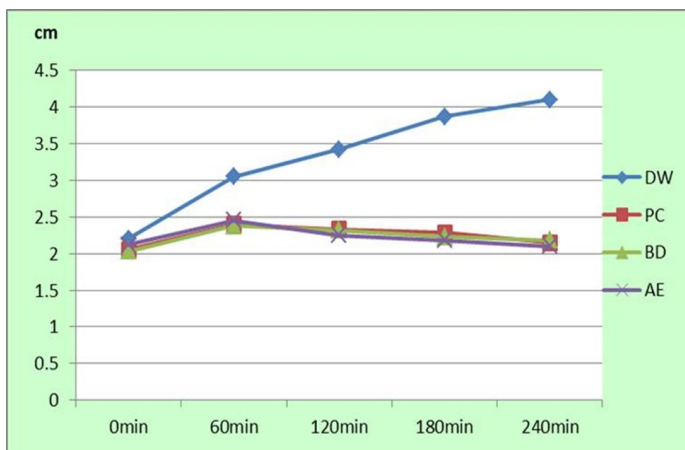


Figure 5. Paw carrageenan-induced oedema thickness (cm) vs. time (min) (n=6). AE: Carrageenan injection + aqueous extract (5 g/kg body weight), BD: Carrageenan injection + PIPERIA drink (5 g/kg body weight), PC: Carrageenan injection + paracetamol (20 mg/kg body weight) (Positive control), DW: Carrageenan injection + distilled water (Negative control).

3. Innovations and impact

When considering innovations and the development of novel food products using indigenous resources, several key points come into play:

Technology: This encompasses food processing and food design, with a focus on preserving and enhancing beneficial effects. This endeavor involves elements with intellectual property value or the potential to be patented, such as extraction methods, ingredients, and processing conditions.

Novelty: The innovation lies in utilizing traditional knowledge to address common health issues and

transforming these products into functional items. The development process can also be not only cost-effective but also simple to adopt, requiring minimal machinery.

Utility: This development paradigm must offer a multitude of benefits. It enhances the utilization of indigenous plants, generates high-value products for various markets, and enriches food composition databases. From an economic perspective, it safeguards and perpetuates traditional knowledge while harnessing Sarawak's rich biodiversity. Furthermore, it fosters growth in rural areas, creating business and employment opportunities.

Economic and social impact: This strategy brings significant economic and social benefits. It preserves and enriches traditional knowledge, strengthening cultural ties within the community. By leveraging Sarawak's unique biodiversity, it drives functional food production and boosts the local economy. Large-scale farming involves rural communities, empowering them and fostering economic growth.

4. Conclusion

Sarawak's status as a botanical treasure trove is emphasized by its vast plant diversity and high endemism. Its Indigenous plant resources, in particular, harbour significant potential for sustainable development through the cultivation, commercialization, and export of value-added products. By harnessing these resources, Sarawak can contribute to its economic growth and the conservation of its unique biodiversity, thus ensuring a harmonious balance between human progress and the preservation of nature.

Conflict of interest

The authors declare no conflict of interest.

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