

Edible Shoots of *Dendrocalamus asper*, *Gigantochloa levis* and *Bambusa blumeana*: A Mini Review of Composition, Bioactivity, Processing and Food Applications

Monjia Belleza Cosmas Mojulat¹; Oliver Dean John² and Noumie Surugau^{1*}

¹Department of Industrial Chemistry, Faculty of Science and Technology, Jalan UMS, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia

² Nutritional Biochemistry Research Group, Faculty of Food Science and Nutrition, Universiti Malaysia Sabah, Kota Kinabalu, Sabah 88400, Malaysia

*Inoumie@ums.edu.my

ABSTRACT

Edible bamboo shoots are widely consumed traditional foods in Asia and are increasingly recognised for their potential as functional food ingredients. This mini review synthesises current knowledge on the edible shoots of *Dendrocalamus asper*, *Gigantochloa levis* and *Bambusa blumeana*, focusing on their ethnobotanical significance, nutritional composition, phytochemical constituents and bioactive properties. Available studies indicate that bamboo shoots are characterised by high moisture content, moderate protein levels, and appreciable dietary fibre, together with essential minerals such as potassium, calcium and magnesium. In addition to their nutritional value, bamboo shoots contain phenolic compounds, flavonoids, phytosterols and polysaccharides associated with antioxidant, enzyme-inhibitory and prebiotic activities. Among the three species, *D. asper* is the most extensively studied, with strong evidence supporting its phytochemical composition and bioactivity, whereas *G. levis* shows promising prebiotic potential through its polysaccharides. In contrast, information on *B. blumeana* remains limited and largely derived from indirect or product-based studies. Although bamboo shoots contain cyanogenic glycosides, appropriate processing methods effectively reduce toxicity while retaining functional properties. Overall, bamboo shoots represent promising functional food resources; however, further species-specific studies are required, particularly for underutilised bamboo species in Southeast Asia.

Received: 18 Mar 2026

Accepted: 16 August 2026

Published: 30 September 2026

Doi: <http://10.51200/ijf.v3i2.7497>

Keywords: bamboo shoots; *bambusa blumeana*; *dendrocalamus asper*; functional food; *gigantochloa levis*; phytochemicals; Southeast Asia

1. Introduction

Bamboo belongs to the subfamily Bambusoideae within the grass family Poaceae and comprises approximately 130 genera and over 1,700 species distributed across tropical, subtropical and temperate regions worldwide (Ahmad et al., 2025; Ji et al., 2024). Bamboo forests cover an estimated 31.5 million hectares globally and represent an important natural resource that provides ecological, economic and social benefits, particularly in developing and tropical countries (Ma et al., 2024; World Bamboo Organization,

2024). In addition to their ecological importance, bamboo species are widely utilised for construction materials, handicrafts, paper production and food resources. More recently, their rapid renewability and versatility have attracted increasing attention within sustainable bioeconomy and functional food sectors, highlighting bamboo as a valuable renewable biological resource for future food and industrial applications (Ahmad et al., 2025).

Among these uses, young edible bamboo shoots are widely consumed as vegetables throughout many Asian countries and constitute an important agricultural commodity. Global consumption exceeds two million tonnes annually, with China, Thailand and India among the leading producers and consumers (Ma et al., 2024). Bamboo shoots have long been recognised as nutritious plant foods because of their favourable composition, including proteins, carbohydrates, dietary fibre, amino acids, vitamins and essential minerals, while generally remaining low in fat (Chongtham et al., 2011; Nongdam & Tikendra, 2014; Nirmala et al., 2014; Jana et al., 2025), although reported values vary among species and sources. These nutritional characteristics, together with their renewable nature, have contributed to growing interest in bamboo shoots as sustainable plant-based foods and functional food ingredients.

Beyond their nutritional value, bamboo shoots have attracted considerable scientific interest owing to their diverse phytochemical constituents associated with biological activity. Previous studies have identified phenolic compounds, flavonoids and other secondary metabolites in edible bamboo tissues, many of which contribute to bioactivities including antioxidant, anti-inflammatory and other health-promoting properties (Panee, 2015; Benjamin et al., 2023). Recent metabolomic analyses further demonstrated that the composition of phenolic acids, flavonoids and other metabolites varies throughout shoot development, influencing both nutritional quality and sensory characteristics (He et al., 2024). Collectively, these findings support the classification of bamboo shoots not only as traditional vegetables but also as promising functional food resources with potential health benefits (Sarkar et al., 2025).

Although edible bamboo shoots are consumed throughout Asia, this review specifically focuses on species that are widely utilised in Southeast Asia, where bamboo represents both an important traditional food resource and a component of regional cultural heritage. Among the numerous edible bamboo species reported in Southeast Asia, *Dendrocalamus asper*, *Gigantochloa levis* and *Bambusa blumeana* were selected for this review because they are among the most widely recognised edible species in the region and collectively represent bamboo resources of nutritional, ethnobotanical and economic importance. Furthermore, the available scientific evidence differs considerably among these species, with *D. asper* being extensively investigated, whereas comparatively limited information is available for *G. levis* and particularly *B. blumeana*. Reviewing these three species together therefore provides both a comprehensive overview of current knowledge and highlights important research gaps. Photographs of the edible shoots of the three selected bamboo species are presented in Figure 1(a–c). The images were adapted from Caasi-Lit et al. (2010), who documented edible bamboo resources across 26 provinces in the Philippines.

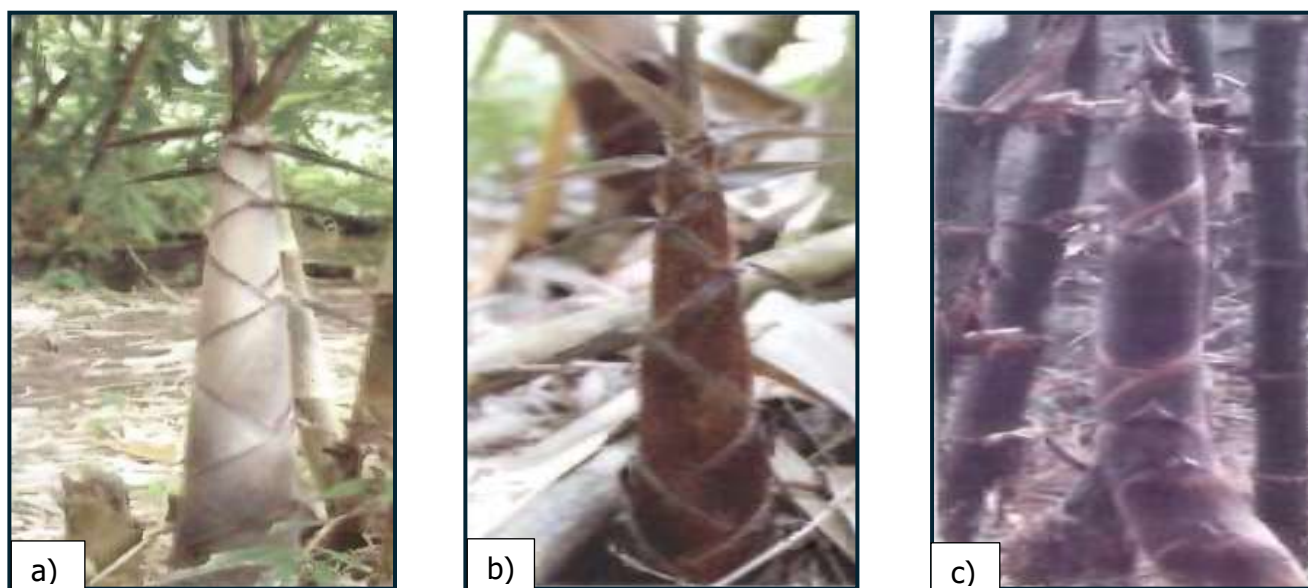


Figure 1. Edible shoots of the selected bamboo species:
a) *Dendrocalamus asper*, **b)** *Gigantochloa levis*, and **c)** *Bambusa blumeana*.

Source: Images adapted from Caasi-Lit et al. (2010).

