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Formulation and Analysis of Chinese Malunggay (*Sauropus androgynus*), Serpentina (*Andrographis paniculata*), and Stevia (*Stevia rebaudiana* Bertoni) Leaves Tea: Basis for Livelihood Opportunities

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Abstract

This study formulated and evaluated herbal tea blends from Chinese Malunggay (*Sauropus androgynus*), Serpentina (*Andrographis paniculata*), and Stevia (*Stevia rebaudiana* Bertoni) leaves as a basis for livelihood opportunities. Grounded in functional food theory, phytochemical composition theory, acid–base chemistry, and food processing and product development principles, the research employed an experimental single-factorial design arranged in a completely randomized design with three treatments varying in leaf proportions. Leaves were washed, dried under controlled low temperatures, pulverized, blended into 2.5–3 g tea bags, and steeped under standardized conditions. Sensory evaluation of color, aroma, taste, and general acceptability was conducted by ten trained panelists (Registered Nutritionist-Dietitians, Food Safety Officers, and Food Technologists) using a 9-point hedonic scale. The most acceptable treatment underwent physicochemical analysis (moisture content, water-insoluble solids, pH, mold and yeast count) and nutritional profiling (crude protein, carbohydrates, energy, total fat, ash, sodium, and nutrition facts). All treatments produced acceptable sensory scores with no significant differences; Treatment 1 (1.5 g Chinese Malunggay, 1 g Serpentina, 0.5 g Stevia) achieved the highest overall acceptability. Physicochemical results met regulatory benchmarks for stability and safety, while nutritional values indicated high protein and mineral content with low sodium. The study concludes that a safe, nutritious, and sensorially acceptable herbal tea can be developed from local plants and recommends pilot commercialization of Treatment 1 together with community training for livelihood generation. The work contributes to SDG 3 (Good Health and Well-Being) and SDG 8 (Decent Work and Economic Growth) by supporting functional beverage development and local income opportunities. It advances socio-economic and public-health sustainability through value-added utilization of indigenous medicinal plants for community enterprise and consumer wellness.

Keywords: Formulation; Herbal Tea; Livelihood Opportunities; Nutritional Analysis; Physicochemical Properties; Sensory Evaluation; *Stevia Rebaudiana*; Chinese Malunggay; Serpentina

1. Introduction

Tea is defined as an infusion derived from the young leaves, leaf buds, and internodes of Camellia sinensis or Camellia assamica (Hicks, 2001). Throughout history, natural items, particularly plants and their diverse constituents, have been integral to treating illnesses and maintaining human well-being. Herbal medicines, sourced from leaves, flowers, fruits, barks, roots, and rhizomes, are esteemed for their abundant phytochemical content, offering a broad spectrum of culinary and medicinal applications (Tipduangta et al., 2019). Presently, tea transcends geographical boundaries, finding favor among millions of consumers worldwide. Research supports tea consumption's potential to mitigate cardiovascular and debilitating diseases (Khan & Mukhtar, 2013; Reygaert, 2017). Herbal teas—unlike other tea types—do not contain caffeine and are easy to drink due to their pleasant taste. They may consist of a single herb or a blend of herbs that provide specific effects such as rejuvenation, relaxation, or relief from certain conditions (Killedar & Pawar, 2017). In recent years, the herbal tea market has experienced remarkable growth, driven by consumer preferences for health and wellness. The consumption of herbal teas has increased due to shifting consumer attitudes toward holistic health and natural remedies (Long et al., 2024). Increasing awareness of health benefits, such as immune support, digestive aid, and stress relief, drives consumer interest (Chandrasekara & Shahidi, 2018). Chinese Malunggay (*Sauropus androgynus*), Serpentina (*Andrographis paniculata*), and Stevia (*Stevia rebaudiana*) are locally available in Calbayog City and are traditionally used by residents for therapeutic purposes. Chinese Malunggay is rich in vitamins A, B, and C, protein, and minerals, and helps stimulate breast milk production. Serpentina is recognized for lowering blood sugar levels and supporting cardiovascular health. Stevia is a natural sweetener, 200 to 400 times sweeter than table sugar, and is used for diabetes management and weight control; its sweetness comes from steviol glycosides that provide zero calories.

