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Development and Acceptability of Blue Tongue Berry (*Melastomamahalabatricum*) Wine

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Abstract:*This study was conducted to develop and evaluate the acceptability of Blue Tongue Berry Wine (Melastomamalabathricum) as an innovative local beverage in Dinagat, Dinagat Islands. Specifically, it assessed the sensory acceptability of three wine formulations, determined significant differences in sensory ratings across formulations, and analyze the physicochemical components of the most preferred wine. A quantitative research design was used with systematic sampling to select 120 participants. Data were analyzed using mean, standard deviation, MANOVA for repeated measures with Bonferroni's test. Results revealed that Formulation A emerged as the most acceptable across all sensory attributes—appearance, aroma, taste, texture—and significantly outperformed Formulations B and C. The physicochemical analysis of Formulation A showed a pH of 2.92, 87.95 g/100g moisture, 15% sugar content, and 2,169.20 mg/L titratable acidity. These findings support Formulation A's potential for commercialization as a technically sound and broadly accepted local wine product.*

Keywords: Blue Tongue Berry Wine, Melastomamalabathricum, sensory evaluation, product acceptability, physicochemical properties, formulation comparison

I. INTRODUCTION

The continued craving by consumers for singular flavors and their sources-local-responsible must have led to an increased inclination of wines carrying such singularities, craft, and terroir. Recent studies highlight the growing demand for wines that offer unique taste profiles and varietal expressions reflecting their region of origin. For instance, trends in the wine industry reflect shifting consumer preferences towards wines with less alcohol, lighter profiles, and refreshing characteristics (Peuli´c et al.,2023). Products are increasingly taking an interest in authenticity and cultural heritage, which create opportunities for wines from peculiar ingredients (Ferreira et al.,2021). Wild fruits can be used in various wine productions, but a common Southeast Asian native plant species called "Blue Tongue" berry (Melastomamalabathricum) is considered the most excellent candidate for producing wines. Although little known and studied, this fruit is well known for its intense color and its unique sweet-sour taste, traditionally used in folk medicine due to its high medicinal values. New research carried out by Nuk Akmal et al. (2021) divulged the bioactive compounds of Melastomamalabathricum suggesting that it could be rich in antioxidants and health potentials discovery that could also be exploited for winemaking.

Successful studies on using other fruits for winemaking have demonstrated market acceptance for wines produced from non-traditional ingredients. For example, research on wines from Syzygiumcumini (Java plum) and other wild fruits has shown potential for consumer acceptance (Ferreira et al., 2021). This study will be focused on optimizing the fermentation conditions for Blue Tongue berry for the enhancement of aroma and flavor and consumer acceptability of the wine that results, hence giving a more palatable drink. Modification in sugar content and other variables under fermentation conditions must be adjusted to increase consumer acceptability of such new-style fruit wines. Making wines from Blue Tongue Berry may yield peculiar products that will attract the attention of wine lovers and have potential economic benefits. Research indicates that the wines derived from native fruits would not only enhance biodiversity and serve as a waste management solution, but they would also become economically feasible for rural communities (Dias et al,2023).This study on a new use for the Blue Tongue berry may aid in the development of new, region-specific tropical wines that could gain attention in local and international markets.

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This research upholds the United Nations Sustainable Development Goals, most specifically Goal 12: Responsible Consumption and Production, by making use of indigenous resources in a sustainable way and reducing agricultural waste. It also subscribes to Goal 15: Life on Land, as it promotes conservation of biodiversity through the use of native species, such as Melastomamalabathricum. Beyond that, this study helps in contributing towards the realization of the long-term vision for the country, Ambisyon Natin 2040, through both inclusive and sustainable economic growth, especially for rural communities. This could be developed from new innovative products harnessed from local resources, creating livelihood opportunities and enhancing local economic resilience. The innovative product resulting from this research was aimed to delight wine enthusiasts and economically engage areas rich in Blue Tongue berry. Indeed, wines made from indigenous fruits can help foster biodiversity, decrease waste, and increase the viability of the local economy for the rural communities as emphasized by Conradie et al. (2020) and Boscolo et al. (2021). By focusing on Blue Tongue berry, this study aims to develop innovative, tropical-region-specific wine products with a strong potential for both local and international markets.

