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Cytotoxic and Teratogenicity of the Formulated Tea Products of Schizostachyum lumampao Leaves

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ABSTRACT

This study evaluated the cytotoxicity, teratogenicity, and sensory acceptability of tea made from Schizostachyum lumampao (Buho) leaves, a bamboo species indigenous to the Philippines. Teratogenic effects were assessed at 12, 24, 36, and 48 h post-treatment, revealing statistically significant results ($p<0.05$) with f-values ranging from 4.00 to 68.83 for hot water extracts and 11.00 to 47.00 for ethanol extracts. The findings demonstrate concentration-dependent cytotoxic and teratogenic effects. Sensory evaluation indicated that 67% of respondents found the tea's taste, color, and overall palatability acceptable, while 58% responded positively to its aroma. When compared to a commercial tea product, no significant differences were observed in sensory attributes. Mean palatability scores were 3.88 (SD = 0.74) for Buho tea and 3.67 (SD = 0.70) for commercial tea. These results suggest that Buho tea is a well-accepted and potentially marketable alternative to commercial teas, highlighting its promise as a sustainable, native botanical resource.

Keywords: Schizostachyum lumampao (Buho), Tea formulation, Cytotoxicity, Teratogenicity, Brine shrimp assay, Zebrafish embryo assay.

INTRODUCTION

Schizostachyum lumampao, locally known as Buho, is a native bamboo species endemic to the Philippines. It is primarily distributed in regions such as Pangasinan, La Union, Ilocos Norte, Ilocos Sur, Isabela, Leyte, and the islands of Panay and Basilan. *S. lumampao* is characterized by its dense, tufted growth pattern, forming clumps with smooth, green culms that can reach heights of 10–15 meters. The culms typically have a diameter of 4–8 cm and a wall thickness of 4–10 mm. This bamboo species has been traditionally used for construction, particularly in the production of bamboo matting, known as sawali, which is a key material in rural housing[1].

Although *S. lumampao* (Buho) has long been valued for its structural applications,there is a growing global interest in exploring the phytochemical and pharmacological potential of botanical resources. Consequently, *S. lumampao* is now being investigated for its potential health

benefits, particularly in the form of herbal tea. However, a prerequisite for the safe and effective utilization of any plant-derived product for human consumption is a thorough evaluation of its potential toxicological effects. Specifically, assessing cytotoxicity, the capacity of a substance to induce cellular damage or death, and teratogenicity, the potential to cause developmental abnormalities, is crucial for establishing its safety profile[2].

This study aims to address the current knowledge gap regarding the safety of *S. lumampao* (Buho) by scientifically evaluating the cytotoxic and teratogenic potential of its leaf extracts. This investigation holds dual significance, acknowledging the cultural relevance of Buho in the Philippines and its potential transition into a consumable product. Understanding the inherent safety profile is a critical step towards informed public health policies and the sustainable commercialization of this native resource. Furthermore, this research provides a valuable context for integrating interdisciplinary concepts, such as toxicology, product safety assessment, and risk evaluation, into science education, thereby enhancing student engagement with real-world applications of scientific inquiry.

The shift in perspective from *S. lumampao* as solely a construction material to a potential functional beverage necessitates a rigorous scientific evaluation of its health implications. Cytotoxicity assays, which quantify the inhibitory effects of a substance on cell proliferation and viability, are fundamental tools in toxicological and pharmacological research[2]. Similarly, the *in vitro* micromass teratogen test serves as a valuable preclinical method for assessing the potential of a substance to disrupt normal embryonic development[3]. These methodologies provide essential safety data and offer practical learning opportunities for students to engage with laboratory techniques relevant to health and environmental sciences.

While anecdotal evidence and some preliminary studies on other bamboo species suggest potential health-promoting properties, including anti-cancer activity, the biomedical potential of *S. lumampao* remains largely unexplored[2]. This study contributes to this area by employing established in vitro assays to ascertain the potential cytotoxic and teratogenic effects of Buho leaf extracts on living cells. Recognizing the concentration-dependent nature of cytotoxicity, the findings from these assays will be critical in determining the safety parameters and potential therapeutic window for *S. lumampao*-based products, such as tea. The integration of these experimental approaches into science curricula will also enhance students' practical understanding of experimental design, dose-response relationships, and analytical techniques.