Therefore, this mini review aims to compile and critically evaluate the available literature on the edible shoots of *D. asper*, *G. levis* and *B. blumeana*, with particular emphasis on their ethnobotanical significance, nutritional composition, phytochemical constituents, bioactive properties, and potential applications as functional food ingredients. By focusing on three representative edible bamboo species of Southeast Asia, this review synthesises the current evidence, identifies existing knowledge gaps and outlines future research directions to support the development of bamboo shoots as sustainable functional food resources. Where species-specific information is unavailable, evidence from closely related edible bamboo species is discussed to provide scientific context while highlighting areas requiring further investigation.

2. Botanical and Ethnobotanical Background of Selected Edible Bamboo Species

D. asper, *G. levis* and *B. blumeana* are among the bamboo species in Southeast Asia that produce edible shoots and are utilised by local communities as food resources. In Sabah and other parts of Borneo, these species are closely associated with traditional livelihoods, where bamboo provides both edible shoots and materials for construction, handicrafts and household tools. The botanical characteristics and traditional uses of these species are outlined below, based primarily on standardised records from the PROSEA (Plant Resources of South-East Asia) database.

2.1 *D. asper*

D. asper is one of the largest tropical bamboo species and is widely cultivated throughout Southeast Asia. Although its exact origin remains uncertain, it is believed to have originated within the region and is now widely planted across tropical Asia. The species has become naturalised in several areas, including parts of Malaysia and Indonesia, and has also been introduced into other tropical regions such as Madagascar and Sri Lanka (Dransfield & Widjaja, n.d.).

The young shoots of *D. asper* are widely consumed as vegetables and are often regarded as among the best edible bamboo shoots in tropical Asia. In Thailand, the species is sometimes referred to as “sweet bamboo” due to its comparatively low bitterness (Dransfield & Widjaja, n.d.). Shoots are typically harvested during the rainy season and consumed fresh, boiled or sold in local markets. Beyond its culinary value, *D. asper* is also highly valued for its large and durable culms, which are used in construction, including houses and bridges, as well as for containers and traditional cooking applications. Owing to these multiple uses, *D. asper* is considered one of the most economically important bamboo species in tropical Asia (Dransfield & Widjaja, n.d.).

2.2 *G. levis*

G. levis is widely distributed in Southeast Asia, particularly in the Philippines and northern Borneo. Although its origin is uncertain, it is commonly cultivated and has become naturalised in several regions. In Sabah, the species is known locally as poring or pering among Dusun communities (Wong, n.d.).

The young shoots of *G. levis* are consumed as vegetables and are sold either fresh or preserved through pickling. In both Sabah and the Philippines, the species is recognised for producing edible shoots of good quality (Wong, n.d.). In addition to its role as a food resource, the culms are widely used for construction, framework structures and wall plaiting, as well as in the fishing industry for rafts, fish traps and fish pens. They are also utilised in handicrafts and furniture production (Wong, n.d.).

This species typically grows in lowland environments, including secondary forests and areas near settlements. Its ability to provide both edible shoots and durable culms makes *G. levis* a multipurpose

bamboo species that plays an important role in traditional rural economies in parts of Borneo (Wong, n.d.).

2.3 *B. blumeana*

B. blumeana, commonly known as thorny bamboo or spiny bamboo, is native to Southeast Asia and is widely distributed across the Philippines, Indonesia and parts of Malaysia. The species forms dense clumps characterised by strong culms and thorny branches. Despite its spiny morphology, it has long been utilised by rural communities for a wide range of purposes.

The culms of *B. blumeana* are valued for their strength and durability and are widely used as construction materials, fencing and structural components. In addition to these utilitarian roles, the young shoots of *B. blumeana* are also harvested and consumed as vegetables in several Southeast Asian cuisines. Although the shoots are sometimes described as slightly more fibrous compared with those of *D. asper*, they remain an important traditional food resource in many areas (Roxas, n.d.).

2.4 Ethnobotanical Significance of Selected Bamboo Species

The utilisation of bamboo shoots in Sabah reflects the broader ethnobotanical importance of bamboo across Southeast Asia. Bamboo species are commonly cultivated near rural settlements or harvested from natural stands, providing accessible food resources for local communities (Dransfield & Widjaja, 1995; Chongtham et al., 2011). In addition to their role as food, bamboo culms are widely used in housing construction, handicrafts, agricultural tools and fishing equipment, highlighting their multifunctional value in rural livelihoods.

Among the bamboo species present in the region, *D. asper*, *G. levis* and *B. blumeana* are particularly notable due to their edible shoots and diverse utilitarian applications. The key morphological characteristics of these species are summarised in Table 1, while their ethnobotanical uses and traditional applications in Sabah are presented in Table 2.

Table 1. Morphological Characteristics of Selected Edible Bamboo Species

Morphological characteristic	<i>G. levis</i>	<i>D. asper</i>	<i>B. blumeana</i>
Growth form	Densely tufted sympodial bamboo	Densely tufted sympodial bamboo	Densely tufted sympodial bamboo forming dense spiny thickets
Culm height and diameter	Culm erect up to ~20 m tall and ~16 cm diameter	Culm erect 20–30 m tall and 8–20 cm diameter	Culm erect 15–25 m tall and up to ~20 cm diameter
Culm characteristics	Green culms with dark hairs near the base; internodes up to 45 cm	Thick-walled culms sometimes nearly solid at base; white wax below nodes	Internodes 25–60 cm long; nodes prominent with aerial roots
Culm sheath	Broadly triangular with dark hairs; auricles with bristles	Large hairy sheath; lanceolate blade; prominent auricles	Sheath up to 30 cm with stiff hairs; auricles with curved bristles
Branching pattern	Branches arise from a single bud with dominant primary branch	Few branches per node with dominant primary branch	Branches arise from nearly all nodes; basal branches bear strong spines

Young shoots	Triangular, brown-green and hairy	Covered with dark brown to black hairs	Yellowish-green sheaths and blades
Distribution	Philippines and northern Borneo	Widely distributed across tropical Asia	Indonesia and Borneo; cultivated across Southeast Asia
Leaves	Leaf blades 8–35 cm × 2–7 cm; slightly hairy beneath	Leaf blades about 30 cm × 2.5 cm; upper surface glabrous	Leaf blades 15–20 cm × 1.5–2 cm; linear-lanceolate

Source: Roxas (n.d.); Wong (n.d.); Dransfield & Widjaja (n.d.).

Table 2. Ethnobotanical Characteristics of Selected Edible Bamboo Species

Ethnobotanical characteristic	<i>G. levis</i>	<i>D. asper</i>	<i>B. blumeana</i>
Vernacular names	Poring, pering (Sabah); bolo (Philippines)	Buloh betong (Malaysia); bambu betung (Indonesia)	Buloh duri (Malaysia); bambu duri (Indonesia); kauayan-tinik (Philippines)
Food use	Shoots eaten fresh, pickled or dried	Shoots widely consumed as vegetables; high-quality edible bamboo	Shoots eaten as vegetables, usually boiled and shredded
Other traditional uses	Construction, handicrafts, furniture, fishing equipment	Houses, bridges, containers and handicrafts	Construction, basketry, furniture, chopsticks and paper
Harvesting practices	Shoots harvested about 7–15 days after emergence	Shoots harvested mainly during the rainy season	Shoots harvested during rainy season and boiled before consumption
Regional importance	Widely used in Sabah and the Philippines	Economically important bamboo cultivated for shoots	Important structural bamboo in Southeast Asia

Source: Roxas (n.d.); Wong (n.d.); Dransfield & Widjaja (n.d.).

Understanding the botanical and ethnobotanical context of these species provides an important foundation for evaluating their nutritional composition, phytochemical constituents and potential roles as functional food resources.

3. Nutritional composition of selected edible bamboo shoots

Young edible bamboo shoots are widely recognised as nutritious vegetables and have long been incorporated into traditional diets across many Asian countries (Ji et al., 2024; Sarkar et al., 2025). Harvested before the culms develop into mature woody stems, bamboo shoots contain a range of essential nutrients, including proteins, carbohydrates, dietary fibre, vitamins and minerals, while generally remaining relatively low in fat (Jana et al., 2025; Chongtham et al., 2011; Nirmala et al., 2014; Panee, 2015; Kong et al., 2020). These nutritional characteristics, together with their renewable nature, have contributed to increasing interest in bamboo shoots as sustainable plant-based foods and potential functional food

ingredients.

