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ORIGINAL ARTICLE

Valorizing Bignay Fruit By-Products: Nutritional, Phytochemical, and Antioxidant Analysis for Potential Food Use

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Abstract

Background : The increased attention to natural additives in the food is mainly attributed to the awareness of synthetic dyes health hazards which can be as dangerous as toxicity and allergic reactions. A natural food colorant from Bignay-Common *(Antidesma bunius)* — a colorful and exotic fruit grown in the region but almost never used — was therefore used in this study as a substitute to address the existing problem. **Objectives:** This study aimed to extract a natural dye from Bignay-common fruit powder and evaluate its potential as a natural food additive by characterizing its nutritional profile, bioactive compounds, and antioxidant capacity. **Methods:** To determine its proximate composition, screen for major phytochemical constituents, and measure its antioxidant activity, laboratory analyses were conducted on Bignay-common fruit powder using standard analytical procedures. **Findings:** The analysis indicated that the Bignay-Common fruit powder is nutritionally rich, with 5.14% ash and 5.07% protein. It has low-fat content (1.41%) and moisture (7.07%). Notably, Bignay-Common fruit powder contained a high proportion of dietary fiber at 11.88%, and an energy of 358.21 kcal/100g, with carbohydrates at 81.31%. In addition to the nutritional content, the fruit powder is characterized by high concentrations of phytochemicals with health benefits, including anthocyanins, flavonoids, alkaloids, phenols, saponins, steroids, tannins, and terpenoids as indicated by the qualitative analysis of secondary metabolites. Although the present study did not quantify these compounds, their presence, along with the observed antioxidant capacity of 9.68% DPPH radical scavenging activity, suggests possible antioxidant properties that merit further quantitative investigation. **Novelty:** This study introduces Bignay-Common as a locally sourced natural additive with promising nutritional and antioxidant characteristics suitable for sustainable food coloring.

Keywords: Bignay-Common; Natural food additive; Nutritional composition; Phytochemical profile; Antioxidant potential

1 Introduction

Color additives have been employed in food products for centuries[1]. Their main function has been to enhance the attractiveness of foods. Alongside appearance, flavor, and aroma, color has become one of the first characteristics consumers observe when they are choosing between competing food products[2],[3],[4]. Color plays a very important role in food as it determines the taste and quality of the food a person can get, while also impacting on their purchasing decisions and satisfaction with the product[2],[5],[6]. In many cases, color can trigger emotional responses and enhance expectations of a given food in a way that creates an important component of the eating experience[7].

Foods often undergo discoloration or fading during the production, packaging, storage, and distribution processes due to a number of physical factors such as light exposure, temperature changes, and oxygen content[6]. One approach that food producers tend to think about as a possible solution to this problem is adding color additives. These colorants are added to food products to provide the desired appearance of natural color lost during processing, brighten dull tones, enhance visual appeal, and, in some cases, covers slight imperfections—thereby enhancing consumer perception[8].

Among local fruits, *Antidesma bunius* (commonly known as bignay) stands out as a promising source of natural pigments. Two principal varieties of bignay fruit are endemic in the Philippines: Bignay-Common and Bignay-Kalabaw[9]. The Cagayan Valley mainly cultivates the Bignay-Common variety. The fruit caught the attention of both locals in the region and throughout the entire country because of its bright color. It is widely recognized as a natural source of anthocyanins, which are polyphenolic pigments that cause red to blue coloration diffused throughout this fruit. These pigments are mostly found in the seed coat[10],[11]. Beyond its eye-catching color, bignay fruit is packed with antioxidants and bioactive compounds, making it quite significant in the realm of food production. Research by Zubia et al.[12] and Hardinasinta et al.[13] highlight its role as a natural ingredient in food processing and various food science applications.

However, despite its nutritional benefits, fresh bignay fruit is not widely consumed due to its sour flavor, tendency to stain purple, and the presence of a hard stone[13]. Consequently, research has focused largely on its antioxidant[12],[13] and nutritional profile[14], while its extractability, and potential for practical food applications remain underexplored. Recent extraction studies on alternative fruit sources, however, have shown that anthocyanin yields can reach about 2,000 mg per 100 g from *Aronia melanocarpa* pomace[15]. This finding demonstrates that several underutilized fruits and their by-products possess anthocyanin concentrations sufficiently high for pigment extraction, reinforcing the potential of *Bignay* and its by-products as a viable natural colorant source for food applications. This gap highlights the need to investigate how bignay's natural pigments can be effectively utilized as a natural colorant in food production.