Beyond safety considerations, the consumer acceptability of *S. lumampao* tea is a crucial factor for its potential commercial success. Therefore, this study will also incorporate sensory evaluation to assess key attributes such as taste, aroma, and overall palatability. Sensory science plays an integral role in product development, bridging objective scientific analysis with subjective consumer preferences[4]. This holistic approach not only broadens the scientific scope of the investigation but also provides students with insights into the multidisciplinary nature of product innovation, encompassing aspects of food science, health research, and consumer studies.

By comprehensively addressing both the safety and sensory aspects of *S. lumampao* tea, this research aims to contribute significantly to the scientific understanding of this native resource, inform public health considerations, and promote sustainable product development. Furthermore, the integration of this study into science education offers a compelling case study that highlights the interdisciplinary nature of scientific inquiry and the potential of applying modern scientific methodologies to evaluate traditional botanical resources. This approach fosters a deeper appreciation for research-driven innovation and the crucial link between scientific investigation, cultural heritage, and community well-being.

MATERIALS AND METHODS

Collection, Preparation, and Drying of Leaf Samples

The researchers authenticated the Schizostachyum lumampao species by submitting photographic and descriptive details to the Bureau of Plant Industry, ensuring accurate species identification for study validity. Following authentication, Buho leaves were collected and photo-documented in Purok Bannuar, Maligaya,

Mallig, Isabela. A sufficient quantity of leaves was gathered, properly identified, and recorded.

The collected leaves were first cleaned to remove debris, then washed thoroughly with water to eliminate dirt and impurities. After washing, the leaves were cut into small pieces and dried using an oven at a constant temperature of 40°C. Drying was conducted at the Flora Fauna Diagnostic Laboratory to ensure standardized conditions. Once dried, the samples were milled using an electric grain grinder to obtain a fine powder, facilitating the extraction of functional components for tea formulation.

Extraction of *Schizostachyum lumampao* Leaf Samples

The extraction of active components from *Schizostachyum lumampao* leaves was performed using both hot water and ethanol extraction methods, following standardized procedures.

Hot Water Extraction

Following the procedure of Eguchi *et al.,* 5 g of milled *S. lumampao* leaves were extracted in 150 mL of distilled hot water at 80-90°C using a water bath for 2 hours. The solid residues were separated by filtration using filter paper, and the resulting filtrate was further sterilized through filter sterilization. The final extract was refrigerated until further use.

Ethanol extraction

For ethanol extraction, 20 g of milled *S. lumampao* leaves were soaked in 300 mL of 95% ethanol for 48 hours. The extract was then subjected to continuous rotation using a rotary evaporator to separate the active components. The final ethanol extract was collected for subsequent analysis.

Spawning of Brine Shrimp and Zebrafish
Brine Shrimp Spawning

The hatching of brine shrimp (Artemia salina) was conducted following a standardized procedure for Brine Shrimp Assay. A solution was prepared by dissolving 29 g of brine shrimp eggs per liter of water. The prepared solution was incubated in aerated containers to maintain optimal oxygen levels, ensuring proper development. Light exposure was provided to stimulate the phototactic response of the larvae, which is essential for successful hatching. Under controlled temperature and lighting conditions, the eggs hatched within approximately 48 h, producing nauplii, the initial larval stage of brine shrimp. The hatched nauplii were then collected and utilized for subsequent experimental procedures.

Zebrafish spawning

A mature male-to-female ratio of 1:4 was maintained, with adult zebrafish sourced from the Science City of Freshwater Aquaculture Center, Muñoz, Nueva Ecija. The fish were transferred to a prepared aquarium filled with dechlorinated tap water and enclosed in a plastic mesh to prevent the adults from consuming the eggs. The spawning process commenced with a 12-h incubation period in a dark environment, followed by exposure to light to stimulate fertilization. Fertilized eggs were collected, cleaned in a Petri dish, and examined under a microscope to confirm their health and segmentation stage before proceeding with experimental procedures[5].