Fresh bamboo shoots are characterised by relatively high moisture content together with moderate levels of carbohydrates and proteins (Sarkar et al., 2025). Nutritional analyses have reported that fresh shoots typically contain approximately 1.49–4.04 g of protein per 100 g fresh weight, along with appreciable levels of carbohydrates, dietary fibre and amino acids that contribute to their overall nutritional value (Ahmad et al., 2025; Ma et al., 2024; Nongdam & Tikendra, 2014). Despite these nutrients, bamboo shoots contain relatively low lipid levels, making them suitable for incorporation into low-calorie and health-oriented diets (Ma et al., 2024), although reported values vary among species and sources. On a dry weight basis, protein concentrations may reach approximately 21.1–25.8%, highlighting the potential of bamboo shoots as plant-derived protein sources (Jana et al., 2025). Recent metabolomic investigations further demonstrated that the nutritional composition of bamboo shoots changes throughout shoot development, reflecting dynamic metabolic changes associated with growth and maturation (He et al., 2024).

Dietary fibre represents one of the most notable nutritional components of bamboo shoots. The fibre fraction includes structural polysaccharides, particularly cellulose and hemicellulose, together with lignin, which collectively contribute to gastrointestinal function (Wójcik et al., 2025). Recent studies have further suggested that the dietary fibre and non-digestible polysaccharides present in bamboo shoots may modulate gut microbiota and support intestinal health, reinforcing their potential as functional food ingredients (Deng et al., 2023; Wójcik et al., 2025). Consequently, bamboo shoots may contribute to dietary fibre intake and support overall dietary balance and digestive well-being (Fang et al., 2021; Satya et al., 2010).

In addition to macronutrients and dietary fibre, bamboo shoots provide important micronutrients that contribute to their nutritional value. Previous studies have reported the presence of vitamins such as thiamine, riboflavin, niacin and vitamin E, together with essential minerals including potassium, phosphorus, magnesium, calcium, iron and zinc (Ahmad et al., 2025; Nongdam & Tikendra, 2014; Nirmala & Bisht, 2012; Ma et al., 2024). Trace minerals such as manganese, copper and selenium have also been reported in bamboo shoots, although the exact concentrations may vary depending on species, environmental conditions and cultivation practices (Ji et al., 2024; Jana et al., 2025).

Among the bamboo species commonly utilised as food in Southeast Asia, *D. asper* has been the most extensively investigated and possesses the most comprehensive nutritional profile. Studies have documented the presence of proteins, dietary fibre and antioxidant compounds in its edible shoots (Chongtham et al., 2011; Nurlila et al., 2024). Comparatively fewer nutritional studies are available for *G. levis*, although existing reports have identified proteins, dietary fibre and polysaccharides associated with nutritional and functional properties. Information on *B. blumeana* remains particularly limited but indicates that its shoots also provide valuable nutrients and may be incorporated into various food products (Roxas, n.d.). Overall, the available evidence suggests that all three species possess favourable nutritional characteristics despite the uneven distribution of scientific evidence among them.

Overall, edible bamboo shoots are generally characterised by high moisture content, moderate protein levels, appreciable dietary fibre and relatively low fat content, although their nutritional composition varies according to species, developmental stage, processing method and reporting basis. As shown in Table 3, *D. asper* has the most comprehensive available nutritional dataset, whereas fewer data are available for *G. levis* and *B. blumeana*.

Table 3. Nutritional Composition of Edible Bamboo Shoots Reported in Selected Studies

	<i>D. asper</i> (Fresh shoot)	<i>D. asper</i> (Fresh shoot)	<i>D. asper</i> (Bamboo shoot flour)	<i>G. levis</i> (Young shoot)	<i>B. blumeana</i> (Young shoot)
Protein (g/100 g)	3.43	3.59	2.26*	3.00	4.00
Carbohydrate (g/100 g)	N.A.	4.90	4.10	0.00	4.00

	<i>D. asper</i> (Fresh shoot)	<i>D. asper</i> (Fresh shoot)	<i>D. asper</i> (Bamboo shoot flour)	<i>G. levis</i> (Young shoot)	<i>B. blumeana</i> (Young shoot)
Fat (g/100 g)	0.30	0.40	N.A.	7.00	0.50
Moisture (%)	88.82	89.40	N.A.	87.00	89.00
Ash (g/100 g)	0.80	0.95	N.A.	1.00	1.00
Fibre (g/100 g)	1.20	3.54	2.40	1.50	1.00
Energy (kcal/100 g)	N.A.	N.A.	N.A.	N.A.	28.68
Minerals reported (ppm)	Ca:110; Cu:2.5; Na:41; K:5030; P:590; Se:0.067; Mg:45	Ca: 55.1; P: 409.5; Fe: 33.7; Na: 101.4; K: 4,640; Mg: 101.4	N.A.	Ca:300; P:270; Fe:10	Ca:370; P:400; Fe:15
Reference	Sood et al. (2017)	Nongdam & Tikendra (2014)	Nurlila et al. (2024)	Wong (n.d.)	Roxas (n.d.)

N.A. = Not available or not reported in the original reference.

ppm = Parts per million (mg/kg).

Note: Mineral concentrations were converted to ppm (mg/kg) where appropriate for unit consistency. Differences in sample form and reporting basis, as well as analytical methods, limit direct quantitative comparison among studies.

*Values were taken from the results table of Nurlila et al. (2024).

4. Phytochemical constituents and polysaccharide yield of selected edible bamboo shoots

Edible bamboo shoots are valued not only for their nutritional composition but also for their phytochemical constituents, which may contribute to their biological and functional properties. Studies have reported phenolic compounds, flavonoids, tannins, terpenoids, phytosterols, alkaloids, polysaccharides and other bioactive constituents in bamboo shoots. Many of these compounds have been associated with antioxidant, antimicrobial and anti-inflammatory activities, supporting the potential use of bamboo shoots as functional food ingredients in addition to their traditional role as vegetables (Chongtham et al., 2011; Nirmala et al., 2014).

Reported phytochemical profiles vary considerably according to species, developmental stage, processing method, extraction solvent and analytical procedure. Differences in these factors affect the types and quantities of compounds recovered and limit direct comparisons among studies. Developmental changes may also alter the accumulation of metabolites during shoot growth (He et al., 2024; Ma et al., 2024). Representative phytochemical assay values and polysaccharide yields reported for the selected edible bamboo shoots are summarised in Table 4.

Table 4. Reported Phytochemical Assay Values and Polysaccharide Yield for Selected Edible Bamboo Shoots

Species (Sample)	Extraction	TPC	TFC	Polysaccharide Yield	Reference
<i>D. asper</i> (Fresh shoot)	Methanol	12.12 ± 0.12 mg GAE/g DW	1.60 ± 0.11 mg QE/g DW	N.A.	Pattarathitiwat et al. (2021)

Species (Sample)	Extraction	TPC	TFC	Polysaccharide Yield	Reference
<i>D. asper</i> (Boiled shoot)	Methanol	9.27 ± 0.27 mg GAE/g DW	0.89 ± 0.01 mg QE/g DW	N.A.	Pattarathitiwat et al. (2021)
<i>D. asper</i> (Dried Shoot)	Methanol	3.78 ± 0.06 mg GAE/g *	8.76 ± 1.43 mg QE/g *	N.A.	Ruiz et al. (2025)
<i>G. levis</i> (Dried shoot)	80% ethanol pretreatment; hot-water extraction (90 °C, 3 h); ethanol precipitation	N.A.	N.A.	3.27 ± 0.18 % DW	Azmi et al. (2012)
<i>B. blumeana</i> (Dried Shoot)	Methanol	4.68 ± 0.06 mg GAE/g *	7.69 ± 0.72 mg QE/g *	N.A.	Ruiz et al. (2025)

GAE = gallic acid equivalent

QE = quercetin equivalent

DW = dry weight

N.A. = not available or not reported in the cited source

* Values from Ruiz et al. (2025) were converted from mg/100 g to mg/g for consistency.