To address these limitations and encourage the broader use of bignay, the present study processed the Bignay-Common fruit into powder and analyzed its proximate composition, bioactive compounds, and antioxidant potential, with particular focus on its suitability as a natural food colorant. Through this investigation, the study aims to contribute to the development of safe, locally sourced, and sustainable colorants that can serve as practical and health-conscious alternatives to the synthetic dyes commonly used in the food industry.

2 Methodology

2.1 Preparation of Bignay-Common Fruit Powder

Bignay pomace from small-scale bignay wine production in Sanchez Mira, Cagayan Valley, Philippines was collected after the winemaking process. To make it dry for further use, pomace was spread in a dehydrator bed in a thin and uniform layer at 55°C in a conditioned room for five hours. Regular monitoring was done to ensure uniform drying. This temperature was chosen to retain the nutritional properties of the pomace and prevent nutrient loss due to high heat. When the material became crumbly, the material was ground using a multipurpose swing disintegrator for three minutes. The powder collected was sifted to remove any remaining coarse particles, resulting to a smooth and fine powder.

2.2 Packing the Bignay-Common Fruit Powder

To ensure its quality and extend its shelf life, Bignay-Common fruit powder was packed in aluminum foil and sealed in plastic containers. This method protected the powder from light, moisture, and oxygen—factors that can degrade the delicate components of anthocyanins. These pigments not only add to the powder's rich color but also offer numerous health benefits. After packaging, the powder was transported carefully to the laboratory for further analysis.

2.3 Proximate Analysis

The sample was proximately analyzed at SGS Philippines, Inc.—a laboratory certified by the Philippine Accreditation Bureau (PAB) for the adequacy of its testing capacity— to ensure correct and consistent outcomes. The process adhered to standard scientific protocol. Ash and moisture content were quantified by using the gravimetric method. Total dietary fiber was analyzed based on an enzymatic-gravimetric process. Crude fat content was measured through acid hydrolysis-gravimetric procedure. Protein content was determined based on Kjeldahl analysis. Nutritional values for energy provided by carbohydrates, fats, and proteins and total caloric content and content in carbohydrates were estimated based on 2019 Philippine Food Composition Tables, a reputable source of nutritional data in the country.

2.4 Phytochemical Screening

The powdered sample was extracted and screened for the identification of different bioactive compounds. The phytochemical screening was carried out to detect secondary metabolites from the sample such as alkaloids, anthocyanins, flavonoids, phenols, saponins, steroids, tannins, and terpenoids. The analysis was performed at the Central Analytical Laboratory of Cagayan State University, Andrews Campus, Tuguegarao City, Philippines.

Using established qualitative tests, the presence of bioactive compounds was affirmed. Alkaloids were detected through Mayer's Test, anthocyanins using the Alkaline Reagent Test, and flavonoids through the Shinoda Test. Phenols were confirmed using the Ferric Chloride Test, while saponins were assessed using the Froth Test. Steroids were identified following the method outlined by Guevarra [16], tannins via the Lead Acetate Test, and terpenoids using the Salkowski Test.

2.5 Antioxidant Content

The antioxidant activity of the sample was also analyzed at the Central Analytical Laboratory of Cagayan State University, Andrews Campus, Tuguegarao City, Philippines. The evaluation was conducted using the DPPH assay on the ethanolic crude extract of dried bignay fruit. Radical scavenging activity was measured at a wavelength of 517 nm using a Varioskan LUX Microplate Reader. Data collection and analysis were performed using SkanIt Software RE (version 6.1.0.51). The assay was carried out under controlled conditions, using 0.05 grams of extract dissolved in 250 mL of ethanol at a consistent temperature of 26°C.

3 Results and Discussion

3.1 Proximate Analysis

The proximate composition of Bignay-Common fruit powder, as detailed in Table 1, reveals its strong nutritional potential. Among the most notable findings is its relatively high ash content of 5.14%, which points to a substantial mineral presence. The concentration of minerals in this powder exceeds that found in the rhizome of *Zingiber officinale* (1.51%) and the bulb of *Allium sativum* (1.54%), both of which are widely regarded for their nutritional and functional benefits in food formulations [17]. This points to bignay powder as a potentially even richer nutrient source.

When it comes to fat content, the powder stands out for health-conscious consumers, boasting a low 1.41%. That is significantly less than the 4.29% found in *Zingiber officinale* and even a bit lower than the 1.28% in Dragon Fruit peel powder [18]. This reduced fat content enhances its appeal as a low-fat ingredient, making it especially suitable for diets that require minimal fat intake.