Brine Shrimp Assay

The cytotoxic effects of *Schizostachyum lumampao* tea extracts were assessed using the brine shrimp (Artemia salina) lethality assay following the modified protocol[6]. The assay evaluated the toxicity of ethanol and hot water extracts by determining their effects on brine shrimp nauplii survival.

Preparation of Serial Dilutions

Stock solutions of ethanol and hot water extracts were prepared at a concentration of 10,000 ppm. Serial dilutions were performed using embryo water in microcentrifuge tubes, creating concentrations of 10,000 ppm, 1,000 ppm, 100 ppm, 10 ppm, and 1 ppm. A control (0 ppm) containing only embryo water was also included.

Exposure of Brine Shrimp Nauplii

Brine shrimp eggs were hatched in aerated artificial seawater under continuous light exposure for 48 hours. Once hatched, ten nauplii were carefully transferred into each well of a 96-well ELISA plate. Each well contained 200 µL of the respective extract concentration, ensuring triplicates for each treatment. Excess water was removed to prevent dilution effects.

Incubation and Observation

The plates were incubated at room temperature for 24 h under controlled conditions.

Following incubation, nauplii were examined under a microscope, and the number of dead nauplii was recorded. Mortality was determined based on the absence of movement after gentle agitation. The percent mortality was calculated using the formula:

$$\%Mortality = \left(\frac{No.of\ Dead\ Brine\ Shrimp}{No.of\ Initial\ Alive}\right) x\ 100$$

Data Analysis

The assay was performed in triplicate to ensure reliability, and the mean mortality rates were analyzed statistically. Extracts were considered cytotoxic if mortality exceeded 50% at any concentration. Quality control measures, such as maintaining consistent environmental conditions and standardized assay procedures, were implemented to enhance reproducibility.

Treatment for Teratogenicity Test

The teratogenicity assay was conducted to evaluate the potential developmental toxicity of Schizostachyum lumampao tea extracts on zebrafish (Danio rerio) embryos. The study involved precise dilution techniques, controlled exposure conditions, and systematic observation of embryo viability and hatchability[5].

Preparation of Treatment Solutions

Embryo water was used as a diluent to prepare various concentrations of ethanol and hot water extracts. Seven microcentrifuge tubes, each containing 900 µL of embryo water, were set up for serial dilution:

Stock Solution Preparation–A 10,000 ppm concentration was created by adding 10 µL of extract to 990 µL of embryo water, forming what is commonly referred to as Hank's solution. This was labeled as T1.

Serial Dilution

- 100 µL from T1 was transferred to T2 (1,000 ppm).
- 100 µL from T2 was transferred to T3 (100 ppm).
- The process continued until T7, which contained only embryo water (0 ppm, control).

Exposure of Zebrafish Embryos

After the dilution series was completed, zebrafish embryos were introduced into the prepared solutions:

1. **ELISA Plate Preparation** – Each well of a 96-well ELISA plate was filled with 200 µL of the corresponding treatment solution.
2. **Embryo Transfer** – Four zebrafish embryos were carefully placed into each well, ensuring that excess water was removed without disturbing the embryos.
3. **Replication and Control** – Each treatment concentration was plated in triplicate to ensure experimental accuracy and reproducibility.

Incubation and Observation

Zebrafish embryos were incubated at a controlled temperature (28 ± 1°C) and observed at 12, 24, 36, and 48 hours post-treatment application (hpta) using a stereo microscope at 40× magnification. The following parameters were recorded:

- **Embryo mortality** – Determined by the absence of heartbeat and structural abnormalities such as tail detachment and failed somite formation.
- **Hatchability rate** – Calculated as the number of successfully hatched larvae relative to the initial number of embryos.

Data Analysis

The percentage of mortality and hatchability were computed using the following formulas:

$$\%Mortality = \left(\frac{No.of\ Dead\ Embryos}{Initial\ No.of\ Embryos}\right) x\ 100$$

$$\%Hatchability = \left(\frac{No.of\ Larvae}{Initial\ No.of\ Embryos}\right) x\ 100$$

Hatchability evaluation followed the methodology from published research tiltled Induced Developmental Toxicity Studies With Mercuric Chloride and Polychlorinated Biphenyls on Danio Rerio (Zebrafish) Embryo[7]. Embryos exhibiting no heartbeat, tail detachment, or lack of somite formation were classified as non-viable. The hatch rate was determined as the number of successfully hatched larvae divided by the total embryos, multiplied by 100[8].