Among the selected species, *D. asper* has the most extensive shoot-level phytochemical data. Pattarathitiwat et al. (2021) reported total phenolic content of 12.12 ± 0.12 mg GAE/g DW and total flavonoid content of 1.60 ± 0.11 mg QE/g DW in methanolic extracts of fresh sliced shoots. The corresponding values for boiled shoots were 9.27 ± 0.27 mg GAE/g DW and 0.89 ± 0.01 mg QE/g DW, respectively. Qualitative screening detected flavonoids and reducing sugars in both fresh and boiled shoots, whereas terpenoids were detected only in fresh shoots. These findings indicate that boiling altered the extractable phytochemical profile. Nevertheless, appropriate processing, including boiling, is important for reducing cyanogenic compounds and improving the safety of bamboo shoots for consumption (Pattarathitiwat et al., 2021).

Ruiz et al. (2025) also reported total phenolic and flavonoid contents in methanolic shoot extracts of *D. asper* and *B. blumeana*. *D. asper* had a total phenolic content of 3.78 ± 0.06 mg GAE/g sample and a total flavonoid content of 8.76 ± 1.43 mg QE/g. The corresponding values for *B. blumeana* were 4.68 ± 0.06 mg GAE/g sample and 7.69 ± 0.72 mg QE/g sample, respectively. Nevertheless, the findings provide direct evidence of phenolic and flavonoid constituents in *B. blumeana* shoots, although the available evidence remains limited to a small number of studies.

Shoot-specific phytochemical evidence for *G. levis* is limited mainly to polysaccharides. Azmi et al. (2012) reported that crude water-soluble polysaccharides extracted from dried *G. levis* shoots yielded $3.27 \pm 0.18\%$ on a dry basis. This value represents the extraction yield obtained under the specified procedure rather than the polysaccharide concentration of the untreated shoot. The extracted polysaccharides also demonstrated in vitro prebiotic potential, indicating a class of functional constituents beyond phenolic and flavonoid compounds. Tongco et al. (2016) reported diterpenes, triterpenes, saponins, phenols, tannins, flavonoids and phytosterols in *G. levis* leaf extracts. However, these leaf-based findings provide only contextual evidence and should not be interpreted as representing shoot composition.

Collectively, *D. asper* has the most comprehensive shoot-level phytochemical evidence among the selected species. Direct evidence for *G. levis* shoots is primarily limited to polysaccharides, whereas its reported phenolic data are mainly leaf-based. *B. blumeana* has direct shoot-level total phenolic and flavonoid data, but the evidence is currently derived from a limited number of studies. Differences in sample preparation, extraction procedures, assays and reporting bases prevent reliable quantitative ranking of the three species. Further species-specific studies using harmonised analytical and reporting methods are therefore required. The reported phenolic, flavonoid and polysaccharide constituents provide a basis for examining the antioxidant, enzyme-inhibitory and prebiotic properties discussed in the following section.

5. Bioactive and Functional Properties of Selected Edible Bamboo Shoots

The bioactive potential of edible bamboo shoots is associated with several phytochemical and polysaccharide constituents, including phenolic compounds, flavonoids, dietary fibre and phytosterols. These constituents have been investigated for antioxidant, enzyme-inhibitory and prebiotic properties (Chongtham et al., 2011; Jana et al., 2025; Nirmala et al., 2014; Satya et al., 2010). Phytosterols such as β -sitosterol, campesterol and stigmasterol have been identified in bamboo shoots generally and have been associated with the regulation of cholesterol absorption and lipid metabolism, although their occurrence has not been established specifically in all three selected species (Lu et al., 2009; Ma et al., 2024). Although bamboo bioactivity has frequently been investigated using leaves and other non-edible tissues, such findings are not treated as direct evidence in the present review because phytochemical composition and biological activity may vary among plant parts. This section therefore focuses on studies that specifically examined edible shoots or shoot-derived polysaccharides of the selected species.

Among the selected species, direct evidence primarily concerns antioxidant, enzyme-inhibitory and prebiotic activities. Ruiz et al. (2025) evaluated methanolic shoot extracts of *D. asper* and *B. blumeana* using FRAP and EC₅₀ measurements, as summarised in Table 5. Pattarathitiwat et al. (2021) evaluated methanolic extracts of fresh and boiled *D. asper* shoots using percentage inhibition at a fixed extract concentration of 0.1 mg/mL, as presented in Table 6.

Table 5. Antioxidant and enzyme inhibitory activities of methanolic extracts from selected bamboo shoots reported as FRAP and EC₅₀ values

Species	FRAP (mg Fe ²⁺ /100 g)	H ₂ O ₂ scavenging EC ₅₀ (ppm)	Superoxide scavenging EC ₅₀ (ppm)	DPPH scavenging EC ₅₀ (ppm)	α -Amylase inhibition EC ₅₀ (ppm)	Reference
<i>D. asper</i>	11.73 $\pm$ 4.81 ^b	87.57 $\pm$ 9.22 ^c	80.17 $\pm$ 3.95 ^b	83.94 $\pm$ 1.59 ^c	702.40 $\pm$ 1.05 ^b	Ruiz et al., 2025
<i>B. blumeana</i>	26.93 $\pm$ 3.07 ^b	69.73 $\pm$ 0.81 ^b	62.00 $\pm$ 4.71 ^b	57.06 $\pm$ 0.54 ^b	681.10 $\pm$ 4.92 ^b	Ruiz et al., 2025

Note: EC₅₀ represents the extract concentration required to achieve 50% antioxidant or enzyme-inhibitory activity; therefore, lower EC₅₀ values indicate greater activity. Higher FRAP values indicate greater ferric-reducing capacity. Values are expressed as mean $\pm$ SEM. For each assay, values with different superscript letters are significantly different according to Duncan's multiple range test (DMRT; $p \leq 0.05$), as reported by Ruiz et al. (2025).

Table 6. Percentage inhibition by methanolic extracts of fresh and boiled *D. asper* shoots at 0.1 mg/mL

Species	ABTS scavenging (% inhibition at 0.1 mg/mL)	DPPH scavenging (% inhibition at 0.1 mg/mL)	α -Glucosidase inhibition (% inhibition at 0.1 mg/mL)	α -Amylase inhibition (% inhibition at 0.1 mg/mL)	Tyrosinase inhibition (% inhibition at 0.1 mg/mL)	Reference
<i>D. asper</i> (fresh shoots)	29.78 $\pm$ 0.65	19.43 $\pm$ 1.20	61.30 $\pm$ 0.45	37.00 $\pm$ 1.82	26.57 $\pm$ 0.57	Pattarathitiwat et al., 2021
<i>D. asper</i> (boiled shoots)	12.43 $\pm$ 0.40	16.00 $\pm$ 0.37	21.40 $\pm$ 0.31	20.01 $\pm$ 0.80	19.11 $\pm$ 0.60	Pattarathitiwat et al., 2021

Note: Antioxidant and enzyme inhibitory activities are expressed as percentage inhibition at a fixed extract concentration (0.1 mg/mL). Higher percentage inhibition indicates greater activity under the assay conditions.

In the study by Ruiz et al. (2025), *B. blumeana* demonstrated greater numerical activity than *D. asper* across the reported antioxidant assays. Its FRAP value was higher than that of *D. asper*, at

26.93 $\pm$ 3.07 and 11.73 $\pm$ 4.81 mg Fe²⁺/100 g sample, respectively. *B. blumeana* also produced lower EC₅₀ values for hydrogen peroxide, superoxide and DPPH scavenging, indicating that a lower extract concentration was required to achieve 50% scavenging activity under the respective assay conditions. The differences between the two species were statistically significant for hydrogen peroxide and DPPH scavenging, whereas their FRAP and superoxide-scavenging activities were not significantly different according to the statistical annotations in the original study. Therefore, the findings indicate greater activity for *B. blumeana* in certain assays but do not establish its superiority across all antioxidant measurements.

Ruiz et al. (2025) also reported α -amylase-inhibition EC₅₀ values of 681.10 $\pm$ 4.92 ppm for *B. blumeana* and 702.40 $\pm$ 1.05 ppm for *D. asper*. Although the lower EC₅₀ value for *B. blumeana* indicates greater numerical inhibitory activity, the difference between the two species was not statistically significant in the original analysis. Furthermore, the EC₅₀ values of both bamboo extracts were considerably higher than that of the acarbose standard reported in the original study. These findings demonstrate in vitro α -amylase-inhibitory activity but do not establish an effect on postprandial glucose concentrations or glycaemic control in humans.