The protein content of bignay powder is moderate at 5.07%. Although this is lower than the protein found in other natural pigments such as carrot (22.5%), marigold (12.3%), hibiscus (10.7%), and rose (8.2%)—frequently used in aquaculture feed to enhance fish color [19], bignay's distinctive profile is still that of a good candidate for use as a natural food coloring agent instead of a protein supplement.

Moisture content is also a critical parameter that influences product stability and shelf life. With 7.07% low moisture content, bignay powder indicates high potential for long-term storage. This is even lower than 7.59% recorded for Bignay pomace dried in a convection oven [12], indicating successful dehydration and conservation of the powder. One of the most notable attributes of this powder is its remarkable dietary fiber composition, which registers at 11.88%. The figure far exceeds the levels of fiber recorded in *Zingiber officinale* (2.64%) and *Allium sativum* (2.13%) [17]. Given such a strong fiber profile, bignay powder is an excellent choice for health-oriented food products, particularly those formulated to promote digestive health or offer functional nutritional advantages [20].

Examining its caloric content, the powder is very energy-rich, with 358.21 kcal per 100 grams. Most of this energy is derived from carbohydrates (325.24 kcal), while fat contributes 12.69 kcal and protein contributes 20.28 kcal. The high-calorie value can be very useful in individuals with greater energy requirements, such as athletes or individuals performing physically demanding activities.

Carbohydrates comprise 81.31% of the powder, making it mainly a carbohydrate-based food item. Nevertheless, if its fiber and possible antioxidant content are considered, bignay powder is a healthier choice than more processed, calorie-laden foods such as sugary foods. Although carbohydrates are good sources of energy[21], their high level must be assessed relative to individual dietary requirements and health objectives.

In general, Bignay-Common fruit powder shows a balanced nutritional profile. Its blend of minerals, fiber, moderate protein, and low-fat content makes it an attractive ingredient for the creation of healthy and functional food products.

Unlike previous works that primarily analyzed fresh fruit or crude extracts, this study focused on bignay fruit in its powder form**,** providing insights into its nutritional stability and potential use as a natural food colorant. This approach not only adds value to an underutilized local fruit but also introduces a practical way of preserving and enhancing its shelf life for food industry applications. Indeed, recent studies on spray-dried cranberry flavored oat milk powder have demonstrated that optimizing drying parameters can produce reconstitutable powders with well-defined nutritional profiles[22]. This aligns with the growing trend of developing powdered functional food ingredients, highlighting the commercial potential of transforming bignay into a value-added, clean-label product[23].

Table 1. Proximate composition of the Bignay-Common fruit powder

Analysis Names	Result	Methodology
Ash	5.14%	Gravimetric Method (QLY-LAB-1153 REV1)
Crude Fat	1.41%	Acid Hydrolysis and Gravimetric Method (QLY-LAB-1147 REV 2)
Crude Protein (N X 6.25)	5.07%	Kjeldahl Method (QLY-LAB-1201 REV1)
Moisture	7.07%	Gravimetric Method (QLY-LAB-1202 REV0)
Total Dietary Fiber (As received)	11.88%	Enzymatic-Gravimetric Method (QLY-LAB-1208 REV0)
Calories from Carbohydrates	325.24 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Calories from Fat	12.69 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Calories from Protein	20.28 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Total Calories	358.21 kcal/100 g	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)
Total Carbohydrates	81.31%	By Computation from Proximate Analysis (Philippine Food Composition Tables 2019)

3.2 Phytochemical Screening of Bignay-common Fruit Powder

Bignay-Common fruit powder ethanolic extract is replete with numerous bioactive molecules such as alkaloids, anthocyanins, flavonoids, phenols, saponins, steroids, tannins, and terpenoids. The rich bioactive composition of the extract clearly underpins its significant contribution to the therapeutic and curative properties of the fruit. This is in line with the research of Suriyaprom et al.[11], which established that various berry extracts have high levels of phytochemical compounds. Since bignay is a berry, this research, therefore, confirms its association with such desired attributes. Other research[13] has also demonstrated huge amounts of phenolic, anthocyanin, and flavonoid in bignay juice. Likewise, Tengco et al.[14] also found the same bioactive compounds in both Bignay-Common and Bignay-Kalabaw freeze-dried samples. The finding corroborates the present study and confirms the presence of health-beneficial substances in bignay, whether fresh or dried fruit, treated as such. In conclusion, evidence affirms the fact that bignay possesses therapeutic potential and is a promising source of health gain[24],[25],[26].