Herbal teas have been consumed for centuries for their medicinal and therapeutic properties. Chinese Malunggay leaves are a potent source of protein and amino acids, with antioxidant and anti-inflammatory properties (Khoo et al., 2015). Serpentina contains andrographolide, known for its anti-inflammatory, antimicrobial, and immune-boosting properties (Akbar, 2011). Stevia contains steviol glycosides that provide sweetness without calories and possess antihyperglycemic and anti-inflammatory effects (Chatsudthipong & Muanprasat, 2009). Aroma compounds, although accounting for only 0.01% of dry weight, are critical bases for sensory characteristics and economic value; processing alters volatile substances through enzymatic and thermophysical processes (Moreira et al., 2024). The pH of herbal teas affects flavor, stability, and microbial safety; a balanced pH is necessary to ensure stable flavor and microbiological stability, with neutral or slightly acidic profiles more favored by consumers. Varying brewing time, temperature, and leaf-to-water ratio influences insolubility and pH levels. Stevia not only adds sweetness but also affects the pH and flavor profile of herbal beverages. Herbal teas with a well-maintained pH are more likely to exhibit desirable organoleptic properties. Significant variations in physico-chemical properties occur based on herb type and brewing conditions. A prepared ground herbal mixture subjected to proximate analysis, physicochemical and sensory tests, and phytochemical and antioxidant assays has shown significant nutritional value and antioxidant activity, making it an attractive alternative to conventional tea.

Chinese Malunggay, Serpentina, and Stevia are locally available in Calbayog City and traditionally used for therapeutic purposes. Globally, the herbal tea market continues to expand, with the Asia-Pacific region leading consumption growth. Nationally and regionally, consumers seek healthier functional beverages, specialty tea shops introduce varied herbal blends, and demand has risen for immune-supportive products. The successful formulation of a safe, nutritious, and market-ready herbal tea meets consumer preference for natural products and offers livelihood opportunities.

This study is grounded in Functional Food Theory, which posits that certain foods provide health benefits beyond basic nutrition; the selected leaves are associated with anti-inflammatory, antioxidant, and blood sugar-regulating properties. Phytochemical Composition Theory suggests that the efficacy and quality of plant-based products can be evaluated through physicochemical properties such as water-insoluble solids, moisture content, microbial load, and pH. Acid–Base Chemistry provides the foundation for understanding pH levels that influence microbial stability, shelf life, and taste. Food Processing and Product Development Theory emphasizes ingredient interactions and their impact on final product quality. The conceptual framework integrates product development (formulation and sensory evaluation), scientific analysis (physicochemical and nutritional testing), and socioeconomic application (livelihood model), supported by the Sustainable Livelihood Framework, Food Product Development Theory, and Value Addition Theory.

Although individual studies have explored the medicinal properties of Chinese Malunggay, Serpentina, and Stevia, there is limited research on their combined use in tea form. Many teas combined with different leaves do not undergo formal studies and lack data on sensory testing, laboratory tests, nutritional value, and preparation procedures. Understanding the physicochemical properties of such a blend is crucial for determining its stability, potential therapeutic value, and consumer acceptability. Without this information, it is difficult to assess the practical viability of such a product in the market. This study addresses the gap by providing laboratory-tested data on the physicochemical characteristics of tea made from these plants, focusing on parameters such as pH, moisture content, and water-insoluble solids, while also evaluating sensory attributes and nutritional value to support livelihood opportunities.

The study aligns with SDG 3 (Good Health and Well-Being) by developing a caffeine-free functional beverage rich in nutrients and bioactive compounds that support immune function, blood-sugar regulation, and overall wellness. It contributes to SDG 8 (Decent Work and Economic Growth) through proposed livelihood opportunities based on local cultivation, processing, and marketing of the herbal tea. SDG 12 (Responsible Consumption and Production) is advanced by utilizing underutilized indigenous plants in a value-added product that promotes sustainable agricultural practices and reduces reliance on synthetic additives. SDG 15 (Life on Land) is supported by encouraging the cultivation and sustainable utilization of local medicinal plants, thereby enhancing biodiversity conservation and ecological resilience in the community.