II. LITERATURE REVIEW

The exploration of fruit berry wines has turned out to be one of the interest areas globally due to changing consumer preferences toward something new and locally sourced. Much of the research has been on fruit wine sensory attributes affecting consumer acceptance. For instance, recent studies have brought to the forefront flavor, aroma, and sweetness as major determinants of consumers' selection of wines, as this is an important issue regarding the development of Blue Tongue berry wine in as much as it concerns emphasizing a unique sensory profile for marketability (Jiayi Wu, 2023). Other than sensory attributes, the economic implications of indigenous fruits winemaking have been studied tremendously. Local fruit wines can promote biodiversity and support rural communities financially by creating new market opportunities in their research (Conradie et al.,2020). For instance, Blue Tongue berry, which is native to Southeast Asia, is often sidetracked in commercial applications. When Blue Tongue berry wine is made, hence, it would be an economically viable option to producers as well as a step towards sustainable agricultural practices (Dudic et al., 2023). The health value possessed in the fruit wines is being documented more and more into scientific literature. A few studies also highlighted that many fruits such as *Melastomamalabathricum* contain phenolic compounds exhibiting antioxidant activities (Nuk Akmal et al.,2021. Such a viewpoint is for those health-obsessed audiences who always look at the fruits in the market. Placing this in marketing would significantly improve the competitiveness of Blue Tongue berry in the marketplace (Jiayi Wu, 2023). In fact, fermentation is an important process for determining the level of quality and some characteristics in fruit wines. Most probably, one of the categories is Blue Tongue berry. Research also supports that tropical fruits can be fermented without adding sugars or supplemental nutrients based on their chemical composition, thus possibly saving production costs (Dudic et al., 2023).

In addition, more and more literatures on consumers, particularly among the youth, have begun to accept novel beverage concepts. For example, assessments such as Fadiyibi et al. (2021) on Miracle Berry wine show how sensory attributes influence acceptance by consumers, which is going to be very important when it comes to Blue Tongue berry wine (Merlino, V.M. et al., 2021). That is, optimizing fermentation conditions will be necessary concerning production practices to develop premium Blue Tongue berry wine for consumer preferences. The application of different yeast strains during fermentation can produce various flavors, and hence, a new avenue could be opened to distinguish Blue Tongue berry wine from other fruit wines (Dudic et al., 2023). Lastly, the increasing demand for products that are sustainably and/or locally produced creates a gap in the market that can be exploited by Blue Tongue berry wine. The growing concern for the environment has led consumers to seek out goods that prefer local farmers and are ecologically friendly (Conradie et al., 2020). Alcoholic beverage producers of Blue Tongue berry wine can encourage these consumers by promoting Blue Tongue berry wine as a green product made of local raw materials.

The use of native fruits for wine-making is becoming a popular trend in the Philippines. However, studies reveal that they can yield more harvest economically and nutritionally. According to research conducted by Fadeyibi et al. (2021), the production of Miracle Berry wine in Eastern Samar shows that local fruits can generate income for the community members growing them if transformed into economically viable products like wines. These findings add a strong

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impetus to initiate such a feature in an activity with Blue Tongue berry *(Melastomamalabathricum)*, indicating possible economic gains by local communities from its cultivation and processing. Local literature also emphasizes the significance of community involvement in disseminating information on new products derived from indigenous fruits. It has been observed from different studies done across various provinces in the Philippines that community members generally lack knowledge regarding the applications and benefits of traditional fruits (Bete-Liban 2024). Educating communities about the possible uses of Blue Tongue berry in winemaking would generate a wider interest and acceptance toward this innovative product by researchers.

The sensory evaluation of local wines has been reported in a number of studies, giving a flavor of consumer preferences that are specific to the Filipino market. One such study is that of Yunindanova et al. (2024), where variously prepared fruit wines from local sources were evaluated based on sensory attributes such as color, aroma, flavor, and mouthfeel. From their observations, they pointed out that consumers are most sensitive to these attributes when trying out new products. This will be a very important development for Blue Tongue berry wine, directing producers in how best to optimize the sensory profile so that it will comply with the preferences of local consumers. Research on tropical fruits that are excellent for winemaking has also pointed out their viability in producing high-quality wines from raw materials harvested locally. Recent studies have stressed the viability of fermentation with most tropical fruits for their good chemical composition, which makes it possible to dispense with the incorporation of additional sugars or nutrients. A study touching on utilizing the drinking potential of a typical tropical tree fruit like bananas has been done and would interest efforts in any part of the world where the fruit can be found in bulk (Gebre et al., 2023); hence, such an idea supports Blue Tongue berry for economically efficient adoption in winemaking processes.