Table 6 demonstrates the influence of boiling on the measured bioactivities of *D. asper*. At 0.1 mg/mL, the fresh extract produced 29.78 $\pm$ 0.65% ABTS inhibition and 19.43 $\pm$ 1.20% DPPH inhibition, whereas the boiled extract produced 12.43 $\pm$ 0.40% and 16.00 $\pm$ 0.37% inhibition, respectively (Pattarathitawat et al., 2021). The lower values in the boiled extract indicate that thermal processing reduced the measured radical-scavenging activity, although the extent of reduction differed between the assays. The reduction was more pronounced for ABTS than for DPPH inhibition.

Boiling also reduced the enzyme-inhibitory activities of *D. asper*. The fresh extract produced 61.30 $\pm$ 0.45% α -glucosidase inhibition, 37.00 $\pm$ 1.82% α -amylase inhibition and 26.57 $\pm$ 0.57% tyrosinase inhibition at 0.1 mg/mL. The corresponding values for the boiled extract were 21.40 $\pm$ 0.31%, 20.01 $\pm$ 0.80% and 19.11 $\pm$ 0.60%, respectively (Pattarathitawat et al., 2021). The greatest reduction was observed for α -glucosidase inhibition, whereas a smaller reduction was observed for tyrosinase inhibition. These findings indicate that measurable enzyme-inhibitory activity remained after boiling, but they do not demonstrate clinical effects on carbohydrate digestion, blood glucose regulation or tyrosinase-related conditions. The reductions in antioxidant and enzyme-inhibitory activities were consistent with the lower total phenolic and flavonoid contents reported in boiled shoots, although the available data do not establish a direct causal relationship.

Although *G. levis* shoot polysaccharides promoted selected *Bifidobacterium* and *Lactobacillus* strains in vitro, they also supported *Salmonella* growth during the earlier incubation periods, although at a lower rate than the probiotic strains (Azmi et al., 2012). Thus, microbial selectivity was not established, and the study did not characterise a complex gut microbial community.

In *D. asper*, shoot-derived oligosaccharides did not significantly alter total aerobic bacterial or lactobacilli counts in broiler caeca, although improvements in intestinal morphology were observed (Sittiya et al., 2025). Community-level changes in gut microbiota composition and short-chain fatty acid production have instead been reported for shoot-derived polysaccharides and dietary fibre from other bamboo species (Chen et al., 2022; Wu et al., 2023; Zhou et al., 2023). These findings provide contextual support, but community-level confirmation remains necessary for the three focal species. Beyond extract-based assays, dietary fibre may contribute to the broader functional properties of bamboo shoots. Park and Jhon (2009) reported improvements in selected lipid-profile and bowel-function measurements following short-term bamboo shoot consumption in eight healthy young women. However, the study was small, of short duration and not specific to the three focal bamboo species. It therefore provides preliminary evidence of the general functional properties of bamboo shoots rather than direct evidence for *D. asper*, *G. levis* or *B. blumeana*.

D. asper has the most extensive direct evidence for antioxidant and enzyme-inhibitory activities among the selected species, including evidence demonstrating the effects of boiling. *B. blumeana* exhibited direct shoot-level antioxidant and α -amylase-inhibitory activities in the study by Ruiz et al. (2025), with greater activity than *D. asper* in some assays. Direct bioactivity evidence for *G. levis* is primarily limited to the in vitro prebiotic potential of its extracted shoot polysaccharides. Differences in extraction procedures, assay conditions, reporting formats and statistical analyses prevent reliable

quantitative comparison among the three species. Further studies using harmonised methods and edible shoot samples are therefore required.

6. Processing and Functional Food Applications of Selected Edible Bamboo Shoots

6.1 Processing Methods

Bamboo shoots are widely consumed across Asia following household or industrial processing. Common processing methods include boiling, steaming, soaking, fermentation, pickling, drying and canning. These methods improve palatability and shelf life and, when adequately applied, reduce the cyanogenic compounds naturally present in freshly harvested shoots (Jana et al., 2025; Ma et al., 2024).

Fresh bamboo shoots contain cyanogenic glycosides, principally taxiphyllin, chemically identified as (R)-p-hydroxymandelonitrile β -D-glucopyranoside (Rosen et al., 1975). Following tissue disruption, endogenous β -glucosidase hydrolyses taxiphyllin to glucose and p-hydroxymandelonitrile, which subsequently decomposes to p-hydroxybenzaldehyde and hydrogen cyanide. Because taxiphyllin is unstable and thermolabile, heat treatment facilitates its degradation, while hydrogen cyanide may volatilise during cooking or leach into the processing water (Jana et al., 2025; Zhang et al., 2024). Slicing further enhances detoxification by increasing tissue disruption and facilitating contact between taxiphyllin and endogenous β -glucosidase before and during thermal treatment (Jana et al., 2025; Pattarathitiwat et al., 2021).

Boiling, steaming, soaking and fermentation are among the most frequently reported detoxification methods. Their effectiveness depends on factors such as bamboo species, shoot maturity, slice thickness, processing duration, temperature, water-to-sample ratio and whether the processing water is replaced. Processing may also alter nutritional and phytochemical composition through thermal degradation and the leaching of water-soluble constituents. The reported effects of the principal processing methods are summarised in Table 7.

However, complete detoxification may not occur in all *D. asper* materials. In bamboo shoot processing-residue powders, boiling for up to 90 minutes followed by oven drying significantly reduced but did not eliminate taxiphyllin, indicating that residual cyanogenic compounds should be verified before food use (Barros et al., 2022).

Table 7. Reported effects of processing methods on the safety and nutritional quality of edible bamboo shoots

Processing method	Primary purpose	Effect on cyanogenic compounds	Effect on nutritional quality	Overall implication	Reference
Boiling	Detoxification	Effectively reduces cyanogenic compounds through thermal degradation and leaching	Reduces vitamin C, total phenolic content, total flavonoid content and antioxidant activity because of heat exposure and leaching	Most widely recommended method before consumption	Pattarathitiwat et al. (2021); Jana et al. (2025)
Steaming	Detoxification	Reduces cyanogenic compounds through heat treatment	Better retention of phenolics, antioxidants and minerals than boiling	Alternative processing method with improved nutrient retention	Ma et al. (2024)

Fermentation	Preservation and detoxification	Substantially reduces cyanogenic compounds during microbial fermentation	Improves digestibility, flavour and shelf life while retaining or enhancing some bioactive compounds	Traditional preservation method with functional food potential	Chongtham et al. (2011); Jana et al. (2025)
Soaking	Detoxification	Promotes leaching of cyanogenic compounds into water	May reduce water-soluble vitamins while having minimal effect on dietary fibre	Usually combined with boiling or fermentation	Santosh et al. (2024); Ma et al. (2024)

Note: Drying is most effective for cyanide reduction when preceded by pre-treatments such as boiling or steaming.

Fresh sliced shoots of *D. asper* were reported to contain 140.40 ± 5.34 mg/kg cyanide, whereas cyanide was not detected after boiling for 30 minutes (Pattarathitiwat et al., 2021). However, boiling was accompanied by reductions in phytochemical content and biological activity. Total phenolic content decreased from 12.12 ± 0.12 to 9.27 ± 0.27 mg GAE/g DW, corresponding to a reduction of approximately 23.5%, as presented in Table 4. At the fixed extract concentration of 0.1 mg/mL, α -glucosidase inhibitory activity decreased from $61.30 \pm 0.45\%$ in the fresh extract to $21.40 \pm 0.31\%$ in the boiled extract, corresponding to a reduction of approximately 65.1%. Nevertheless, the boiled extract retained measurable α -amylase and α -glucosidase inhibitory activities of $20.01 \pm 0.80\%$ and $21.40 \pm 0.31\%$, respectively, as presented in Table 6. These findings indicate that boiling can achieve effective detoxification while retaining a proportion of the biological activity, although losses of phenolic compounds and associated bioactivities occur.