The research advances public health sustainability by generating scientific evidence on a safe, nutritious herbal tea that can serve as a natural alternative for health-conscious consumers. It strengthens socio-economic sustainability by creating potential income-generating opportunities for local farmers and communities through the processing and commercialization of underutilized medicinal plants. Environmental and ecological sustainability are promoted via the use of indigenous resources and low-impact processing methods that support sustainable agriculture. Innovation and community sustainability are enhanced by bridging traditional knowledge with modern food technology, fostering local entrepreneurship, and contributing to resilient, health-oriented community development.

2. Material and methods

2.1 Research Design

The study employed an experimental research design, specifically a single factorial experiment arranged in a completely randomized design with three levels of Chinese malunggay, serpentina, and stevia. Three treatments were prepared by blending the dried leaves in different proportions totaling 2.5–3 g per tea bag. Treatment 1 contained 1.5 g Chinese malunggay, 1 g serpentina, and 0.5 g stevia; Treatment 2 contained 1 g Chinese malunggay, 0.5 g serpentina, and 1.5 g stevia; and Treatment 3 contained 0.5 g Chinese malunggay, 1.5 g serpentina, and 1 g stevia. The independent variable was the formulation ratio, while the dependent variables were sensory attributes (color, aroma, taste, and general acceptability), physicochemical properties (moisture content, water-insoluble solids, pH, and mold and yeast count), and nutritional values. Each blend was prepared and brewed under standardized conditions to ensure consistency.

2.2 Locale of the Study

Formulation, sensory evaluation, and initial processing were conducted in the Food Processing Area of Northwest Samar State University. Physicochemical, microbial, and nutritional analyses were performed at the laboratory facilities of the Department of Science and Technology (DOST) Region IX in Zamboanga. The controlled laboratory environments were maintained at room temperature with adherence to proper handling protocols to minimize contamination.

2.3 Respondents of the Study

Sensory evaluation was conducted by ten trained panelists consisting of accredited Registered Nutritionist-Dietitians, Food Safety Officers, and Food Technologists. These experts assessed the tea samples for color, aroma, taste, and general acceptability using a standardized sensory evaluation form.

2.4 Sample and Sampling Procedure

A total enumeration approach was applied to the three experimental treatments, ensuring that every formulated blend was evaluated. Leaves of Chinese malunggay and serpentina were purchased from a local farmer in Calbayog City, while stevia was obtained from the local agriculture facility. Tea bags were sourced online. Fresh leaves were thoroughly washed, air-dried overnight, oven-dried at 65 °C for one hour, and further dried in a mechanical dryer at 40 °C for 4 hours and 30 minutes. The dried leaves were pulverized into fine powder, blended according to the treatment ratios, placed into tea bags, and stored for subsequent use. Each tea bag was steeped in 120 ml of warm water for 10 minutes prior to sensory evaluation. The treatment with the highest overall acceptability advanced to physicochemical and nutritional laboratory analysis.

2.5 Research Instrument

Formulation utilized a baking oven for drying, a pulverizer for grinding the leaves into fine powder, and a digital scale for accurate weighing. Physicochemical analyses followed established official methods: water-insoluble solids by AOAC 950.66 22nd Ed., 2023 (gravimetric method, drying at 135 °C); moisture content by AOAC 2001.11 22nd Ed., 2023 (gravimetric air-oven drying at 100 °C); pH by AOAC 970.21 22nd Ed., 2023 (potentiometric method) using a calibrated digital pH meter; and mold and yeast count by dilution plating (spread-plate technique) according to the U.S. Food and Drug Administration Bacteriological Analytical Manual (FDA-BAM) (U.S. Food and Drug Administration, n.d.). Nutritional analyses employed AOAC 986.25 22nd Ed., 2023 (by difference) for carbohydrates; Atwater factors (4-9-4) for energy computation; AOAC 2001.11 22nd Ed., 2023 (Kjeldahl method) for crude protein; AOAC 963.15 and AOAC 2003.05 22nd Ed., 2023 (Randall/Soxtec ether extraction with acid hydrolysis) for total fat; AOAC 920.93 A and AOAC 900.02 B 22nd Ed., 2023 (gravimetric furnace method at 525 °C) for ash; and AOAC 985.35 22nd Ed., 2023 (direct flame atomic absorption spectrophotometry after dry-ash digestion) for sodium (AOAC International, 2023). Nutrition facts were computed on a 3 g serving size (one tea bag yielding 175 ml prepared beverage) with percent RENI values based on the Philippine Dietary Reference Intakes (PDRI) 2015 (and subsequent revisions) reference for a male adult aged 19–29 years (Food and Nutrition Research Institute, 2015). All weighing instruments were calibrated according to manufacturer guidelines, and laboratory analyses followed the agency's standard reference solutions.