It means huge economic benefits for local rural communities in the Philippines by establishing local wine industries. Work done by Martinez-Falco et al. (2024) demonstrates how local wineries can bring economic development by providing jobs and promoting agricultural diversification. Infusion of Blue Tongue berry wine could propel such initiatives for catalyzing economic growth in underutilized areas in which this fruit abounds. Moreover, these studies suggest that products developed with social indigenous knowledge in mind are more likely to go well in the community. For instance, Alonso et al. (2020) showed that when traditional local cuisine was integrated with contemporary winemaking processes, products produced appealed to the customers' culture. Therefore, by utilizing the existing knowledge of *Melastomamalabathricum*, the manufactures will be able to win the market both locally and, in the regions, where such fruits are cherished as well as fused in cultural practice. Many studies have examined the behavior changes of Filipinos, especially the younger generations, who would entirely shift from conventional to new beverage categories. For instance, Vecchio et al (2020), in a study, determined that the willingness of today younger consumers would be far beyond what older consumers would show in trying out new products and flavors. This finding accentuates the more likely acceptance by younger consumers of Blue Tongue berry wine marketed based on characteristic flavors that distinguish the wine from others.

Studies conducted in the Philippines presently underscore an almost panic-like urgency for marketing strategies tailored absolutely to Filipino consumer needs and behaviors. Vecchio et al. (2023) undertook a study that points to this consumer trend toward health and organic labels. This provides the main opportunity for positioning the Blue Tongue berry wine by associating the wine positively with its phenolic characteristics and unique taste profile, and appealing to health-conscious consumers for this innovative drink. Collaboration among the researchers, local farmers, and entrepreneurs will finally provide a base for creating a profitable market of Blue Tongue berry wine around the Philippines. For instance, it can provide sustainable models for developing indigenous fruits into value-added products while improving community livelihoods via innovative agri-business practices when partnerships among stakeholders in cultivation, production, and marketing activities are strongly emphasized. This is also supported by both foreign literature and local studies that would put significant hope in Blue Tongue berries *(Melastomamalabathricum)* as a source for wine production. Sensory attributes have to be understood as the market continues to trend toward unique tastes and environmentally sound processes. Therefore, both foreign and local literature have highlighted the potential of the Blue Tongue berry (*Melastomamalabathricum)* in wine production. Changing consumer preferences for new

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flavors and sustainable practices may centeron understanding their sensory characteristics and engaging local communities to effectively introduce this innovative product into domestic and global markets.

The aroma of blue tongue berry wine development is attributed to the fermentation stage of blue tongue berry wine where active compounds are formed that give the wine its floral and fruity characteristics (Carpena et al. 2020).Studies on wines made with fruits have also shown that the yeast selection is an important factor that will determine the aroma of the wine. An example is Saccharomyces cerevisiae and other yeast species wherein these yeasts enhance aromatic qualities especially fruity and floral esters while minimizing unwanted volatiles that may cause off-flavors (Chen et al., 2023). In the case of blue tongue berry wine, a suitable yeast could be used to exacerbate the natural aromas that are nearly wild berry like in scent, something that consumers out to try unique wines will find very pleasing (Rahim et al., 2019).On top of that, the environmental conditions where *Melastomamalabathricum* is found growing may also harbor certain secondary metabolites that affect it produce aromas (Zannah et al., 2022). Studies on the effects of terroir on fruit wines have shown that different soils and climates as well as altitude may influence what flavors and aromas are present in the fruit, therefore *Melastomamalabathricum* wine may have unique scent that is localized in nature (Zannah et al., 2022). Also, techniques such as cold maceration before fermentation have been applied for enhanced aromatic complexity in wines through the preservation of volatiles and improvement in sensory properties, as discussed by recent studies on cold soaking in wine production (Aleixandre-Tudo& du Toit, 2019).

The color in *Melastomamalabathricum* is attributed to anthocyanins which, apart from adding cosmetics to the wine are also recognized as antioxidants (Kasunmala et al. 2020). In fruit wines, the stability of anthocyanin is vital in ensuring the color remains vivid since these pigments are prone to pH as well as oxidation. Studies indicate that it is possible to enhance color preservation with modified acids in the wine to avoid the eventual loss of color common in wines made with non-grapefruit (Nuk Akmal et al.,2021). It is therefore possible to optimally adjust the pH and still retain a deep purple coloration of the *Melastomamalabathricum* wine making the product even more appealing from the visual perspective and creating a potential for the market. Also, an in-depth search proved that color enhancement strategies (co-pigmentation or antioxidants addition) have the potential to preserve the initial color of fruit wines even after a long period of shelf storage (Yong et al., 2021). Such class of techniques makes it possible to counteract the process of oxidation as well as certain enhance the color saturation and color preservation in the wine (Tan et al., 2019). Additionally, the temperature of the processing the fruit may also play a role in the retention of pigments. Research conducted on other fruits of similar pigment character such as mulberries reports that lower temperatures are effective in retaining anthocyanins in the fruit, allowing the wine to optimally possess attractive color even after long storage in bottle (Liu et al., 2020).