Steaming may provide an alternative thermal treatment with improved retention of water-soluble nutrients because the shoots are not immersed directly in water. Cyanide reductions of approximately 78–97% have been reported under the steaming conditions reviewed by Ma et al. (2024). Steaming may also help preserve minerals and antioxidant-related constituents by limiting leaching and inactivating enzymes associated with oxidative deterioration. However, the degree of cyanide reduction and nutrient retention depends on the species and processing conditions, and direct comparative evidence for the three focal species remains limited.

Fermentation represents another important processing method traditionally practised in Asian communities. It can reduce cyanogenic compounds and other antinutritional factors while extending shelf life and contributing to flavour development (Nirmala et al., 2014; Jana et al., 2025). Fermentation may also improve digestibility and preserve certain nutritional and functional constituents, although its effects vary according to the microorganisms, fermentation conditions and bamboo species involved.

These findings demonstrate that processing conditions must be optimised to achieve adequate detoxification while minimising the loss of nutritional and bioactive constituents. Among the focal species, the strongest direct processing evidence is currently available for *D. asper*, whereas species-specific processing studies involving *G. levis* and *B. blumeana* remain limited.

6.1 Development of value-added functional food products

In addition to their traditional consumption, bamboo shoots have attracted increasing attention as ingredients for value-added food products. Their favourable nutritional composition, dietary fibre content and functional properties enable their incorporation into various food matrices, including bakery products, cassava-based crackers, flour, paste formulations and fermented foods. Studies have demonstrated the use of *D. asper* in bamboo shoot flour, paste and cookies, *G. levis* bamboo shoot powder in cassava-based crackers, and shredded *B. blumeana* shoots in cupcakes (Darmajana et al., 2023; Heong et al., 2024; Nurlila et al., 2024; Tamayo & Tamayo, 2020; Watanabe et al., 2021). These developments support the transition of bamboo shoots from traditional vegetables to value-added functional food ingredients. Representative applications of the selected bamboo species and their principal findings are summarised in Table 8.

Table 8. Functional food applications of edible bamboo shoots

Bamboo species	Food product	Key findings	Reference
<i>D. asper</i>	Traditional fermented bamboo shoots	Fermentation reduces cyanogenic compounds while enhancing shelf life and preserving nutritional and functional properties, making fermented bamboo shoots an important traditional functional food.	Chongtham et al. (2011); Nirmala et al. (2014); Jana et al. (2025)
<i>D. asper</i>	Bamboo shoot paste	Pre-processing eliminated detectable cyanide after 60 minutes of boiling. The formulated paste remained low in fat, retained soluble and insoluble fibre, phenolic compounds and antioxidant activity, and demonstrated microbiological stability over five months of storage.	Watanabe et al. (2021)
<i>D. asper</i>	Fortified cookies	Improved nutritional value, acceptable sensory properties	Darmajana et al. (2023)
<i>D. asper</i>	Bamboo shoot flour	Steaming for 8 minutes followed by drying and milling produced bamboo shoot flour containing 2.40 g/100 g fibre. The flour exhibited DPPH radical-scavenging activity with an IC ₅₀ of 701.86 µg/mL, supporting its potential use as a functional food ingredient.	Nurlila et al. (2024)
<i>G. levis</i>	Bamboo shoot flour	The shoot flour yielded 62.78%; starch was detected by the iodine test, and it showed favourable water-holding and oil-absorption capacities.	Trayvilla and Pansacala (2023)
<i>G. levis</i>	Cassava-based crackers containing bamboo shoot powder	Incorporation of bamboo shoot powder increased the protein, ash, crude fibre and total dietary fibre contents of the crackers. The formulation containing 5% <i>G. levis</i> bamboo shoot powder received the highest overall liking score.	Heong et al. (2024)
<i>B. blumeana</i>	Bamboo shoot cupcakes	Incorporation of shredded bamboo shoots increased dietary fibre and produced cupcakes with good consumer acceptability, demonstrating their potential as a nutritious bakery product.	Tamayo & Tamayo (2020)
Multiple edible bamboo species	Commercial canned, natural and fermented bamboo shoot products	Commercial utilisation of bamboo shoots has expanded into canned, natural and fermented products, reflecting growing industrial interest and market potential for bamboo-based functional foods.	Jana et al. (2025)

Among the three focal species, *D. asper* has the most extensive product-development evidence, while recent findings demonstrate the successful incorporation of *G. levis* bamboo shoot powder into cassava-based crackers. Product-development evidence for *B. blumeana* is represented mainly by its incorporation into bakery products such as cupcakes (Heong et al., 2024; Tamayo & Tamayo, 2020).

Processing is central to the safe and effective utilisation of these shoots because it reduces cyanogenic compounds while influencing their sensory characteristics, nutritional composition and functional properties. The available findings support the potential of *D. asper*, *G. levis* and *B. blumeana* as value-added functional food ingredients, although further species-specific research is required to evaluate product safety, storage stability, consumer acceptability, commercial scalability and wider nutraceutical applications.

7. Research Gaps and Future Prospects

Although bamboo shoots have long been consumed as traditional foods, evidence concerning their composition, biological activity, processing and food applications remains uneven. Although a human intervention has evaluated a flavone-C-glycoside-rich antioxidant derived from bamboo leaves (Chen et al., 2020), direct clinical evidence linking the consumption of edible bamboo shoots to specific human health outcomes remains limited (Pizzol et al., 2025). This distinction is critical, as phytochemical profiles and resulting bioactivities often vary significantly between different plant parts (Panee, 2015). Bamboo shoots therefore remain underutilised food resources with considerable potential for sustainable food systems (Zhang et al., 2024).

Among the three focal species, *D. asper* has the most comprehensive evidence across nutritional composition, phytochemical constituents, bioactivity, processing and product development. Research on *G. levis* has demonstrated prebiotic polysaccharides and successful incorporation of shoot powder into cassava-based crackers, but its shoot-level phytochemical and bioactivity profiles remain insufficiently characterised (Azmi et al., 2012; Heong et al., 2024). Evidence for *B. blumeana* includes nutritional data, antioxidant and enzyme-inhibitory activities and bakery-product development, although comprehensive studies of its edible shoots remain scarce (Ruiz et al., 2025; Tamayo & Tamayo, 2020).

Processing-related research also requires greater standardisation. Although boiling, steaming, soaking and fermentation can reduce cyanogenic compounds, their effects on nutrient retention and biological activity vary according to species, shoot maturity and processing conditions. Comparative studies should therefore evaluate residual cyanide alongside nutritional, phytochemical and functional properties using clearly defined processing parameters. Existing food-product studies are also largely laboratory-based, creating a need for further evaluation of shelf life, sensory acceptability, nutrient bioaccessibility, processing scalability and commercial feasibility.

Emerging green extraction methods may also support bamboo by-product valorisation. Ultrasound-assisted extraction using a choline chloride–glycerol deep eutectic solvent improved polyphenol recovery from *Chimonobambusa purpurea* shoot shells relative to ethanol extraction, although this approach has not yet been evaluated for the three focal species (Dong et al., 2026).

Future research should prioritise integrated nutritional and phytochemical profiling using metabolomics and high-resolution analytical techniques, particularly for the less-studied shoots of *G. levis* and *B. blumeana*. In vivo investigations and well-designed human studies are also required to substantiate the functional effects suggested by laboratory assays.

8. Conclusion

This review demonstrates that edible bamboo shoots from *D. asper*, *G. levis* and *B. blumeana* are valuable plant-based food resources with considerable nutritional and functional significance. Bamboo shoots are generally characterised by favourable nutritional profiles, moderate protein levels and substantial dietary fibre, together with essential micronutrients. In addition, the presence of phytochemicals such as phenolic compounds, flavonoids, phytosterols and polysaccharides underpins a range of biological activities, including antioxidant, enzyme inhibitory and prebiotic effects.

Among the three species, *D. asper* is supported by the most comprehensive evidence regarding its nutritional composition, phytochemical constituents and bioactive properties. In contrast, comparatively limited information is available for *G. levis*, while *B. blumeana* remains the least studied species despite its traditional consumption and potential as a functional food resource. This disparity in species-specific evidence represents one of the principal limitations identified in the current literature and underscores the need for systematic investigations of underrepresented edible bamboo species.

