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# Utilization of Saponin-Rich Vacuum Concentrates from *Polyscias fruticosa* (L.) Harms Leaves for Herbal Beverage Formulation

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***Abstract:*** *Polyscias fruticosa (L.) Harms is a plant possessing high pharmacological properties. With the aim of enhancing the utilization value of this plant, this study introduces the initial development of a production process for a herbal beverage utilizing saponin-rich vacuum concentrates derived from P. fruticosa leaves. The research results established an optimal blending ratio of concentrate/water (v/v) at 1:11; sucrose content at 10 (g/100ml); citric acid content at 0.1 (g/100ml); and a pasteurization regime at 65°C for 3 minutes. The final product achieved a "Good" sensory classification, a Total Saponin Content (TSC) of 0.364 ± 0.05 (mg/ml), and complied with microbiological criteria according to QCVN 6-2:2010/BYT for non-alcoholic beverages.*

***Keywords: Polyscias fruticosa L. Harms, P. fruticosa beverage, saponin.***

## 1. Introduction

Contemporary consumers are increasingly gravitating towards organic foods and beverages of natural origin. Notably, herbal beverages serve not only as refreshments but also as functional drinks for disease prevention and treatment support. In practice, numerous herbal species exhibit pharmacological properties, typically *Polyscias fruticosa*, a cooling herb known for its ability to promote blood circulation, combat asthenia, improve appetite and sleep, stimulate lactation, act as a diuretic, and treat hemoptysis. The leaves, stems, and roots are all utilized as medicinal ingredients. *P. fruticosa* contains various beneficial compounds such as alkaloids, glycosides, saponins, flavonoids, tannins, vitamins B1, B2, C, and essential amino acids like lysine, cysteine, and methionine. Specifically, saponins represent a critical bioactive constituent with significant medical applications. This study introduces the preliminary development of a production process for a saponin-rich herbal beverage to enhance the value of *P. fruticosa* and diversify the herbal beverage market.

## 2. Materials and methods

### 2.1. Materials

Dried *Polyscias fruticosa* (L.) Harms leaves were purchased from a traditional medicine pharmacy in Ho Chi Minh City. The dried leaves were selected based on specific criteria: bright brown color, characteristic aroma, dryness, absence of mold, and minimal impurities (twigs, sand, foreign odors). In the laboratory, the leaves were crushed using a hammer mill, vacuum-packed, and stored at room temperature in a cool, dry place, avoiding direct sunlight.

### 2.2. Methods

- **Ash content determination:** AOAC 941.12.
- **Protein content determination:** AOAC 991.20.
- **Lipid content determination:** AOAC 948.22.
- **Carbohydrate determination:** TCVN 4594:1988.
- **Total Saponin Content (TSC) determination:** Samples were diluted 10-fold. 0.2ml of the diluted solution was mixed with 0.2ml of 8% vanillin-acetic acid solution and 1.2ml of perchloric acid. The mixture was shaken well and incubated at 70°C for 15 minutes, then cooled rapidly in an ice bath for 2 minutes. Subsequently, 3.4ml of ethyl acetate was added. Absorbance was measured at a wavelength of 550 nm. The calibration curve was described by the equation $C = 0.103A$, with a coefficient of determination $R^2 = 0.9985$.
- **Sensory evaluation:** Preference testing method.

- **Quality scoring:** Evaluation based on standard criteria.
- **Data processing:** Microsoft Excel 2010 and Statgraphics. Results are presented as mean ± standard deviation.

## 3. Results and discussions.

### 3.1. Analysis of Saponin-Rich Vacuum Concentrate

#### 3.1.1. Chemical composition of the concentrate

***Table 1.*** *Chemical composition of the saponin-rich concentrate from P. fruticosa leaves*

| Component | Content |
|---|---|
| Ash (mg/100mL) (*) | 0.49 |
| Total carbohydrate (mg/100mL) (*) | 0.94 |
| Lipid (mg/100mL) (*) | ND |
| Protein (mg/100mL) (*) | 0.32 |
| TSC (mg/mL) (**) | 0.705 ± 0.04 |

Note:

(*), Analysis results from Khai Nam Scientific Services Co., Ltd.