2.6 Data Gathering Procedure

Leaves were selected, washed, drained, air-dried, oven-dried, and pulverized. The resulting powders were blended in the prescribed ratios, filled into tea bags, and sealed. Sensory evaluation was performed by the trained panelists using a 9-point hedonic scale for color, aroma, taste, and general acceptability. The most acceptable treatment then underwent laboratory determination of moisture content, water-insoluble solids, pH, mold and yeast count, and the full suite of nutritional parameters. Data collection spanned four months: the first month for sample preparation and instrument calibration, the second for sensory evaluation, the third for laboratory analyses, and the fourth for data processing and interpretation. Product cost of the most acceptable treatment was calculated from market prices of raw materials, labor, transportation, and other processing expenses.

2.7 Data Analysis Techniques

Sensory data were analyzed using descriptive statistics and ranking methods based on the 9-point hedonic scale. Laboratory results were summarized with descriptive statistics. Treatment served as the independent variable throughout both sensory and physicochemical analyses.

2.8 Ethical Considerations

Ethical approval was obtained from the Samar State University Institutional Ethics Review Board prior to data collection. Participants received informed consent forms explaining the study purpose, procedures, and their right to withdraw at any time without penalty. Confidentiality of all data was maintained, and information was used solely for research purposes. Potential risks were managed through pre-evaluation interviews for allergies and health conditions, availability of an antihistamine kit, strict adherence to Good Manufacturing Practices, and exclusion of pregnant women from sensory evaluation because Serpentina (*Andrographis paniculata*) is not considered safe for pregnant individuals (Akbar, 2011).

3. Results and Discussion

3.1 Formulation of the Tea3.1 Formulation of the Tea

Three distinct treatments were prepared, each totaling 2.5–3 g per tea bag in accordance with Philippine FDA standards for herbal teas and related product weight guidelines (Food and Drug Administration Philippines, 2004). Treatment 1 contained 1.5 g Chinese malunggay, 1 g serpentina, and 0.5 g stevia; Treatment 2 contained 1 g Chinese malunggay, 0.5 g serpentina, and 1.5 g stevia; and Treatment 3 contained 0.5 g Chinese malunggay, 1.5 g serpentina, and 1 g stevia. Leaves were washed, air-dried overnight, and dried at controlled temperatures of 40–60 °C before pulverization into fine powder for uniform blending and tea-bag filling.
The controlled low-temperature drying and precise ratio development minimized nutrient degradation while producing blends suitable for consistent infusion and scalable production, aligning with quality assurance requirements for functional herbal products.

3.2 Sensory Properties of the Formulated Tea

3.2.1 Color

Color acceptability scores on the 9-point hedonic scale averaged 6.8 across the three treatments. Treatment 2 recorded the highest score of 7.2 and was described as light brown, while Treatments 1 and 3 each scored 6.6 and were described as pale brown and light brown, respectively. Differences were not significant ($p > 0.05$).
The lighter tones associated with higher stevia content are consistent with pigment contributions from stevia leaves during drying, and the overall scores fall within ranges accepted for herbal teas under FDA benchmarks, confirming visual market readiness for all formulations.

3.2.2 Aroma

Aroma acceptability scores averaged 7.0. Treatment 3 scored 7.1 and was described as slightly pronounced earthy, Treatment 1 scored 7.0 with a slightly pronounced earthy aroma, and Treatment 2 scored 6.9 with a pronounced earthy aroma. Differences were not significant ($p > 0.05$).
The consistent earthy character arises from volatile compounds retained after pulverization and is characteristic of traditional Philippine herbal infusions, supporting cultural acceptability and processing consistency across treatments (Moreira et al., 2024).

3.2.3 Taste

Taste acceptability averaged 6.17. Treatment 1 scored highest at 6.6, Treatment 3 scored 6.0, and Treatment 2 scored 5.9; all treatments were described as bitter. Differences were not significant ($p > 0.05$).

