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Original Article

Analysis of Fiber Content and Antioxidant Activity of Bamboo Shoots (*Dendrocalamus asper*) to Support Functional Foods

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Abstract

The purpose of food consumption extends beyond meeting the body's nutritional requirements, increasingly emphasizing the potential of food as a form of medicine or health enhancer. Functional foods, which can be integrated into daily menus without specific dosage requirements, present a favorable nutritional option. In the archipelagic region of Southeast Sulawesi, characterized by extensive forests, bamboo shoots thrive abundantly. Consequently, the local community in this area has acknowledged and incorporated bamboo shoots as a dietary component. This study aims to explore the content of bamboo shoots and analyze protein, carbohydrate, and fiber levels. The research employs various methods, including phytochemical screening, alkaloid testing, flavonoid testing, saponin, tannin, triterpenoid, and steroid assessments, as well as content analysis, proximate analysis, carbohydrate analysis, and fiber level analysis. The study outcomes reveal the presence of alkaloids and flavonoids in bamboo shoots, with protein levels at 2.6 g/100 g, carbohydrate levels at 4.10 g/100 g, and fiber levels at 2.40 g/100 g. It can be concluded that bamboo shoots have important secondary metabolites, namely flavonoids and alkaloids, which may have health benefits such as being anti-inflammatory, antiviral, and inhibitory of allergies.

Keywords: *Bamboo shoots, carbohydrates, protein*

Introduction

In recent times, the demand for food consumption has transcended the mere fulfilment of nutritional needs. It has evolved to encompass the consideration of food as not only a nutritional source but also as a potential form of medicine or a promoter of health. Functional food, whether occurring naturally or as a result of processing, refers to food containing one or more compounds that, according to scientific studies, are deemed to possess specific physiological functions beneficial to health. Moreover, functional food is characterized by its positive impact on an individual's health, physical appearance, and spiritual well-being, in addition to its nutritional content and taste. It's worth noting that functional food can be derived from both animal and plant sources, despite its health-promoting compounds.

Plants, recognized as one of the oldest and most natural sources of functional food, have played a pivotal role in this domain. As nutritional and medical science has progressed in the realm of functional food, various traditional Indonesian medicinal plants have gained acknowledgment as functional foods containing health-beneficial active substances (Galanakis, 2021). The consumption

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of functional food, which doesn't require specific dosages, is an advantageous and fitting nutritional practice for daily menus. It is suitable for individuals of all age groups. Commencing the incorporation of diverse functional foods into diets from early childhood is vital to ensuring optimal benefits and efficacy in adulthood. This practice contributes to health, vitality, productivity, independence, and longevity. Anticipatedly, the prevalence of functional food is expected to further flourish in Indonesia in the future (Helmalia *et al.*, 2019).

The flora in Indonesia is incredibly diverse and holds significant potential. Bamboo shoots are a useful food ingredient of local origin that the community uses for both culinary and medicinal purposes and has the potential to slow the progression of atherosclerosis. In Southeast Sulawesi, particularly in the South Konawe Regency, young bamboo shoots are frequently used in the preparation of vegetable dishes. Beyond their delicious taste, young bamboo shoots also offer health benefits attributed to their inherent nutritional content. The high levels of antioxidants, potassium, and fiber in bamboo shoots contribute to the reduction of harmful cholesterol levels in the body without compromising the levels of good cholesterol. Additionally, bamboo shoots contain protein, carbohydrates, vitamin A, vitamin B6, vitamin E, and 12 essential amino acids, all of which are highly beneficial for overall health (Rachmadi, 2011).

Southeast Sulawesi is one of the island regions in Indonesia that still possesses a considerable expanse of forest. Numerous forested areas are populated with bamboo trees that yield bamboo shoots, commonly known as bamboo sprouts or "rebung bamboo." These bamboo shoots are abundant in this region, leading the people of Southeast Sulawesi to become familiar with and utilize bamboo shoots as a food ingredient. However, the local community is not fully aware of the processed benefits of bamboo shoots that they frequently consume. In reality, bamboo shoots contain various beneficial compounds, positioning them as a substantive component of the dietary needs of the community. Therefore, it is essential to conduct an analysis of the secondary metabolite content of the active ingredients present in functional foods.

Bamboo shoots contain a variety of antioxidants, including vitamin E, polyphenols, flavonoids, vitexin, orientin, palmitic acid, curcumene, limonene, toluene, naphthalene, and 1,3,5-trimethyl benzene (Lu. *et al.*, 2010). Additionally, other antioxidant compounds present in bamboo shoots encompass vitamin A, thiamine, riboflavin, vitamin C, and curcumin (Choudhury *et al.*, 2010). All these antioxidants belong to the phytosterol type, which can effectively lower harmful cholesterol levels in the body without diminishing the levels of beneficial cholesterol. Furthermore, the antioxidants found in bamboo shoots play a protective role against cell damage. The protein content within bamboo shoots contributes to maintaining healthy cells. The elevated levels of potassium and fiber in bamboo shoots have the potential to reduce blood cholesterol levels. The potassium content also aids in lowering blood pressure on the heart by promoting smooth blood flow, thereby supporting heart health and mitigating the risk of coronary heart attacks and strokes. Moreover, the substantial fiber content in bamboo shoots offers various health benefits, including preventing gastrointestinal diseases, managing diabetes, controlling weight or obesity, reducing blood fat levels, and preventing cardiovascular diseases (Gaikwad *et al.,* 2019).

Research Method

Phytochemical Screening

Phytochemical screening was conducted on all filtrates to determine the solvent's capability for extracting secondary metabolite compounds from bamboo shoots. The phytochemical tests performed represent the primary synthesis pathways of secondary metabolites. Filtrate testing was carried out for each solvent repetition, including alkaloids, saponins, flavonoids, tannins, triterpenes, and terpenoids.