Quality control measures, including maintaining consistent environmental conditions and standardized handling techniques, were implemented to ensure the reliability of the results.

Treatment of Data

The teratogenic effects of Schizostachyum lumampao tea extracts were assessed based on published morphological criteria[4]. Observations during the monitoring period were classified into three categories:

- **Lethal Effects** – Coagulation, undetached tail, absence of somites, and no heartbeat.
- **Teratogenic Effects** – Malformations in the head, tail, or heart, scoliosis, yolk deformities, and growth retardation.
- **Normal Development** – Embryos exhibiting typical morphological features with no visible abnormalities.

Data were analyzed to determine the incidence of developmental abnormalities and mortality, ensuring accurate interpretation of the tea product's potential teratogenic effects.

***S. lumampao* Leaves Tea Product Formulation**

Following extraction, the residual milled *Schizostachyum lumampao* leaves were collected and processed into a tea product. The tea was formulated by measuring 1.5 g of dried leaves per serving.

For preparation, the tea leaves were steeped in hot water for approximately 3 minutes. After steeping, the tea bag or plant material was removed, ensuring proper infusion before consumption.

Preparation of *S. Lumampao* Tea Beverage

The preparation of *S. lumampao* tea beverage was guided by factors such as tea-to-water ratio, infusion time, and water temperature. A 1.5 g portion of dried S. lumampao leaves was infused in 177 mL of hot water (70°C–100°C) for 3 minutes. After steeping, the tea bag or plant material was removed. The prepared tea could be consumed hot, warm, or iced, with optional additives such as milk or sweeteners.

Sensory Evaluation

A sensory evaluation was conducted with 24 tea drinkers from Cabanatuan City and Sta. Rosa, Nueva Ecija. Participants were randomly selected and briefed on the study's objectives and procedures. Two tea samples, labeled as Brand A and Brand B, were prepared by steeping 1.5 g of tea in 177 mL of boiled water for 3 minutes. Respondents assessed taste, color, aroma, and overall palatability using a structured questionnaire.

Comparative Analysis

The sensory attributes of *S. lumampao* tea were compared with a commercialized tea sample. Evaluations were conducted in a controlled environment free from external odors, noise, and inconsistent lighting. Each tea sample was prepared identically to ensure fairness. Judges rated taste, aroma, color, and overall palatability using a 5-point scale 9:

- 5 = Like extraordinarily
- 4 = Like
- 3 = Neither like nor dislike
- 2 = Dislike
- 1 = Dislike extremely

Both tea samples were presented simultaneously for direct comparison. The results provided insights into consumer preferences and the sensory qualities of *S. lumampao* tea relative to a commercial alternative.

RESULTS AND DISCUSSION

Tea Formulation of *S. lumampao* Leaves

The formulation of *S. lumampao* (Buho) tea began with the collection of bamboo leaves from Purok Bannuar, Maligaya, Mallig, Isabela. The tea preparation was conducted at the Flora Fauna Diagnostic Laboratory, Central Luzon State University, Muñoz City, Nueva Ecija.

The collected leaves were cut into small pieces and spread on a tray for oven drying at 40°C for 24 hours. Once dried, the leaves were pulverized using an electric grain grinder, producing the final *S. lumampao* tea product.

Bioactivities of Tea Product from S. lumampao
Cytotoxic Property of Buho Extract at 48 HPTA Hot Water Extraction

This assay evaluated the cytotoxic effects of *S. lumampao* (Buho) hot water extract 48 h post-treatment (HPTA). The extract was prepared using hot water as a solvent to isolate bioactive compounds, assessing its impact on cell viability and proliferation.