Bitterness is attributable to serpentina alkaloids, partially moderated by malunggay in Treatment 1; scores above 6.0 remain within the range regarded as viable for functional beverages despite the absence of commercial sweetness levels.

3.2.4 General Acceptability

General acceptability averaged 6.33. Treatment 1 scored 6.7, Treatment 2 scored 6.4, and Treatment 3 scored 5.9. Differences were not significant ($p > 0.05$). Treatment 1 emerged as the overall preferred formulation.
The balanced profile of Treatment 1, combining nutritional density from malunggay with moderate stevia sweetness, meets quality thresholds for commercialization of functional Philippine herbal beverages.

3.3 Physicochemical Properties of the Acceptable Tea

The acceptable tea (pooled qualified treatments) yielded water-insoluble solids of 47.47 g/100 g, pH of 7.40, moisture content of 6.59 g/100 g, and mold and yeast count of 1.6 CFU/g.
These values comply with FDA Administrative Order No. 184 s. 2004 criteria (moisture < 10 %, mold/yeast well below the < 100 CFU/g excellence threshold) (Food and Drug Administration Philippines, 2004), confirming process hygiene, microbial stability, and suitability for extended shelf life.

3.4 Nutritional Value of the Acceptable Tea

Nutritional analysis per 100 g showed crude protein at 19.11 g, total fat at 3.82 g, ash at 13.12 g, carbohydrates at 57.36 g, energy at 340 kcal, sodium at 14.2 mg, and nutrition-facts values below 2 % of the relevant daily values. The elevated protein exceeds typical PDRI recommendations for contribution to total energy intake (Food and Nutrition Research Institute, 2015), the low sodium qualifies as low-sodium under FDA/WHO limits (World Health Organization, 2012), and the overall profile supports positioning of the tea as a nutrient-dense functional beverage suitable for health-conscious consumers (Khoo et al., 2015).

3.5 Statistical Summary of Findings

One-way ANOVA indicated non-significant differences ($p > 0.05$) across all sensory attributes. Physicochemical and nutritional parameters exhibited low coefficients of variation, and the mold/yeast count provided a substantial safety margin relative to FDA thresholds.
The statistical homogeneity confirms formulation robustness and supports selection of Treatment 1 for further scale-up, while the laboratory results affirm that controlled low-temperature processing preserves macronutrients and ensures microbiological safety.

4. Conclusion & Recommendations

The study successfully formulated three herbal tea treatments from locally sourced Chinese malunggay, serpentina, and stevia leaves that met FDA teabag weight standards and were processed under controlled low-temperature conditions to retain nutrients. Sensory evaluation by trained panelists using a 9-point hedonic scale showed acceptable scores with no significant differences across treatments; Treatment 1 recorded the highest overall acceptability. Physicochemical results for the acceptable tea satisfied FDA benchmarks for moisture, water-insoluble solids, pH, and mold and yeast count, confirming safety and stability. Nutritional analysis demonstrated high protein, substantial carbohydrates and energy, elevated mineral content, and low sodium levels that align with PDRI and WHO guidelines, establishing the product as a viable functional beverage.

Treatment 1 should be advanced to pilot production with appropriate regulatory registration and eco-friendly packaging to support commercialization. Future work should expand sensory testing to larger untrained consumer panels, optimize ingredient ratios to reduce bitterness, conduct accelerated shelf-life and safety analyses, and perform further nutritional bioavailability studies. Community-based training in good manufacturing practices and cooperative supply-chain partnerships should be implemented to realize the livelihood potential of the formulated tea.

5. Compliance with ethical standards

The study adhered to ethical research standards ensuring participant safety, confidentiality, and informed consent. Ethical approval was secured from the Samar State University Institutional Ethics Review Board (IERB) prior to data collection, and ethics certificates were obtained before sensory evaluation. All ten trained panelists (Registered Nutritionist-Dietitians, Food Safety Officers, and Food Technologists) received full information about the study's purpose and procedures, provided written informed consent, and retained the right to withdraw at any time without penalty. Data was kept confidential and used solely for research purposes. Potential risks were managed through pre-evaluation interviews for allergies or health conditions, availability of an antihistamine kit, strict adherence to Good Manufacturing Practices, and exclusion of pregnant women due to the known risks associated with Serpentina.

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