1. Alkaloid Test

A sample weighing 0.5 g was measured and subsequently introduced into 5 mL of ethanol. The mixture was then heated in a water bath for a duration of 2 minutes, followed by filtration. The

resulting filtrate underwent further treatment with 3 drops of concentrated HCl and 5 drops of Mayer's reagent (K2HgI4). The formation of a white precipitate indicates the positive presence of alkaloids.

2. Flavonoid Test

A 0.5 g sample was measured and introduced into 5 mL of ethanol, followed by heating and filtration. The resulting filtrate was then combined with 0.1 g of Mg metal and 5 drops of concentrated HCl. A positive reaction is identified by the development of an orange-to-red color, signifying the reduction of flavonoids.

3. Saponin Test

A sample weighing 0.5 g was measured and placed into a test tube, followed by the addition of 10 mL of hot distilled water. The mixture was then filtered and allowed to cool. Through vigorous shaking, a stable foam with a height ranging from 1 to 10 cm was generated. This foam persisted for at least 10 minutes and remained unchanged even with the addition of 2 drops of 2 NHCl, indicating the presence of saponins.

Top of Form Bottom of Form

4. Tannin Test

Following measurement and introduction of a 0.5 g sample into 5 mL of ethanol, heating for 5 minutes, and then filtering came next. The resulting filtrate was then subjected to the addition of 5 drops of 1% $FeCl_3$. The formation of a dark greenish-black color signifies the positive presence of tannins.

e. Triterpenoid and Steroid Test

0.5 g sample was weighed and added to 5 mL of ethanol, then filtered. The filtrate was added with 3 drops of concentrated HCl and 1 drop of concentrated H_2SO_4 (Salkowsky reagent). If triterpenoids are present, a red or purple color will form, and if steroids are present, a green color will develop.

Proximate Content Analysis in Bamboo Shoot Flour

a. Protein Content Analysis Using the Kjeldahl Method

A 1 g sample was measured and placed into a 100 mL Kjeldahl flask. Subsequently, 2 g of a selenium mixture and 25 mL of concentrated H_2SO_4 were added to the flask. The mixture underwent heating on an electric heater or burner until reaching a boiling point, causing the solution to acquire a greenish hue (lasting for 2 hours). Following this, the solution was allowed to cool, diluted, and transferred to a 100 mL volumetric flask, where it was adjusted to the mark. In the subsequent step, 5 mL of the solution was pipetted and introduced into a distillation apparatus. To this, 5 mL of 40% NaOH and a few drops of PP indicator were added. The distillation process took approximately 10 minutes, utilizing a collector consisting of 10 mL of a 2% borax solution mixed with PP indicator. The distillation end was rinsed with distilled water, and titration was performed using a 0.01 NHCl solution, along with the execution of a blank determination (Nisah *et al.*, 2020).

b. Carbohydrate Content Analysis Using the Luff Schoorl Method

For the carbohydrate analysis, initiate by measuring 5 grams of the sample and placing it in a 500 mL Erlenmeyer flask. Introduce 200 mL of a 3% HCl solution, and then proceed to boil the mixture for one hour with an upright condenser. Next, let the solution cool down, and then neutralize it with a 30% NaOH solution. To keep it slightly acidic, add a small amount of a 3% CH_3COOH solution. Quantitatively transfer the resulting solution to a 500 mL volumetric flask, dilute it with distilled water, and adjust the volume to the mark. Shake the solution and filter it through filter paper. Pipette 10 mL of the filtrate into a 500 mL Erlenmeyer flask, adding 25 mL of Luff Schoorl Solution along with some boiling stones, and 15 mL of distilled water. Apply constant heat to the mixture, allowing it to boil for 10 minutes, then rapidly cool it in an ice container. Following the cooling process, slowly introduce 15 mL of a 20% KI solution and 25 mL of a 25% H_2SO_4 solution. Promptly titrate the mixture with a 0.1 N $Na_2S_2O_3$ solution until the yellow color disappears. Utilize a small amount of a 1% starch solution as

an indicator. Continue the titration until the blue color vanishes, and subsequently perform a blank experiment using 25 mL of distilled water as a substitute for the sample.

c. Fiber Content Analysis Using the Gravimetric Method

Commence the procedure by measuring 2 grams of the substance and combining it with 200 mL of H_2SO_4 solution (0.255N). Employ reflux for 30 minutes during the boiling process. Filter the mixture using filter paper and rinse the remaining residue with boiling distilled water until the wash water attains a non-acidic state (confirmed with universal pH). Transfer the residue from the filter paper to an Erlenmeyer flask and wash the residue remnants with 200 mL of boiling NaOH solution (0.255N). Subject the mixture to another 30-minute boiling session. Filter the residue using filter paper with a known weight while washing it with a 10% K_2SO_4 solution. Further, wash the residue with boiling distilled water and 15 mL of 95% alcohol. Dry the filter paper along with the residue in an oven at 110°C until a consistent weight is achieved (typically 1-2 hours). Allow it to cool in a desiccator for 15 minutes before taking measurements (Marlett & Navis, 1988).

Antioxidant Analysis

Antioxidant activity analysis was conducted using the DPPH method with the following research steps: Preparation of DPPH Solution: Weigh 0.1 grams of DPPH and dissolve it in methanol up to the 50 mL mark in a volumetric flask. Determination of Maximum Absorption Wavelength: By measuring the DPPH solution's absorption at a wavelength of 513 nm, determine the maximum absorption wavelength. Preparation of Sample Parent Solution: Weigh 25 mg of bamboo shoot samples, dissolve them in a 25 mL volumetric flask, and fill it with methanol up to the mark. Preparation of Standard Vitamin C Solution: Weigh 25 mg of vitamin C, dissolve it in a 25-mL volumetric flask, and fill it with methanol up to the mark. Preparation of Sample Test Solution: Pipette 0.75 ml, 1.5 ml, 2.25 ml, 3 ml, and 3.75 ml from the bamboo shoot parent solution into 5 mL volumetric flasks. Then, add 1 ml of DPPH solution to each flask and fill it with methanol up to the mark. Incubate the solution for 30 minutes, then measure its absorption with a UV-visible spectrophotometer at the maximum absorption wavelength. Preparation of Comparative Solution: Pipette 0.75 ml, 1.5 ml, 2.25 ml, 3 ml, and 3.75 mL from the Vitamin C parent solution into 5 mL volumetric flasks. Then, add 1 ml of DPPH solution to each flask and fill it with methanol up to the mark. Incubate the solution for 30 minutes, then measure its absorption with a UV-visible spectrophotometer at the maximum absorption wavelength.