Table 1: Buho Hot Water Cytotoxicity at 48 HPTA

Treatment (ppm)	Mean	SD	F-Value	p-Value
10,000	23.33	5.77		
1,000	6.67	5.77		
100	0.00	0.00		
10	0.00	0.00		
1	0.00	0.00	24.17	0.000
0.1	0.00	0.00		
0 (Control)	0.00	0.00		
LC_{50} Value	38,974.8	21,448.7		

LC_{50} Toxicity Classification:<249 µg/mL = Highly toxic, 250-499 µg/mL = Moderately toxic, 500-1000 µg/mL = Mildly toxic

The results show a significant difference in cytotoxicity across concentrations (p<0.000). The LC_{50} value (38,974.8 µg/mL) classifies the extract as non-toxic. The findings align with research on *Chrysophyllum cainito*[10] where ethanolic extracts exhibited greater cytotoxicity than hot water extracts. Similarly, *Pseudelephantopus spicatus*[10] showed inactive cytotoxicity with decoction, supporting the concentration-dependent effect of plant extracts.

Ethanol Extraction

This assay examined the cytotoxicity of *S. lumampao* ethanol extract 48 h post-treatment, assessing its ability to induce cell death.

Table 2: Buho Ethanol Cytotoxicity at 48 HPTA

Treatment (ppm)	Mean	SD	F-Value	p-Value
10,000	63.33	15.28		
1,000	20.00	10.00		
100	0.00	0.00		
10	0.00	0.00	35.90	0.000
1	0.00	0.00		
0.1	0.00	0.00		
0 (Control)	0.00	0.00		
LC_{50} Value	8,305.94	4,271.93		

LC_{50} Toxicity Classification:<249 µg/mL = Highly toxic, 250-499 µg/mL = Moderately toxic, 500-1000 µg/mL = Mildly toxic

The ethanol extract also showed significant cytotoxicity variation across concentrations (p<0.000). However, the LC_{50} value (8,305.94 µg/mL) classifies it as non-toxic. Contrary to this study, *Antidesma ghaesembilla* ethanolic extracts[11] exhibited 100% mortality at all tested concentrations. Similarly, *Ficus carica* ethanol fractions[12] demonstrated strong cytotoxic effects, emphasizing the role of solvent choice in bioactive compound extraction.

Tetratogenic Property of Buho Extract at 48 HPTA
Teratogenic Property of Buho Hot Water Extract

The study investigates the teratogenic effects of Buho hot water extract on prenatal development. Teratogenicity refers to a substance's ability to cause abnormalities or malformations in embryos or fetuses when exposed during pregnancy.

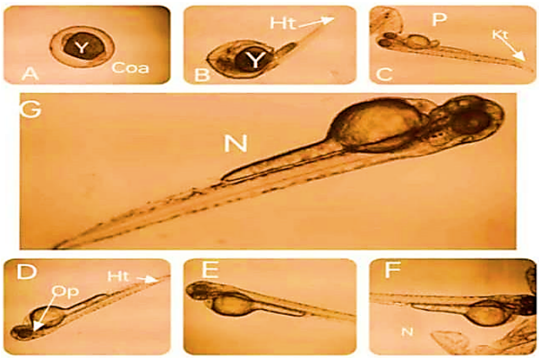

Fig. 1. Morphological development of embryos exposed to concentrations of *S. lumampao* leaves contain Hot water extract after 60 hours

Description:

- (A) Coagulated embryo at 10,000 ppm.
- (B) Unhatched embryo with delayed growth, dark yolk, hook-like tail, and minimal pigmentation at 1000 ppm.
- (C) Hatched zebrafish with minimal pigmentation and kink tail end at 100 ppm.
- (D) Hatched zebrafish with minimal pigmentation at 10 ppm.
- (E) Normal zebrafish at 1 ppm.
- (F) Normal zebrafish at 0.1 ppm.
- (G) Normal zebrafish (control group, 0 ppm).

Table 3: Teratogenic Property of Buho Hot Water Extract at 48 HPTA

Treatment (ppm)	Mean	SD	F-Value	p-Value
10000	100.0A	0.0		
1000	8.33B	14.43		
100	8.33B	14.43	68.83	0.000*
10	0.000B	0.000		
1	0.000B	0.000		
0.1	0.000B	0.000		
0	0.000B	0.000		

Note: A–Significantly Different, B–No Significant Difference, p-value<0.05

At 10,000 ppm, the teratogenic effect was significantly high (mean = 100.0). Teratogenic effects were also noted at 1000 ppm and 100 ppm, while no effects were observed at lower concentrations (10 ppm, 1 ppm, 0.1 ppm, and 0 ppm). These results align with previous studies, such as those on Lentinus sajor-caju and Phyla nodiflora, which

showed concentration-dependent teratogenic effects in zebrafish embryos, including delayed growth, coagulation, and malformations[13].