Processing remains a critical factor in the utilisation of bamboo shoots, as methods such as boiling, fermentation and drying are essential for reducing cyanogenic glycosides and ensuring food safety while preserving, as far as possible, their nutritional value and functional properties. Continued optimisation of

processing techniques will be important for balancing detoxification with the retention of bioactive compounds.

Overall, edible bamboo shoots demonstrate considerable potential as functional food ingredients capable of supporting both traditional dietary practices and the development of sustainable food products. However, further research is required to address existing knowledge gaps through species-specific

nutritional and phytochemical profiling, comprehensive bioactivity evaluation and optimisation of processing techniques.

Such efforts will not only strengthen scientific understanding of edible bamboo species but also support the conservation, sustainable utilisation and value addition of bamboo resources, particularly in regions where these species provide important nutritional, economic and sociocultural benefits to local communities.

Author contributions: Conceptualisation, Mojulat, M.B.C and John, O.D.; methodology, Mojulat, M.B.C; validation, Mojulat, M.B.C, John, O.D. and Surugau, N.; formal analysis, Mojulat, M.B.C; investigation, Mojulat, M.B.C.; resources, Mojulat, M.B.C; data curation, Mojulat, M.B.C; writing— original draft, Mojulat, M.B.C.; writing—review and editing, John, O.D. and Surugau, N.; supervision, Surugau, N. All authors have read and approved the final manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

References

- Ahmad, Z., Kumari, R., Mir, B., Saeed, T., Firdaus, F., Vijayakanth, V., Keerthana, K., Ramakrishnan, M., & Wei, Q. (2025). Bamboo for the future: From traditional use to industry 5.0 applications. *Plants*, 14(19), 3019. <https://doi.org/10.3390/plants14193019>
- Azmi, A. F., Mustafa, S., Hashim, D. M., & Manap, Y. A. (2012). Prebiotic activity of polysaccharides extracted from *Gigantochloa levis* (Buluh beting) shoots. *Molecules*, 17(2), 1635–1651. <https://doi.org/10.3390/molecules17021635>
- Barros, M. G. A., Watanabe, L. B., Aquino, A. C. M. S., & Amante, E. R. (2022). Bamboo shoots - an evaluation of powders obtained from the processing residues of the species *Dendrocalamus asper*. *Research, Society and Development*, 11(5), e57411528894. <https://doi.org/10.33448/rsd-v11i5.28894>
- Benjamin, M. A. Z., Saikim, F. H., Ng, S. Y., & Rusdi, N. A. (2023). A comprehensive review of the ethnobotanical, phytochemical, and pharmacological properties of the genus *Bambusa*. *Journal of Applied Pharmaceutical Science*, 13(5), 1–21. <https://doi.org/10.7324/JAPS.2023.98082>
- Caasi-Lit, M. T., Mabesa, L. B., & Candelaria, R. B. (2010). Bamboo shoot resources of the Philippines: I. Edible bamboo and the current status of the local bamboo shoot industry. *Philippine Journal of Crop Science*, 35(2), 3–21. <https://www.cabidigitallibrary.org/doi/pdf/10.5555/20103257388>
- Chen, C., Guan, X., Liu, X., Zhuang, W., Xiao, Y., Zheng, Y., & Wang, Q. (2022). Polysaccharides from bamboo shoot (*Leleba oldhami* Nakal) byproducts alleviate antibiotic-associated diarrhea in mice through their interactions with gut microbiota. *Foods*, 11(17), 2647. <https://doi.org/10.3390/foods11172647>
- Chen, X., Jia, W., Wang, Q., Han, J., Cheng, J., Zeng, W., Zhao, Q., Zhang, Y., & Zhang, Y. (2020). Protective effect of a dietary flavonoid-rich antioxidant from bamboo leaves against internal exposure to acrylamide and glycidamide in humans. *Food & Function*, 11(8), 7000–7011. <https://doi.org/10.1039/d0fo00811g>
- Chongtham, N., Bisht, M. S., & Haorongbam, S. (2011). Nutritional properties of bamboo shoots: Potential and prospects for utilization as a health food. *Comprehensive Reviews in Food Science and Food Safety*, 10(3), 153–168. <https://doi.org/10.1111/j.1541-4337.2011.00147.x>
- Darmajana, D. A., Sagita, D., & Wulandari, N. (2023). Influence of bamboo shoots (*Dendrocalamus asper*) flour addition and baking

- temperatures on the sensory and physical characteristics of cookies. *International Journal of Design & Nature and Ecodynamics*, 18(6), 1427–1434. <https://doi.org/10.18280/ij dne.180616>
- Deng, J., Yun, J., Gu, Y., Yan, B., Yin, B., & Huang, C. (2023). Evaluating the in vitro and in vivo prebiotic effects of different xylo-oligosaccharides obtained from bamboo shoots by hydrothermal pretreatment combined with endo-xylanase hydrolysis. *International Journal of Molecular Sciences*, 24(17), 13422. <https://doi.org/10.3390/ijms241713422>
- Dong, X., Sun, H., Zhang, Y., Song, W., Li, Y., & Yu, X. (2026). Efficient extraction of polyphenols from bamboo shoot shells using deep eutectic solvents under optimized ultrasound-assisted conditions. *Advances in Bamboo Science*, 15, 100239. <https://doi.org/10.1016/j.bamboo.2026.100239>
- Dransfield, S., & Widjaja, E. A. (Eds.). (1995). *Plant resources of South-East Asia No. 7: Bamboos*. Backhuys Publishers.
- Dransfield, S., & Widjaja, E.A. (n.d.). *Dendrocalamus asper*. *Plant Resources of South-East Asia (PROSEA) database*. Retrieved 18 July 2026, https://prosea-bamboos.linnaeus.naturalis.nl/linnaeus_ng/app/views/species/taxon.php?id=95652&epi=129
- Fang, D., Wang, Q., Chen, C., Li, Z., Li, S., Chen, W., & Zheng, Y. (2021). Structural characteristics, physicochemical properties and prebiotic potential of modified dietary fibre from the basal part of bamboo shoot. *International Journal of Food Science and Technology*, 56(2), 618–628. <https://doi.org/10.1111/ijfs.14709>
- He, Y., Cao, X., Pan, K., Shi, W., & Ying, Y. (2024). Integrated transcriptome and metabolome analyses provided insight into the variation in quality of green bamboo (*Bambusa oldhamii*) shoots at different growth stages. *Forests*, 15(9), 1582. <https://doi.org/10.3390/f15091582>
- Heong, M. H., Sulaiman, N. S., Zaini, H. M., Chai, A., Mantihal, S., & Pindi, W. (2024). Impact of bamboo shoot powders on the quality attributes of cassava-based crackers. *Advances in Bamboo Science*, 9, 100114. <https://doi.org/10.1016/j.bamboo.2024.100114>
- Jana, U. K., Bhardwaj, P. K., Jeyaram, K., Shukla, J. K., Somkuwar, B. G., & Mukherjee, P. K. (2025). Bamboo shoots: Comprehensive perspectives on food composition, nutritional value, and therapeutic potential. *Journal of Food Composition and Analysis*, 140, 107198. <https://doi.org/10.1016/j.jfca.2025.107198>
- Ji, H., Ni, W., & Shao, J. F. (2024). Comparison and assessment of nutritional composition in shoots of six bamboo species in Southeast China. *Advances in Bamboo Science*, 7, 100087. <https://doi.org/10.1016/j.bamboo.2024.100087>
- Kong, C. K., Tan, Y. N., Chye, F. Y., & Sit, N. W. (2020). Nutritional composition and biological activities of the edible shoots of *Bambusa vulgaris* and *Gigantochloa ligulata*. *Food Bioscience*, 36, 100650. <https://doi.org/10.1016/j.fbio.2020.100650>
- Lu, B., Ren, Y., Zhang, Y., & Gong, J. (2009). Effects of genetic variability, plant parts and seasons on the sterol content and composition in bamboo shoots. *Food Chemistry*, 112(4), 1016–1021. <https://doi.org/10.1016/j.foodchem.2008.06.059>
- Ma, T., Mo, W., Lv, B., Wang, W., He, H., Jian, C., Liu, X., Li, S., & Guo, Y. (2024). A review of the nutritional composition, storage challenges, processing technology and widespread use of bamboo shoots. *Foods*, 13(22), 3539. <https://doi.org/10.3390/foods13223539>
- Nirmala, C., & Bisht, M. S. (2012). Bamboo shoots as a functional food. *Proceedings of the IXth World Bamboo Congress*, 753–763.
- Nirmala, C., Bisht, M. S., & Laishram, M. (2014). Bioactive compounds in bamboo shoots: Health benefits and prospects for developing functional foods. *International Journal of Food Science and Technology*, 49(6), 1425–1431. <https://doi.org/10.1111/ijfs.12470>
- Nongdam, P., & Tikendra, L. (2014). The nutritional facts of bamboo shoots and their usage as important traditional foods of northeast India. *International Scholarly Research Notices*, 679073. <https://doi.org/10.1155/2014/679073>
- Nurlila, R. U., La Fua, J., Andriani, R., Armayani, Saranani, S., & Rahmawati, A. A. (2024). Analysis of fiber content and antioxidant activity of bamboo shoots (*Dendrocalamus asper*) to support functional foods. *International Journal of Advancement in Life Sciences Research*, 7(2), 92–103. <https://doi.org/10.31632/ijalsr.2024.v07i02.007>
- Panee, J. (2015). Potential medicinal application and toxicity evaluation of extracts from bamboo plants. *Journal of Medicinal Plant Research*, 9(23), 681–692. <https://doi.org/10.5897/jmpr2014.5657>
- Park, E. J., & Jhon, D. Y. (2009). Effects of bamboo shoot consumption on lipid profiles and bowel function in healthy young women. *Nutrition*, 25(7–8), 723–728. <https://doi.org/10.1016/j.nut.2009.01.007>