Result and Discussion

Table 1: Processing Methods Used by the Community

Processing Method	Quantity	Percentage (%)
Cleaned, peeled, thinly sliced, and washed	3	10
Cleaned, peeled, thinly sliced, and washed twice	3	10
Pre-boiled beforehand	24	80
Total	30	100

Table 2: Types of Processed Foods

Type of Processed Food	Quantity	Percentage (%)
Boiled in water	13	26
Cooked with coconut milk	16	31
Cooked with other vegetables	15	29
Boiled	4	7.8
Sautéed	3	5.9
Total	51	100

Table 3: Phytochemical Screening Results

No	Compound Group	Reagent	Observation Result	Remarks
1	Alkaloid	Dragendorff	Reddish-orange precipitate formed	Positive
2	Flavonoid	Wagner	Red precipitate formed	Negative
3	Saponin	Mg powder + HCL	Orange to red color formed	Positive
4	Tannin	HCL 2N	Foam formed for 20 seconds	Negative
5	Triterpen and	FeCl3	Brownish-red color formed	Negative
6	Steroid	HCL + H_2SO_4	Yellow to orange color formed	

Note: (+) indicates Positive, (-) indicates Negative.

a. Proximate Analysis

Table 4: Results of Protein, Carbohydrate, and Fiber Tests

No	Test Parameter	Test Result
1	Protein	2.26 g
2	Carbohydrate	4.10 g
3	Fiber	2.40 g

b. Antioxidant Analysis

Table 5: Antioxidant Test Results

Sample	Maximum Wavelength (nm)	Concentration (µg/mL)	Absorbance	% Inhibition	Regression Equation	IC50 (µg/mL)
Blank	513	-	0.5571	-	-	-
Vitamin C		3.125	0.3800	31.790	y = 1.3338x + 31.221, R^2 = 0.9905	14.08
		6.25	0.3300	40.765		
		12.5	0.2820	49.381		
		25	0.1840	66.972		
		50	0.0200	96.410		
Bamboo Shoots		12.5	0.5490	1.454	y = 0.0683x + 2.063, R^2 = 0.9761	701.86
		25	0.5400	3.069		
		50	0.5290	5.044		
		100	0.4970	10.788		
		200	0.4580	17.789		
		400	0.4010	28.020		

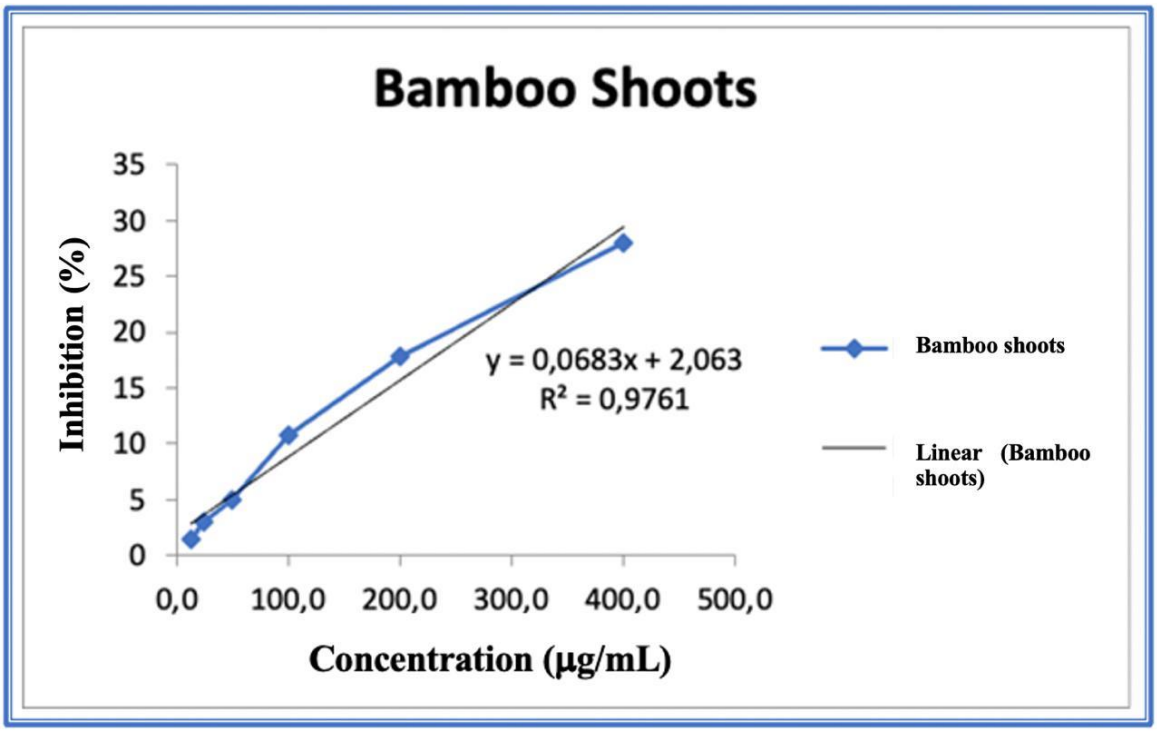

Figure 1. Antioxidant Activity Chart of Bamboo Shoot Flour (*Dendrocalamus asper)*

A study has been conducted on the analysis of secondary metabolite content and fibre in bamboo shoots (*Dendrocalamus asper*) as functional food for the inland communities of Southeast Sulawesi. The aim of this research is to determine the content of secondary metabolites and fiber in bamboo

shoots, as well as to understand how bamboo shoots are utilized as functional food by the inland communities of Southeast Sulawesi, specifically in Amohola Village, Moramo District, Konawe Selatan Regency.