Hatchability at 48 HPTA

Table 4: Hatchability Rate of Buho Hot Water Extract at 48 HPTA

Treatment (ppm)	Mean (%)	SD	F-Value	p-Value
10000	0.000A	0.000		
1000	16.7B	28.9		
100	16.67B	14.43	16.14	0.000*
10	16.67BC	14.43		
1	41.67BC	14.43		
0.1	50.00BC	0.00		
0	100.0C	0.0		

Note: Means that do not share a letter are significantly different

Hatchability was significantly reduced at higher concentrations, with 10,000 ppm resulting in 0% hatchability. Lower concentrations (1 ppm and 0.1 ppm) showed increased hatchability, approaching the control group's 100% rate. Findings are consistent with studies on Christia vespertilionis, where higher concentrations led to lower hatchability and increased embryonic mortality[14].

Teratogenic Property of Buho Ethanol Extract

The study also examined the effects of Buho ethanol extract on embryonic development.

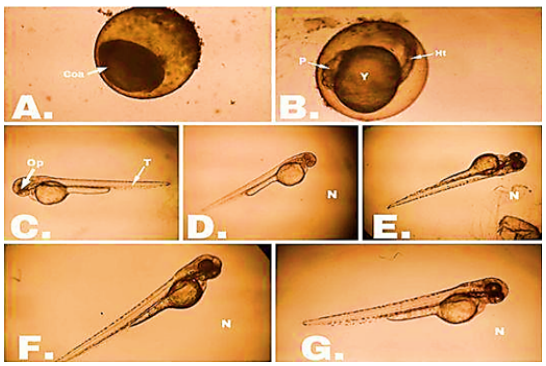

Fig. 2. Morphological development of embryos exposed to concentrations of *S. Lumampao* leaves contain Ethanol extract after 60 hours

Description

- (A) Coagulated embryo at 10,000 ppm.
- (B) Unhatched embryo with delayed growth, dark yolk, hook-like tail, and minimal pigmentation at 1000 ppm.
- (C) Hatched zebrafish with minimal pigmentation and kink tail end at 100 ppm.
- (D) Hatched zebrafish with minimal pigmentation at 10 ppm.
- (E) Normal zebrafish at 1 ppm.
- (F) Normal zebrafish at 0.1 ppm.
- (G) Normal zebrafish (control group, 0 ppm).

Table 5: Teratogenic Property of Buho Ethanol Extract at 48 HPTA

Treatment (ppm)	Mean	SD	F-Value	p-Value
10000	100.0A	0.0		
1000	25.0B	25.0		
100	0.000B	0.000	47.00	0.000*
10	0.000B	0.000		
1	0.000B	0.000		
0.1	0.000B	0.000		
0	0.000B	0.000		

Note: A–Significantly Different, B-No Significantly Difference, *p-value<0.05

At 10,000 ppm, teratogenicity was highest, while at 1000 ppm, moderate effects were noted. No significant teratogenic effects were observed at lower concentrations. The findings align with previous studies on the teratogenicity of Momordica charantia, where higher concentrations led to embryonic abnormalities, delayed hatching, and mortality[15].

Hatchability at 48 HPTA

Table 6: Hatchability Rate of Buho Ethanol Extract at 48 HPTA

Treatment (ppm)	Mean (%)	SD	F-Value	p-Value
10000	0.000A	0.000		
1000	0.000AB	0.000		
100	25.0B	25.0	17.47	0.000*
10	25.00BC	0.00		
1	41.67BC	14.43		
0.1	50.00C	0.00		
0	83.33C	14.43		

Note: Means that do not share a letter are significantly different

Higher concentrations significantly reduced hatchability. The findings contradict previous studies on Ficus glomerata, where higher extract concentrations led to decreased hatchability and increased mortality[16]. These results highlight the concentration-dependent effects of Buho extracts on zebrafish embryonic development.