(**), Experimental determination of TSC.

ND, not detected under the applied analytical conditions.

**Comment:** The total triterpenoid saponin (TTS) content was determined to be $0.705 \pm 0.040$mg/mL, which is higher than the results reported by Le Thi Bich Hoa and Nguyen Thi Khanh Huu (2016) regarding the production process of *P. fruticosa* extract (184 ppm). This discrepancy may be attributed to differences in raw material origin, commercial sourcing versus specific cultivars, and variations between *P. fruticosa* species.

#### 3.1.2. Microbiological analysis of the concentrate

***Table 2.*** *Microbiological results of the concentrate*

| No. | Criteria | Unit | Result |
|---|---|---|---|
| 1 | Total Aerobic Bacteria (*) | CFU/mL | $1.2 \times 10^3$ |
| 2 | Coliforms (*) | CFU/mL | ND |
| 3 | *Escherichia Coli* (*) | CFU/mL | ND |
| 4 | Yeasts and Molds (*) | CFU/mL | ND |

Notes:

(*): Analysis results from Khai Nam Scientific Services Co., Ltd.

ND: Not detected under the applied analytical conditions.

CFU/mL: Colony-forming units per milliliter.

The results show the presence of aerobic bacteria ($1.2 \times 10^3$ CFU/ml) while Coliforms, *E. Coli*, yeasts, and molds were not detected. This necessitates a thermal treatment (pasteurization) step to ensure safety.

### 3.2. Consumer Demand Survey Results

#### 3.2.1. Survey of commercially available herbal beverages

A survey of 25 retail locations, including supermarkets, convenience stores, and grocery stores, in Ho Chi Minh City was conducted to assess the herbal beverage market landscape.

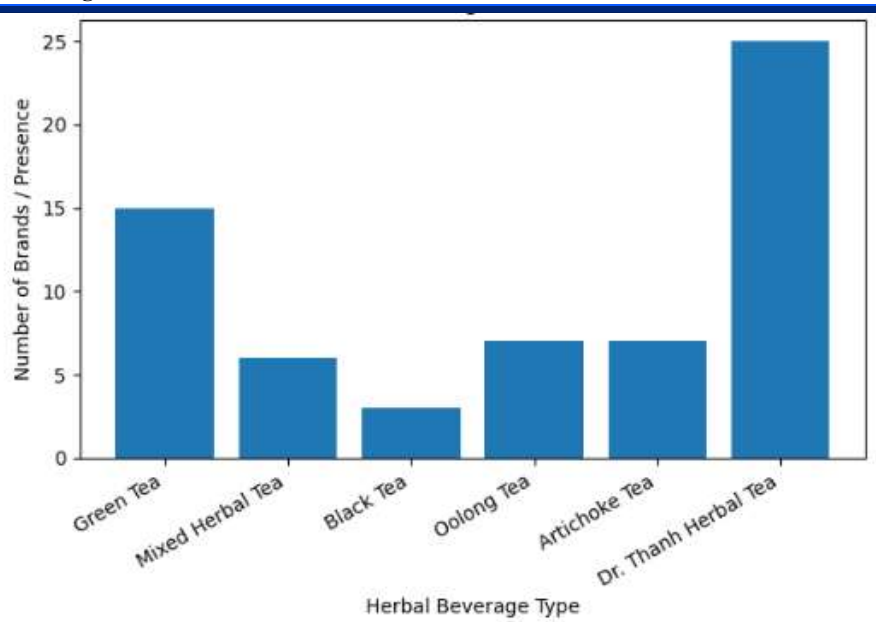


***Figure 1.*** *Distribution of herbal beverage brands across 25 surveyed retail locations in Ho Chi Minh City***.**

Across the 25 surveyed locations, six product categories were identified, with green tea being the most prevalent. Most products were formulated using natural extracts, water, sugar, and citric acid.