Ayu *et al.* (2023) reported the presence of eight bamboo varieties across various regencies in Southeast Sulawesi. These varieties include Gigantochloa apus (Apus Bamboo), *Dendrocalamus asper Schult*. F. Backer, *Bambusa blumeana*, *Bambusa atra lindl* (Small Bamboo), *Bambusa vulgaris Vittata* (Ivory Bamboo), *Asparagus cochinchinensis*, and *Melocana baccifera*. In the Moramo District, four bamboo seedling types were identified and distributed across Moramo and North Moramo Districts, namely *Dendrocalamus asper Schult*. F. Backer, *Bambusa atra lindl* (Small Bamboo), *Bambusa vulgaris Vittata* (Ivory Bamboo), and *Asparagus cochinchinensis*, as outlined in the bamboo seed source distribution table for Southeast Sulawesi.

Table 6. Source of Bamboo Seedlings in Distribution Locations

Types of Bamboo	**Quantity**	Distribution Locations (district)
Gigantochloa apus (Bambu Apus)	34	Lantari Jaya, Poleang Utara, Poleang, Rarowatu Utara.
Dendrocalamus asper Schult. F. Backer	30	Laeya, Kolono, Ranomeeto, Tinanggea, Palangga, Angata, Basala, Konda, Moramo, Lainea
Bambusa blumeana	20	Laeya, kolono, Ranomeeto, Andoolo, Tinanggea, Palangga, Palangga Selatan, Konda.
Bambusa atra lindl (Bambu Kecil)	15	Laeya, Andolo Barat, Kolono, Tinanggea, Palangga, Moramo, Lalembu
Bambusa vulgaris Vittata (Bambu Gading)	13	Laeya, Kolono, Ranomeeto, Andoolo, Moramo Utara, Wolasi, Tinanggea, Basala, Konda, Moramo dan Lainea.
Asparagus cochinchinensis	9	Ranomeeto, Moramo Utara, Tinanggea, Basala dan Moramo.
Melocana baccifera	1	Wolasi

The types of bamboo obtained from the sampling in Amohola Village, Moramo District, South Konawe Regency, are *Dendrocalamus asper*. This bamboo species grows on the riverbank, where the soil is moist, and the location is at an altitude of approximately 200 meters from the riverbank."

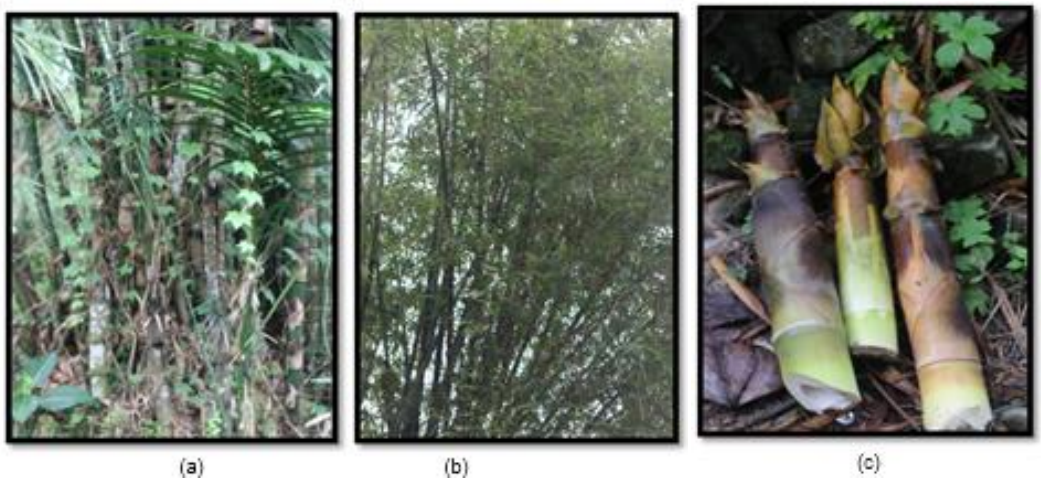

Figure 2. Betung Bamboo (*Dendrocalamus asper*): (a) roots, (b) leaves, (c) bamboo shoots. “Source: Personal Document”

Bamboo plants can grow from lowland to highland areas, ranging from 100 to 2,200 meters above sea level (masl). However, not all bamboo types thrive in high-altitude locations. Nevertheless, in places with high humidity or high rainfall, such as along riverbanks or steep cliffs, bamboo can achieve optimal growth. Bamboo plants can thrive in both lowland and highland areas, with altitudes ranging from 0 to 2,000 masl. Bamboo with slender stems is found to grow at elevations between 2,000 masl and 3,750 masl. At an altitude of 3,750 meters above sea level, its habitat takes the form of grass, as seen in the genus Dinochloa. Bamboo can grow in various soil types, especially brown

latosol-associated soils with grey regosol. The preferred soil pH is between 5.6 and 6.5. Bamboo can grow in all soil types except those near the coast, as coastal areas are considered marginal land with poor nutrient content, high erosion susceptibility, uncontrolled sunlight, and rapid water loss in the soil. Bamboo plants can grow well and spread widely, influenced by climate conditions. Climate elements include sunlight, temperature, rainfall, and humidity. The preferred habitat for bamboo plants is open land where sunlight can directly enter the gaps in the bamboo clumps, allowing the photosynthesis process to run smoothly. This condition also prevents the growth of fungi that may affect the fertility of bamboo plants, leading to a decline in bamboo quality. The suitable environment for bamboo plants has a temperature range of 8.8°C to 36°C. The climate types for bamboo plants range from A, B, C, D to E (from wet to dry climates). The wetter the climate type, the more bamboo species can thrive. This is because bamboo is a water-demanding plant, requiring a minimum annual rainfall of 1,020 mm and a minimum humidity of 76%. Factors influencing bamboo growth include rainfall, air temperature, and air humidity. The optimal conditions are a temperature of 8.8 - 36°C, a minimum annual rainfall of 1,020 mm, and 80% humidity (Sujarwanta & Zen, 2020).