Sensory Evaluation Differences Between Commercialized Bamboo Tea and Formulated Buho Tea

This study compares Commercialized

Bamboo Tea and Buho Tea based on taste, aroma, color, and overall palatability to assess consumer preferences.

Taste

Table 7: Significant Difference in Taste

Groups	Mean	StDev	T-Value	P-Value
Commercialized Bamboo Tea	3.5	0.83	-1.446	0.155
Buho Tea	3.83	0.76		

Note: p-value < 0.05 = no significant difference

Although Buho Tea (M = 3.83) received a slightly higher mean taste rating than Commercialized Bamboo Tea (M = 3.5), the difference was not statistically significant (p = 0.155). Nevertheless, the consistent preference for Buho Tea suggests promising sensory appeal. This observation aligns with recent studies highlighting a growing consumer interest in naturally flavored and locally sourced herbal beverages (Santos, Dela Cruz, & Ramos, 2023; Lee & Kim, 2022)[17].

Aroma

Table 8: Significant Difference in Aroma

Groups	Mean	StDev	T-Value	P-Value
Commercialized Bamboo Tea	3.21	1.06	-2.232	0.031
Buho Tea	3.83	0.87		

Note: p-value < 0.05 = significant difference

Buho Tea (3.83) had a significantly higher aroma rating than Commercialized Bamboo Tea (3.21) (p = 0.031). This finding highlights the strong aromatic appeal of Buho Tea, which may be attributed to its natural volatile compounds unique to *Schizostachyum lumampao*. Recent studies emphasize that aroma plays a critical role in consumer preference and overall sensory satisfaction in herbal beverages (Garcia, Mendoza, & Lim, 2023; Tan & Villanueva, 2022)18.

Color

Table 9: Significant Difference in Color

Groups	Mean	StDev	T-Value	P-Value
Commercialized Bamboo Tea	3.5	0.83	-0.326	0.651
Buho Tea	3.63	1.06		

Note: p-value < 0.05 = no significant difference

Although no statistically significant difference was found in color perception between Buho Tea (M = 3.63) and Commercialized Bamboo Tea (M = 3.50) (p = 0.651), the slightly higher rating for Buho Tea suggests a positive visual impression among participants. Recent studies have highlighted that even marginal differences in visual appeal can influence overall consumer perception and purchasing behavior, particularly in herbal and specialty teas (Reyes, Tan, & Domingo, 2023; Nakamura & Lee, 2022)[19].

Overall Palatability

Table 10: Significant Difference in Overall Palatability

Groups	Mean	StDev	T-Value	P-Value
Commercialized Bamboo Tea	3.67	0.70	-1	0.323
Buho Tea	3.88	0.74		

Note: p-value < 0.05 = no significant difference

Buho Tea (3.88) had a slightly higher palatability rating than Commercialized Bamboo Tea (3.67), but the difference was not significant (p = 0.323).

In conclusion, Buho Tea had slightly higher ratings across all categories, with aroma showing a statistically significant difference. However, taste, color, and overall palatability were not significantly different between the two teas.

CONCLUSION

The research concluded that *S. lumampao* (Buho) tea exhibits concentration-dependent cytotoxicity, with the highest concentration showing significant cytotoxic effects, supporting previous research on plant-based extracts and highlighting the importance of dosage in evaluating cytotoxic potential. It also demonstrated teratogenic effects in a similar concentration-dependent manner, as higher concentrations resulted in developmental abnormalities and lower hatchability rates in zebrafish embryos, underscoring the need for careful dosage consideration in assessing the safety of plant-derived substances. In the sensory evaluation, participants consistently preferred the taste, aroma, color, and overall palatability of Buho tea compared to commercially available bamboo tea, and although differences were not statistically significant, the consistent preference suggests strong consumer appeal and promising

market potential. Furthermore, a project plan was created to integrate the research process used in developing *Schizostachyum lumampao* (Buho) tea into Science Education curricula, aiming to enhance students' understanding of experimental research, data analysis, and sensory evaluation while demonstrating the real-world applications of scientific inquiry.

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Conflict of interest

The author declare that we have no conflict of interest.

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