### 3.2.2. Survey of consumer habits regarding natural herbal beverages

Survey sample size: 200 participants in HCMC.

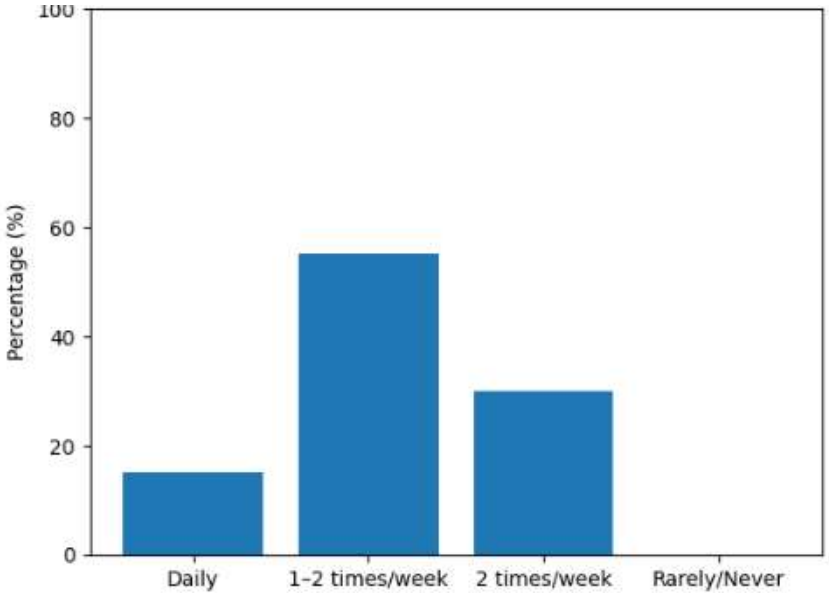


***Figure 2.*** *Frequency of consumption of herbal beverages among surveyed consumers in Ho Chi Minh City (%).*

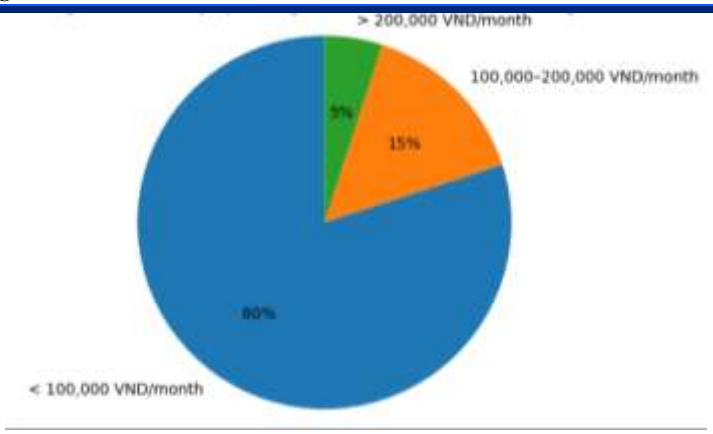


***Figure 3***. *Distribution of respondents by monthly spending allowance for herbal beverages (%)*

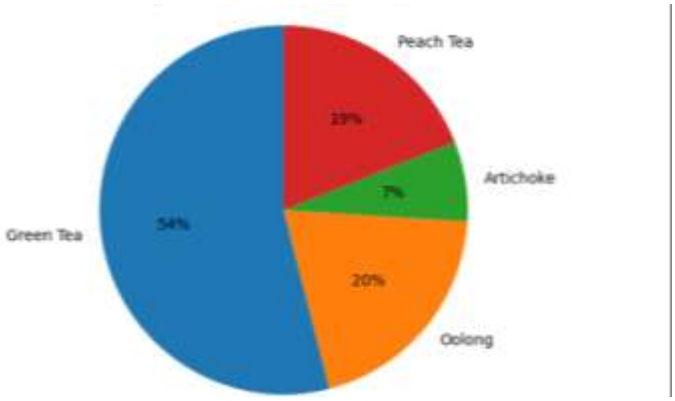


***Figure 4.*** *Preference of respondents by tea type (%).*

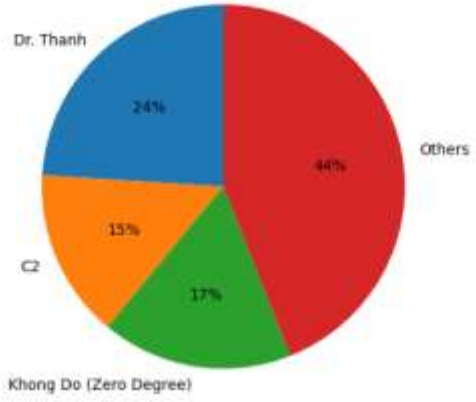