The research began by selecting respondents, and based on observation results, it was found that in the village of Amohola, there are many bamboo shoot plants around the houses of the community. The number of respondents available for interviews was 30, consisting of 23 women and 7 men. Out of these 30 respondents, all utilized bamboo shoots as functional food. The characteristics of bamboo shoots that were considered suitable for harvesting were a height of 4-10 cm, young bamboo, and fine brownish-black hairs. Harvesting bamboo shoots was a straightforward process, involving cutting the bottom part of the bamboo shoot or the part intended for extraction.

The interviews were carried out based on the community's knowledge level. According to Nongdam (2014), Puspitasari (2014), Sariningrum & Irdawati (2009), and Soraya (2013), knowledge is the result of "knowing" and arises after people perceive a particular object through human senses like sight, hearing, smell, taste, and touch. Predominantly, human knowledge is acquired through visual and auditory means. Therefore, from the interview findings with respondents, it can be inferred that the community's understanding of bamboo shoots as functional food is inherited from their ancestors, spanning through generations, reaching a 100% consensus. The residents of Amohola Village frequently incorporate bamboo shoots into their diet, preparing them by cleaning, peeling, washing, and thinly slicing the shoots. Various cooking methods, such as boiling in clear broth, coconut milk, stir-frying, and combining with other vegetables, are employed.

Following the interviews with the residents of Amohola Village, North Moramo Sub-district, the subsequent step involved the sampling process, which would later be transformed into bamboo shoot flour. The production of bamboo shoot flour commenced with the sampling process, where the selected criteria included bamboo shoots with a bright yellow skin color before peeling and a length of 15-20 cm. The bamboo shoot underwent peeling, washing, and extraction of the edible part. It was then divided into three equal segments (tip, middle and base), thinly sliced, and steamed for 8 minutes to prevent browning during the drying phase. Subsequently, it was dried at approximately 50°C for 2 days and 2 hours. The dehydrated bamboo shoot slices were then finely ground and sifted using a 60-mesh sieve to obtain a high-quality bamboo shoot flour.

The bamboo shoot flour acquired underwent phytochemical screening to ascertain the existence of compounds within the bamboo shoot flour. The screening encompassed the detection of alkaloids, flavonoids, saponins, tannins, triterpenoids, and steroids in the bamboo shoot flour. Following the completion of the phytochemical screening, the outcomes revealed the presence of alkaloids and flavonoids in the tested bamboo shoot flour. The detailed screening results are presented in Table 3. The identification of these secondary metabolite compounds could offer potential health benefits to the community that incorporates bamboo shoots into their diet.

Alkaloids, characterized by the presence of nitrogen atoms, stand out as the predominant secondary metabolite compounds in plant tissues. They actively participate in metabolic processes and regulate developmental aspects within the plant's life cycle. The origin of most alkaloid compounds can be

traced back to plants, particularly angiosperms. Studies indicate that over 20% of angiosperm species contain alkaloids (Wink, 2008); Gusmiarni *et al.*, (2021). Alkaloids are distributed across various plant parts, including flowers, seeds, leaves, branches, roots, and bark. Typically found in modest quantities, alkaloids must be isolated from intricate compound mixtures originating from plant tissues (Ningrum *et al.*, 2016). In plants, alkaloids function as toxins to safeguard against insects and herbivores, serve as growth regulators, and act as storage compounds supplying nitrogen and other essential elements (Wink, 2008). Furthermore, alkaloid compounds demonstrate antifungal properties by disrupting peptidoglycan components in fungal cells, impeding the formation of intact cell walls, and resulting in cell death (Sari *et al.*, 2022).

The phenolic compound group includes flavonoids, which are secondary metabolite compounds with a benzene structure that has OH groups swapped out. This compound is the largest group found in nature and is present in roots, wood, bark, leaves, stems, fruits, and flowers. Generally, flavonoid compounds are found in higher plants. About 5-10% of secondary metabolite compounds in plants are flavonoids. The phenolic compound group includes flavonoids, which are secondary metabolite compounds with a benzene structure that has OH groups swapped out. This compound is the largest group found in nature and is present in roots, wood, bark, leaves, stems, fruits, and flowers. Generally, flavonoid compounds are found in higher plants. About 5-10% of secondary metabolite compounds in plants are flavonoids (Ferreyra, 2012).

After the process of chemical compound identification, the next step involves the analysis of protein, carbohydrate, and fiber content. Fresh bamboo shoots have a nutritional content that is predominantly composed of water, which is about 90.6% (Rachmadi, 2011). Fresh bamboo shoots of the tabah bamboo type contain water (92.2%), protein (2.29%), starch (1.68%), fiber (3.07%), and HCN (7.97 ppm). The advantage of fresh tabah bamboo shoots is that they have higher protein and fiber content compared to betung bamboo shoots (Dendrocalamus asper) with lower HCN content (Pandey *et al.*, 2012). Fresh bamboo shoots have varying fiber, protein, and ash content in different parts. The tip of the bamboo shoot contains smaller fibers compared to the base. The protein and ash content in the tip are higher than in the base (Swarnalatha *et al.,* 2016).