Turning bignay into powder helps preserve its rich phytochemical content — the natural compounds responsible for its health-giving and antioxidant properties — while making it easier to use in food and health products. This study provides new insight, showing that bignay fruit powder remains a sustainable and long-lasting source of beneficial bioactive compounds and natural color, making it a valuable ingredient for both the nutrition and wellness industries.

Table 2. Phytochemical screening of Bignay-Common fruit powder

Sample Code	Sample Description	Parameter	Result	Method Used
AL-334	Bignay Fruit Ethanolic Extract	Alkaloids	(+)	Mayer's Test
		Anthocyanin	(+)	Alkaline Reagent Test
		Flavonoids	(+)	Shinoda Test
		Phenols	(+)	Ferric Chloride Test
		Saponins	(+)	Froth Test
		Steroids	(+)	Guevarra, B. (2015)
		Tannins	(+)	Lead Acetate Test
		Terpenoids	(+)	Salkowski Test
Legend: (+) = presence of secondary metabolite content (-) = absence of secondary metabolite content				

3.3 Antioxidant Content of Bignay-Common Fruit Powder

Table 3 discloses the results of the DPPH assay which measures the antioxidant activities of ethanolic crude extract from dried Bignay-Common fruit. The investigation confirmed that the antioxidant activity in the ethanolic crude extract of dried Bignay-Common fruit stood at 9.68%. At a comparable level of 7.04% reported in the spray-dried formulation studied by Carbonera and colleagues [24], this present investigation on ethanolic crude extract achieved significantly more potency (difference 2.64%). This implies that the crude ethanolic extract of dried bignay fruit exhibits higher antioxidant activity than the spray dried extract. In addition, the present results are consistent with those of Castillo-Israel et al. [9], who reported a 9.60% antioxidant level in whole ripe bignay flesh and seeds. The similar antioxidant profile, regardless of extraction methods, suggests that the antioxidant potential of bignay is reliable and reproducible.

While earlier studies mainly examined fresh or spray-dried extracts, this research demonstrates that powdered bignay fruit provides comparable antioxidant effects, with added benefits in storage stability, ease of incorporation into food products, and sustainability as a locally sourced material.

Overall, the evidence indicates that bignay fruit could offer a useful natural antioxidant supplement that might encourage greater intakes of Bignay fruit and its by-products among people seeking an antioxidant boost through alternative sources.

Table 3. Antioxidant activities of Bignay-Common fruit powder

Sample Code	Description	Parameter	Result		Method Used
AL-012	Dried Bignay Fruit Ethanolic Crude Extract	% Radical Scavenging Activity @ 517nm using Varioskan LUX Skanlt Software RE for Microplate Readers RE, ver. 6.1.0.51 at 26^0C.	Concentration, % w/v	% Radical Scavenging Activity	
			0.05g/250mL EtOH	9.68	DPPH Assay

4 Conclusion

The proximate analysis of bignay fruit powder indicates positive nutritional qualities, including a notable level of ash (5.14%) and moderate protein content (5.07%). The powder is low in fat (1.41%) and has minimal moisture (7.07%). Additionally, it stands out with high dietary fiber (11.88%) and falls into the high-calorie category at 358.21 kcal per 100 g, mainly from carbohydrates, fat, and protein. However, it is important to highlight a relatively high percentage of total carbohydrates at 81.31%.

In addition to its macronutrient profile, bignay fruit powder is rich in bioactive compounds like alkaloids, anthocyanin, flavonoids, phenols, saponins, steroids, tannins, and terpenoids, highlighting its nutritional value and potential as a natural food color additive. These compounds improve bignay's overall nutritional quality, making it a valuable option for enhancing both the visual appeal and health benefits of food products.

Furthermore, it emerges as a promising and natural source of antioxidants, with a DPPH radical scavenging activity of 9.68% at 0.05 g/250 mL ethanolic concentration, underscoring its potential not only as a nutritional powerhouse but also as a source for natural food color additive.

5 Recommendations

This study provides a new perspective by characterizing the nutritional, bioactive, and antioxidant properties of bignay in its powder form, highlighting its suitability as a stable, locally sourced natural food colorant—an area scarcely explored in previous works. While the findings highlight the strength of its compositional and antioxidant profiling, the qualitative nature of the phytochemical analysis presents an opportunity for further investigation.

Future research should focus on quantifying individual phytochemical groups, evaluating color stability and sensory properties in food applications, and exploring scaling-up processes for sustainable production. Overall, bignay fruit powder shows strong potential as both a functional food ingredient and a natural colorant, supporting local resource utilization and contributing to the development of safer, eco-friendly food additives.

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