***Figure 5***. *Brand preference for herbal beverages among surveyed consumers (%).*

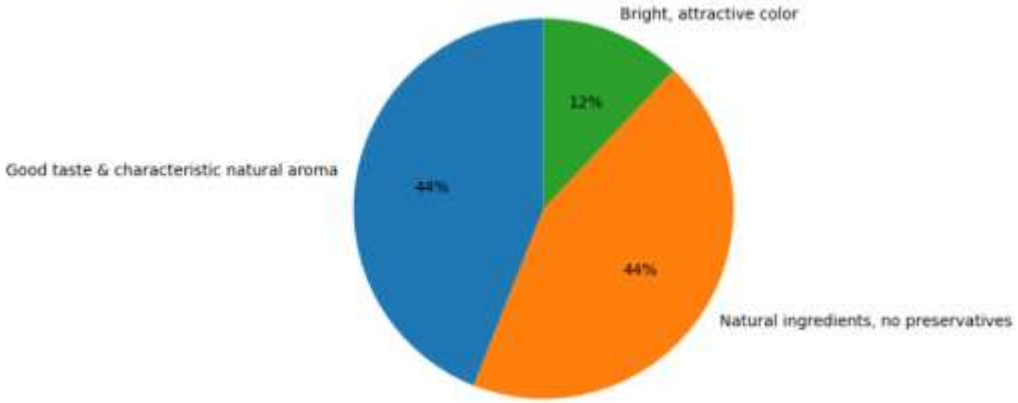


***Figure 6.*** *Required product attributes for herbal beverages among surveyed consumers (%).*

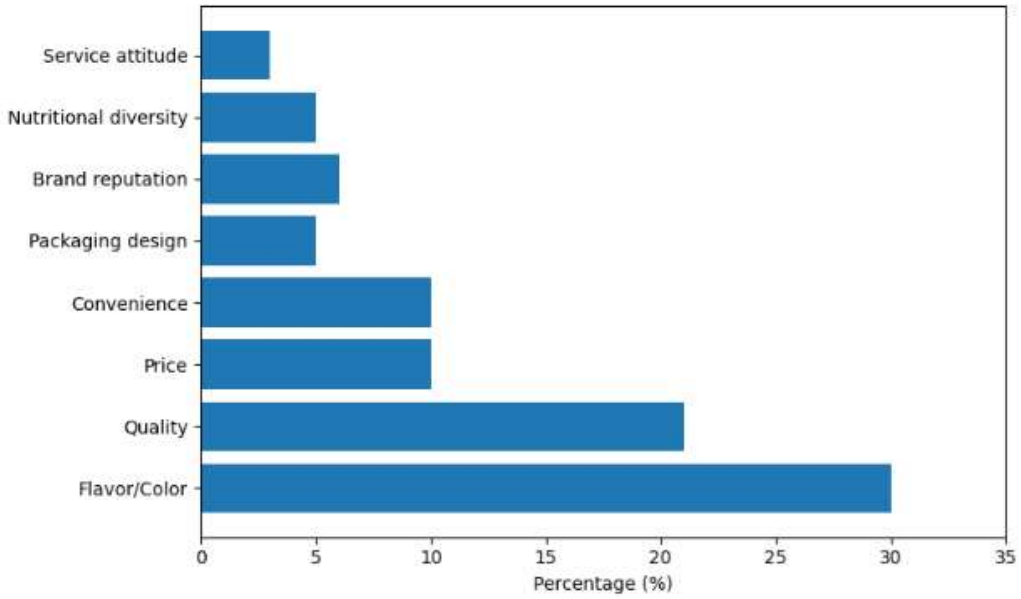


***Figure 7.*** *Factors influencing purchase decisions for herbal beverages (%).*

Summary: 55% of respondents use herbal drinks 1-2 times/week. 80% spend under 100,000 VND. Dr. Thanh is the preferred brand (24%). Key attributes desired are natural ingredients/flavor (44%) and absence of preservatives.