There are two approaches to analyzing protein content in food materials: qualitative and quantitative methods. The Xanthoprotein reaction, the Hopkins-Cole reaction, the Millon reaction, the Nitroprusside reaction, and the Sakaguchi reaction are some of the techniques used in qualitative analysis to find out if a substance contains protein or not. In contrast, quantitative protein analysis aims to measure the protein content accurately. The Kjeldahl method is a widely used technique for quantitative protein analysis, particularly for determining total nitrogen in amino acids, proteins, and nitrogen-containing compounds. In this method, the sample is decomposed with sulfuric acid, catalyzed with a suitable catalyst, yielding ammonium sulphate. After liberating ammonia with alkali, the resulting ammonia is distilled into an absorbent solution and quantitatively determined through titration. The Kjeldahl method has undergone several modifications, adapting it for semi-micro applications by requiring minimal sample and reagent quantities and featuring a short analysis time (Afkar *et al.*, 2020).

For protein testing, the procedure commences by weighing 1 g of the sample and depositing it into a 100 mL Kjeldahl flask. Subsequently, 2 g of a selenium mixture and 25 mL of concentrated H_2SO_4 are introduced. The mixture undergoes heating on either an electric heater or a Bunsen burner until it reaches a boiling point, resulting in a green-colored solution (maintained for 2 hours). After cooling, dilution follows, with the solution being transferred into a 100 mL measuring flask and adjusted to the mark. Then, 5 mL of the solution is extracted and transferred to a distillation apparatus, where 5 mL of 40% NaOH, along with a few drops of PP indicator, is added. Distillation occurs for approximately 10 minutes, utilizing 10 mL of a 2% boric acid solution mixed with PP indicator as the collector. After rinsing the distillation end with distilled water, titration using a 0.01 N HCl solution and incorporating blank determination follow.

The Kjeldahl method for protein analysis involves three sequential stages: destruction, distillation, and titration. Upon completion of these stages, the analysis outcomes reveal that the protein content in bamboo shoot flour is 2.26 g/100 g. The findings of Felisberto's (2017) research are consistent with this protein content. As indicated by the research data, fresh bamboo shoots, characterized by 90% moisture content, encompass essential nutrients (6-8 g/100 g) alongside protein (1.49-4.04 g/100 g). The protein present in consumed food plays diverse roles, including supporting tissue and cell growth and maintenance, forming crucial bonds within the body, regulating hormones such as thyroid, insulin, and epinephrine to sustain water balance, maintaining body neutrality, generating antibodies, and facilitating the transport of nutrients from the digestive tract to the blood and further into tissues and cells as an energy source (Dangin *et al.,* 2001).

The analysis of carbohydrate levels was conducted using the Luff Schoorall method. The Luff Schoorall method is a chemical technique employed to determine carbohydrate levels (Cejpek, 2007). It is an excellent method for determining carbohydrate content and is considered the best for assessing carbohydrate levels, with an error rate of 10% compared to the Nelson-Somogy method.

The carbohydrate analysis begins by measuring 5 grams of the sample and placing it in a 500 ml Erlenmeyer flask. Introduce 200 ml of 3% HCl solution and conduct a one-hour boil with an upright condenser. Following this, cool the solution and neutralize it with a 30% NaOH solution, incorporating a small quantity of 3% CH_3COOH solution to maintain a slightly acidic condition. Quantitatively transfer the solution to a 500 ml volumetric flask, dilute it with distilled water, and adjust the volume to the mark. After shaking and filtering through filter paper, pipette 10 ml of the filtrate into a 500 ml Erlenmeyer flask. Add 25 ml of Luff Schoorl Solution, a few boiling stones, and 15 ml of distilled water. Apply constant heat to the mixture, bringing it to a boil for 10 minutes, then promptly cool it in an ice container. After cooling, gradually introduce 15 ml of 20% KI solution and 25 ml of 25% H_2SO_4. Titrate promptly with 0.1 N $Na_2S_2O_3$ solution until the yellow color disappears, incorporating a small amount of 1% starch solution as an indicator. Continue titration until the blue color dissipates, followed by conducting a blank experiment using 25 ml of distilled water as a substitute for the sample.

As elucidated earlier, the carbohydrate content identified in bamboo shoot flour is 4.10 g/100 g. Carbohydrates play a crucial role in furnishing energy within the body. Each gram of consumed carbohydrates generates 4 kcal of energy, and this energy, derived from the oxidation (combustion) of carbohydrates, is subsequently utilized by the body for diverse functions, including respiration, cardiac and muscular contractions, and various physical activities such as exercise or labor (Irawan, 2007).

Next is the analysis of fiber content using the Gravimetric Method. The gravimetric method is a quantitative analysis based on the measurement of the weight of a specific element or compound, typically used to determine the total minerals (as ash) in a substance. The advantages of gravimetry include not requiring a standard substance and using only an analytical balance that needs to be calibrated. Gravimetric analysis is the simplest analytical method when compared to other analysis methods (Darma and Marpaung, 2020). This is because the substance content is determined by directly weighing the mass of the substance that has been separated from other substances (Marpaung & Romelan, 2019). The principle of determining the crude fiber content using the gravimetric method involves extraction, of protein, and carbohydrates, leaving only crude fiber, which is then weighed until a constant weight is achieved (Marlett & Navis, 1988).

The assessment of fiber content utilized the gravimetric method, commencing with the measurement of 2 grams of the sample. The process involved adding 200 ml of H_2SO_4 solution (0.255N) and subjecting it to boiling with reflux for 30 minutes. Afterward, the mixture underwent filtration using filter paper, and the residual residue was rinsed with boiling distilled water until the rinse liquid no longer exhibited acidity (as confirmed with universal pH paper). Transferring the residue on the filter paper to an Erlenmeyer flask allowed for a second wash using 200 ml of boiling NaOH solution (0.255N), then a 30-minute boil. The residue underwent filtration using pre-weighed filter paper, and was concurrently washed with a 10% K_2SO_4 solution. Subsequently, the residue underwent additional washing with boiling distilled water and 15 ml of 95% alcohol. The filter paper, along with the residue,

was then desiccated in an oven at 110°C until a consistent weight was attained (1-2 hours), cooled within a desiccator for 15 minutes, and subsequently weighed. In accordance with the aforementioned procedure, the fiber content detected in tabah bamboo shoot flour is 2.40 g/100 g. This outcome aligns with the discoveries of Singh *et al.,* (2021), indicating that bamboo shoots contain 2.6 g of protein, 5.2 g of carbohydrates, 2.2 g of fiber, and 0.3 g of fat.