- Pattarathitawat, P., Chinvongamorn, C., & Sansenya, S. (2021). Evaluation of cyanide content, volatile compounds profile, and biological properties of fresh and boiled sliced Thai bamboo shoot (*Dendrocalamus asper*). *Preventive Nutrition and Food Science*, 26(1), 92–99. <https://doi.org/10.3746/pnf.2021.26.1.92>
- Pizzol, D., Zampieri, T., MacKinnon, R., Yon, D. K., Richardson, F., López-Sánchez, G. F., Caminada, S., Bertoldo, A., Butler, L., Veronese, N., Soysal, P., Shin, J. I., & Smith, L. (2025). Bamboo consumption and health outcomes: A systematic review and call to action. *Advances in Bamboo Science*, 13, 100210. <https://doi.org/10.1016/j.bamboo.2025.100210>
- Roxas, C. A. (n.d.). *Bambusa blumeana*. *Plant Resources of South-East Asia (PROSEA) database*. Retrieved 18 July 2026, https://prosea-bamboos.linnaeus.naturalis.nl/linnaeus_ng/app/views/species/taxon.php?id=95638
- Rosen, M. A., Farnden, K. J., & Conn, E. E. (1975). Stereochemical aspects of the biosynthesis of the epimeric cyanogenic glucosides dhurrin and taxiphyllin. *The Journal of biological chemistry*, 250(21), 8302–8308. PMID: 1194256
- Ruiz, J. H., Pascual, P. R. L., & Alburo, R. P. (2025). Antioxidant activity and α -amylase inhibition of methanolic extracts from selected bamboo species. *Journal of Tropical Life Science*, 15(1), 31–42. <https://doi.org/10.11594/jtls.15.01.04>
- Santosh, O., Nirmala, C., Bajwa, H. K., Bisht, M. S., Indira, A., & Bano, S. (2024). Fortification of noodles with processed bamboo shoots: Evaluating the impact on nutritional composition, antioxidant activity and sensory characteristics. *Advances in Bamboo Science*, 8, 100089. <https://doi.org/10.1016/j.bamboo.2024.100089>
- Sarkar, P. K., Bhattacharjee, B., Das, S., Das, B., Singh, N. R., Bhutia, P. L., Chakrabarti, A., Das, B., Podder, R., & Choudhury, B. U. (2025). Edible bamboo shoots: A sustainable nexus of nutrition, livelihood, and food security for rural communities in India. *Frontiers in Nutrition*, 12, 1654510. <https://doi.org/10.3389/fnut.2025.1654510>
- Satya, S., Bal, L. M., Singhal, P., & Naik, S. N. (2010). Bamboo shoot processing: Food quality and safety aspects. *Trends in Food Science & Technology*, 21(4), 181–189. <https://doi.org/10.1016/j.tifs.2009.11.002>
- Sittiya, J., Chintong, S., Thongwittaya, N., & Yamauchi, K. (2025). Crude oligosaccharides extracted from bamboo shoots (*Dendrocalamus asper*) exhibit prebiotic activity and modulate intestinal morphology in broiler chickens without affecting growth performance. *Veterinary World*, 18(6), 1789–1798. <https://doi.org/10.14202/vetworld.2025.1789-1798>
- Sood, S., Walia, S., & Sood, A. (2017). Quality evaluation of different species of edible bamboo shoots. *ARC Journal of Nutrition and Growth*, 3(1), 1–6. <https://doi.org/10.20431/2455-2550.0301001>
- Tamayo, F. A., & Tamayo, P. A. (2020). Sensory evaluation, acceptability and proximate analysis of *Bambusa blumeana* as bamboo shoot cupcake: A product development. *International Journal of Disaster Recovery and Business Continuity*, 11(3), 33–43.
- Tongco, J. V. V., Rodriguez, E. B., Abasolo, W. P., Mun, S. P., & Razal, R. A. (2016). Mineral, nutritional, and phytochemical profile, total phenolic content, and radical scavenging activity of Philippine bamboo “bolo” *Gigantochloa levis* (Blanco) Merr. leaves. *Natural Product Sciences*, 22(1), 60–63. <http://dx.doi.org/10.20307/nps.2016.22.1.60>
- Trayvilla, A. J. C., & Pansacala, J. B. (2023). Functional properties of flour substitute from bolo (*Gigantochloa levis*) bamboo shoots and culms. *International Journal of Biosciences*, 22(6), 180–188. <https://doi.org/10.12692/ijb/22.6.180-188>
- Watanabe, L. B., Aquino, A. C. M. de S., & Amante, E. R. (2021). Paste as a new product from bamboo shoot (*Dendrocalamus asper*): Physicochemical and microbiological properties. *Research, Society and Development*, 10(3), e27610313353. <https://doi.org/10.33448/rsd-v10i3.13353>
- Wong, K. M. (n.d.). *Gigantochloa levis*. *Plant Resources of South-East Asia (PROSEA) database*. Retrieved 18 July 2026, https://prosea-bamboos.linnaeus.naturalis.nl/linnaeus_ng/app/views/species/taxon.php?id=95673&epi=129
- Wójcik, M., Matwijczuk, A., Ślusarczyk, L., & Różyło, R. (2025). The use of bamboo fiber in the production of high-fiber, low-carbohydrate, and gluten-free bread: Physicochemical and spectroscopic properties. *Processes*, 13(1), 83. <https://doi.org/10.3390/pr13010083>
- World Bamboo Organization. (2024). *2024 Global Bamboo Plantation Resource Survey Results Report*. Retrieved 18 July 2026, <https://www.worldbamboo.net/news-1/global-bamboo-resource-report-2024>
- Wu, W., Li, Q., Chen, H., Fang, X., Niu, B., Liu, R., Mu, H., & Gao, H. (2023). In vitro fermentation characteristics of the dietary fiber in bamboo (*Phyllostachys edulis*) shoots and its regulatory effects on the intestinal microbiota and metabolites. *Food Chemistry*, 404, 134707. <https://doi.org/10.1016/j.foodchem.2022.134707>

- Zhang, Y., Wu, L., Li, Y., Yang, J., Yang, H., Zhao, Y., & Chen, G. (2024). Bamboo shoot and its food applications in the last decade: An undervalued edible resource from forest to feed future people. *Trends in Food Science & Technology*. 146, 104399. <https://doi.org/10.1016/j.tifs.2024.104399>
- Zhou, X., Pak, S., Li, D., Dong, L., Chen, F., Hu, X., & Ma, L. (2023). Bamboo shoots modulate gut microbiota, eliminate obesity in high-fat-diet-fed mice and improve lipid metabolism. *Foods*, 12(7), 1380. <https://doi.org/10.3390/foods12071380>