### 3.3. Development of Product Profile

***Table 3****. Product Profile for Saponin-Rich P. fruticosa Beverage*

| No. | Criteria | Description |
|---|---|---|
| 1 | Material | Dried *P. fruticosa* leaves, bright brown, fragrant, dry, no mold. |
| 2 | Formulation | Concentrate: 9-11%; Sugar: 9-11%; Acid citric: 0.08-0.12%; Water: Remaining. |
| 3 | Safety standards | Preserved in a cool place, avoid direct sunlight. |
| 4 | **Product** | |
| 4.1 | Purpose of use | Refreshment, convenient (no heat processing needed by user). |
| 4.2 | Benefits | Thirst quenching, health promotion, stress reduction, sleep aid, and detoxification. |
| 4.3 | Ingredients | Dried *P. fruticosa* leaves, sucrose, water, citric acid. |
| 4.4 | Sensory Requirements | Color: slightly turbidity, brownish-yellow. Smell: characteristic strong aroma. Taste: sweet and sour, slightly characteristic bitterness. |
| 4.5 | Microbiological limits | Total Aerobic Bacteria: < 100 CFU/mL. Coliforms: < 10 CFU/mL. *E. coli*: ND. Yeasts/Molds: < 10 CFU/mL. |
| 4.6 | Nutritional value | Provides carbohydrates and saponins. |

| | | |
|---|---|---|
| 4.7 | Usage instructions | Drink directly or with ice. Shake well before use. |
| 4.8 | Storage | Cool, dry place. |
| 4.9 | Packaging | Heat-resistant glass bottle, 250mL. |
| 5 | Target Consumer | All ages (above 6 years old). |

### 3.4. Effect of Pasteurization Time on Microbiological Quality and Total Saponin Content

***Table 4.*** *Effect of pasteurization time on Aerobic Bacteria and TSC*

| Time (min) | 3 | 5 | 7 | 9 |
|---|---|---|---|---|
| Aerobic Bacteria | ND | ND | ND | ND |
| TSC (mg/mL) | 0.397 ± 0.04 | 0.279 ± 0.09 | 0.226 ± 0.02 | 0.137± 0.05 |

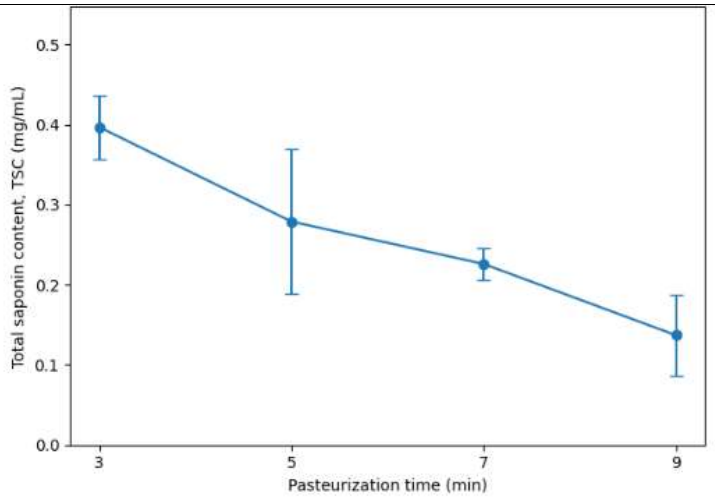


***Figure 8.*** *Decline of total saponin content (TSC) with pasteurization time (mean ± SD).*

- **Selection:** Since aerobic bacteria were eliminated (ND) at all tested times, the shortest time (3 minutes) was selected to maximize saponin retention (0.397 ± 0.04 mg/mL).