Fiber constitutes a dietary element resistant to enzymatic hydrolysis within the human digestive system, rendering it impervious to enzymatic breakdown. Its inclusion in the diet imparts various health advantages, such as weight management, regulation of blood sugar levels, and the prevention of colorectal cancer and cardiovascular ailments (Santoso, 2011). The fiber found in betung bamboo shoots contributes to health benefits by containing bioactive compounds, particularly phenols, phytosterols, and dietary fiber. These constituents play a pivotal role in promoting health and shielding against chronic and degenerative diseases. It's worth mentioning that dietary fiber and phytosterols are good for lipid profiles and intestinal function. They lower levels of total serum cholesterol and low-density lipoprotein cholesterol (Nirmala *et al.*, 2014).

Processing bamboo shoots as functional food involves incorporating essential compounds with physiological functions. The crude fiber found in bamboo shoots plays a pivotal role as a compound with physiological properties beneficial for the body. The fiber content in bamboo shoots demonstrates significant potential for use as a source of dietary fiber. As per Chongtham *et al.* (2011), bamboo shoots, particularly young shoots, are not only delectable but also rich in nutritional components, including protein, carbohydrates, minerals, low fat, and sugar. Furthermore, bamboo shoots contains phytosterols and high fiber. Therefore, based on the proximate analysis conducted, bamboo shoots have promising potential as functional food for communities in the interior of Southeast Sulawesi, featuring a protein content of 2.6 g/100 g, carbohydrate content of 4.10 g/100 g, and fiber content of 2.40 g/100 g.

The antioxidant assessment was conducted using the DPPH method at a wavelength of 513 nm. The purpose of the antioxidant activity test was to ascertain whether bamboo shoot flour exhibits antioxidant properties. The DPPH radical scavenging method employed in this test is known for its rapidity, simplicity, ease of use, and suitability for small sample quantities within a short duration (Violita, *et al.*, 2021). IC_{50} values show how much of the extract is needed to stop the activity of a free radical by 50%. They are used to show the results of the DPPH method (Molyneux, 2004). A lower IC_{50} value signifies greater antioxidant activity, as it indicates that only a small concentration is necessary to reduce or neutralize free radicals by 50%.

Conclusion

Based on the study, it can be concluded that bamboo shoots have important secondary metabolites, namely flavonoids and alkaloids, which may have health benefits such as being anti-inflammatory, antiviral, and inhibitory of allergies. The analysis revealed that bamboo shoots contain 2.6 g/100 g of protein, 4.10 g/100 g of carbohydrates, and 2.40 g/100 g of fiber. Consequently, the nutritional composition of bamboo shoots positions them as a potential functional food for rural communities in Southeast Sulawesi, owing to their protein, carbohydrate, and fiber content. The residents of Amohola village incorporate bamboo shoots into their daily meals as a vegetable, employing various cooking methods such as boiling, steaming, stir-frying, and combining them with other vegetables.

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Conflict of interest:

No conflict of interests.

References

Ayu, N. G. A. K. S., Rianse, I. S., & Sadimantara, F. N. (2023). Analysis of Added Value of Bamboo into Woven Bamboo Products in Punggawukawu Village, Benua District, South Konawe Regency (Case Study of the Narti Sekar Craft Business Group). *International Journal of Technology and Education Research*, 1(01), 111-128.https://e-journal.citakonsultindo.or.id/index.php/IJETER/article/view/262

Cejpek, A. (2007). Determination of Saccharides (Schoorl Method). Laboratory course in Analysis of Food and Natural Products. *ICT Prague*. 1-4

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

Choudhury, D., Sahu, J. K., & Sharma, G. D. (2010). Biochemistry of bitterness in bamboo shoots. *Assam University Journal of Science and Technology*, 6(2),105-111.https://www.researchgate.net/publication/228363342

Dangin, M., Boirie, Y., Garcia-Rodenas, C., Gachon, P., Fauquant, J., Callier, P., Ballevre, O., & Beaufrere, B. (2001). The digestion rate of protein is an independent regulating factor of postprandial protein retention. *American Journal of Physiology. Endocrinology and Metabolism,* 280(2), E340–E348. https://doi.org/10.1152/ajpendo.2001.280.2.E340

Darma, W., & Marpaung, M. P. (2020). Gravimetric analysis of types and levels of saponins in yellow root extract (*Fibraurea chloroleuca* Miers). *Dalton: Journal of Chemical Education and Chemical Science*, 3(1). http://dx.doi.org/10.31602/dl.v3i1.3109

Falcone Ferreyra, M. L., Rius, S. P., & Casati, P. (2012). Flavonoids: biosynthesis, biological functions, and biotechnological applications. *Frontiers in plant science*, *3*, 222. 1-15. https://doi.org/10.3389/fpls.2012.00222

Gaikwad, H. R., Divate, M. M., Chaudhari, R. V., Patil, S. R., & Mali, S. S. (2019). Nutritional and Health Benefits of Bamboo Shoots: A Review. *Journal of Pharmacognosy and Phytochemistry*, *8*(3), 2863-2868.

Galanakis, Charis M. (2021) Functionality of food components and emerging technologies. *Foods* 10(1)128. https://doi.org/10.3390/foods10010128

Gusmiarni, A. N., & Des, M. (2021). Antifungal Effectiveness of Hyptis suaveolens (L.) Poit Leaf Extract against Fusarium oxysporum Colonies. In Proceedings of the National Seminar on Biology Antifungal Effectiveness of *Hyptis suaveolens* (L.) Poit Leaf Extract against *Fusarium oxysporum* Colonies. *In Proceedings of the National Seminar on Biology*, *1*(2), 1619-1624.