### 3.5. Product Quality Evaluation

#### 3.5.1. Sensory Evaluation Results

***Table 5.*** *Sensory scores of the final product*

| Quality Criteria | Member A | B | C | D | E | F | G | Total | Avg Score | Weight coeff. | Weighted Score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Color & Clarity | 4 | 3 | 4 | 4 | 3 | 4 | 4 | 26 | 3.7 | 1.6 | 5.92 |
| Smell | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 30 | 4.3 | 1.2 | 5.16 |
| Taste | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 33 | 4.7 | 1.2 | 5.64 |
| **Total** | | | | | | | | | | | **16.72** |

- **Result:** With a total weighted score of 16.72 (according to TCVN 3215-79), the product is classified as "Good".
    - *Color:* Slightly turbid, bright brownish-yellow.
    - *Smell:* Strong characteristic aroma of *P. fruticosa*, long-lasting aftertaste.
    - *Taste:* Sour, sweet, fairly harmonious, with a characteristic sweet-bitter finish.

#### 3.5.2. Microbiological Evaluation Results

***Table 6.*** *Microbiological indicators of the final product*

| No. | Criteria | Unit | Result |
|---|---|---|---|
| 1 | Total Aerobic Bacteria | CFU/mL | ND |

| | | | |
|---|---|---|---|
| 2 | Coliforms | CFU/mL | ND |
| 3 | *E. Coli* | CFU/mL | ND |
| 4 | Yeasts and Molds | CFU/mL | ND |

*Result: Complies with safety standards.*

### 3.5.3. Chemical Evaluation Results

***Table 7.*** *Chemical indicators of the final product*

| No. | Criteria | Unit | Result |
|---|---|---|---|
| 1 | Total Carbohydrate (*) | mg/100Ml | 8.52 |
| 2 | Total Saponin (TSC) (**) | mg/mL | 0.364 ± 0.05 |

(*): Analysis results from Khai Nam Scientific Services Co., Ltd.

(**): Experimental determination of Total Triterpenoid Saponins.

## 4. Conclusion

This study successfully established a preliminary technological process for producing a saponin-rich herbal beverage from *Polyscias fruticosa* (L.) Harms leaves, thereby contributing to the valorization of this medicinal plant and expanding its application in functional beverage development. Through systematic optimization of formulation and processing parameters, the optimal conditions were determined as a concentrate-to-water dilution ratio of 1:11 (v/v), sucrose content of 10 g/100 mL, citric acid content of 0.1 g/100 mL, and pasteurization at 65 °C for 3 minutes.

Under these conditions, the final product achieved a "Good" sensory classification according to TCVN 3215-79, exhibiting a harmonious sweet–sour taste, a characteristic herbal aroma, and acceptable color and clarity. Importantly, the beverage retained a relatively high total saponin content (0.364 ± 0.05 mg/mL), indicating that the selected mild pasteurization regime effectively ensured microbiological safety while minimizing the degradation of bioactive compounds. All microbiological indicators complied with QCVN 6-2:2010/BYT for non-alcoholic beverages, confirming the product's safety for consumer use.

Beyond technical feasibility, consumer survey results revealed a clear market potential for natural herbal beverages with clean-label attributes, moderate pricing, and health-promoting functions. The developed *P. fruticosa* beverage aligns well with these preferences, particularly in terms of natural ingredients, functional value, and convenient ready-to-drink format.

Overall, the findings demonstrate that saponin-rich vacuum concentrates from *P. fruticosa* leaves can be effectively utilized as a functional ingredient in herbal beverage formulation. This study provides a scientific foundationfoundation for further research focusing on shelf-life evaluation, bioactivity stability during storage, and in vivo assessment of functional effects. Additionally, scaling-up studies and economic feasibility analyses are recommended to support potential industrial application and commercialization of *P. fruticosa*-based functional beverages.

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