Helmalia, A. W., Putrid, P., & Dirpan, A. (2019). Potensi rempah-rempah tradisional sebagai sumber antioksidan alami untuk bahan baku pangan fungsional):(The potential of traditional spices as a source of natural antioxidants for functional food raw materials). *Canrea Journal*, 26-31. https://doi.org/10.20956/canrea.v2i1.113

Irawan MA. (2007). Body energy metabolism and exercise. *Sport Science Brief.* 01(07), 1-9.

Lu, B., Xia, D., Huang, W., Wu, X., Zhang, Y., & Yao, Y. (2010). Hypolipidemic effect of bamboo shoot oil (*P. pubescens*) in Sprague–Dawley rats. *Journal of Food Science*, *75*(6), H205-H211. https://doi.org/10.1111/j.1750-3841.2010.01716.x

Marlett, J. A., & Navis, D. (1988). Comparison of gravimetric and chemical analyses of total dietary fiber in human foods. *Journal of agricultural and food chemistry*, *36*(2), 311-315.https://doi.org/10.1021/jf00080a018

Marpaung, M. P., & Romelan, R. (2019). Analisis jenis dan kadar saponin ekstrak metanol daun kemangi (*ocimum basilicum* l.) Dengan menggunakan metode gravimetric, *Jurnal Farmasi Lampung*, *7*(2), 343448. https://doi.org/10.37090/jfl.v7i2.57

Molyneux, P. (2004). The use of the stable free radical diphenylpicrylhydrazyl (DPPH) for estimating antioxidant activity. *Songklanakarin J. sci. technol*, *26*(2), 211-219.

Ningrum, R., Purwanti, E., & Sukarsono, S. (2016). Alkaloid compound identification of Rhodomyrtus tomentosa stem as biology instructional material for senior high school X grade. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *2*(3), 231-236. https://doi.org/10.22219/jpbi.v2i3.3863

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 & Technology*, *49*(6), 1425-1431.https://doi.org/10.1111/ijfs.12470

Nisah, K., Afkar, M., & Sa'diah, H. (2019). Analisis kadar protein pada tepung jagung, tepung ubi kayu dan tepung labu kuning dengan metode Kjedhal. *Amina*, *1*(3), 108-113. https://doi.org/10.22373/amina.v1i3.46

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*, *2014*. http://dx.doi.org/10.1155/2014/679073

Pandey, A. K., & Ojha, V. (2013). Standardization of harvesting age of bamboo shoots with respect to nutritional and anti-nutritional components. *Journal of Forestry Research*, *24*, 83-90. https://doi.org/10.1007/s11676-012-0317-6

Puspitasari, R. (2014). The Effect of Work Motivation and Job Training on Employee Performance at the Primary Tax Service Office. Thesis Faculty of Economics, Yogyakarta State University. https://core.ac.uk/download/pdf/33512706.pdf

Rachmadi, A. T. (2011). Utilization of Bamboo Shoot Fermentation for Food Supplements and Fiber Flour. *Journal of Forest Products Industry Research*, 3(1), 37-41. http://dx.doi.org/10.24111/jrihh.v3i1.1187

Santoso, A. (2011). Dietary fiber and its benefits for health Dietary fiber and its benefits for health. *Magistra*, 23(75), 35-40.

Sari, K., Advinda, L., Anhar, A., & Chatri, M. (2022). Potential Of Red Shoot Leaf Extract (*Syzygium oleina*) as An Antifungi Against The Growth of *Sclerotium rolfsii in vitro. Jurnal Serambi Biologi*, *7*(2), 163-168. Retrieved from https://serambibiologi.ppj.unp.ac.id/index.php/srmb/article/view/116

Sariningrum E., Irdawati. (2009). Hubungan Tingkat Pendidikan, Sikap Dan Pengetahuan Orang Tua Tentang Kebersihan Gigi Dan Mulut Pada Anak Balita 3-5 Tahun Dengan Tingkat Kejadian Karies Di Paud Jatipurno. *Berita Ilmu Keperawatan*. 2(3):119124. https://publikasiilmiah.ums.ac.id/bitstream/handle/11617/2376/KARIES%20GIGI%20PADA%20ANAK.pdf?sequence=1&isAllowed=y

Singh, P., Rathore, M., & Prakash, H. G. (2021). The nutritional facts of bamboo shoots have a potential and prospects for utilization as a health food: a review. *Asian Journal of Dairy and Food Research*, *40*(4), 388-397. http://dx.doi.org/10.18805/ajdfr.DR-1586

Soraya, M. N. (2013). Hubungan Tingkat Pengetahuan tentang Anemia pada Ibu Hamil dengan Kepatuhan dalam Mengkonsumsi Tablet Besi (Fe) di Puskesmas Keling II Kabupaten Jepara Tahun 2013. http://repository.uinjkt.ac.id/dspace/handle/123456789/26380

Sujarwanta, A., & Zen, S. (2020). Identifikasi jenis dan potensi bambu (bambusasp.) Sebagai senyawa antimalaria, *Jurnal Pendidikan Biologi*, *11*(2), 131-151. http://dx.doi.org/10.24127/bioedukasi.v11i2.3423

Swarnalatha, S., Kumar, P., & Sudha, S. (2016). Proximate Composition and Anti-Nutritional Factors in Different Morphological Parts of Fresh Bamboo Shoots. *Journal of Food Science and Technology*, 53(4), 2020–2027. https://doi.org/10.1007/s13197-015-2128-3

Violita, L., Purba, R., Emilia, E., Damanik, M., & Juliarti, J. (2021). Organoleptic Test and Analysis of Nutritional Content of Cookies Substituted with Avocado Seed Flour. *Journal of Nutrition and Culinary,* 1(2), 1-10. https://doi.org/10.22373/kenanga.v2i1

Wink, M. (2008). Ecological roles of alkaloids. *Modern alkaloids*, 3-52. https://doi.org/10.1002/9783527621071