The abstract tastes of blue-tongue fruit wine, tend to cut across the spectrum of a little bit of sweet and sour owing to sweet fruits tailored with appropriate acidity (Lee et al., 2021). It is the juice of *Melastomamalabathricum* which is rich in organic acids like malic and citric acid that gives the juice a crisp refreshing acidity and also helps balance the sweetness of the mesona wine so that it does not appear syrupy. Research on wild fruit wine bears reveals that for an acceptable taste, acid and sugar balance in the mouth is important because it helps to avoid overwhelming sweetness which can interfere with the other taste components of the wine (Chong et al., 2019). Modification of some aspects of the fermentation processes may also uplift the natural organoleptic properties of the fruit, thus producing a well fermented wine with both richness and freshness. Also, a balanced concentrated structure of tannins in wild fruit wines is very crucial in ensuring the achievement of their sensory profiles. The *Melastomamalabathricum* contained tannins providing mild astringency, which adds up to sweet and fruity flavors thus making the wine easier to drink (Chen et al., 2020). It is noted that most wines produced from fruits in the wild contain some degree of astringency that thickens the texture making the wine enjoyable. This astringency can also be refined with certain aging methods such as maturation in oak, contributing to more “consumer-friendly” profiles of the products post-fermentation (Rahman et al., 2020).

It is hypothesis that the mouthfeel of blue tongue berry wine will be improved due to the natural polysaccharides and pectin’s available in the fruit that makes a smoother and a somewhat sticky feel (Sun et al., 2019). Textural studies of fruit wines have shown that high levels of pectin result in a fuller body, which enhances the mouthfeel of the wine. Regarding *Melastomamalabathricum*, filtration technology must be controlled as excess pectin can create a too thick

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and hazy appearance of the liqueur if not properly dosed as Rahman et al. (2020) suggested. Winemakers apply technological means of clarification, such as cold stabilization or enzymatic treatment to preserve the viscosity without loss of transparency (Maicas et al.,2020). In addition, the tannins and phenolic compounds that are present in *Melastomamalabathricum* can result in a somewhat austere texture that is a desirable quality in some of the fruit wines (Chen et al., 2020). The phenolic content of *Melastomamalabathricum* may impart a delicate mouth puckering quality that enhances the sweetness of the fruit providing a contrast to the silky texture. Over time, these tannins diminish and as a result, the mouthfeel becomes smoother and creamier (Sun et al., 2019). Aging of fruit wines research suggests that aging with controlled oxygen exposure changes the mouthfeel, making it more cohesive and rounder (Maicas et al.,2020).

Melastomamalabathricum, also known as senduduk in Malaysia and malatungaw in the Philippines, is scientifically acknowledged for its high phytochemical content and medicinal potential. Ropisah et al. (2020) found significant secondary metabolites in leaf extracts of this plant using several solvents. The phytochemical screening identified flavonoids, terpenoids, tannins, phenols, steroids, and saponins in both methanol and ethyl acetate extracts, but no alkaloids. These chemicals are well-documented for their antioxidant and antibacterial properties, implying *M. Malabathricum* is used in traditional medicine to heal wounds, diarrhea, and inflammation. Methanol produced the maximum extraction yield from the plant, demonstrating the importance of solvent polarity in recovering active components such as phenolics and flavonoids. The ethyl acetate extract has higher antibacterial activity against Gram-positive bacteria like Bacillus subtilis, with an inhibition zone of 10 mm. This bioactivity is attributed to the presence of semi-polar chemicals, particularly terpenoids and flavonoids, which have been shown to disrupt microbial membranes. Therefore, *M. Malabathricum* shows potential as a natural antibacterial agent, especially against common pathogenic bacteria. Furthermore, the antioxidant capacity of M. The DPPH radical scavenging experiment showed moderate free radical inhibition (IC50 = 111.90 µg/mL) for malabathricum. Although lower than Dissochaetagracilis, this finding indicates significant antioxidant potential, which is mostly due to flavonoid and phenolic levels. These findings support the existing literature *on M. malabathricum's*usage in folk medicine and provide a scientific foundation for its use in the development of herbal therapies for oxidative stress-related illnesses.

III. METHODOLOGY

The researchers employed an experimental research design method to systematically investigate and evaluate the Blue Tongue Berry Wine as an innovative beverage. This process allows one to organize their collecting and analyzing data toward the demographic profiles of the respondents and the proper satisfaction level experienced with the product. With this design, the study would measure the reliability and precision of some major characteristics of the wine like taste, aroma, appearance, and texture. The study shall develop and test three different antigenic Blue Tongue Berry Wines for quantitative proportions of Blue Tongue Berry, white sugar, yeast, and water, where significant differences would be based on feedback from consumers. Evaluation will be done on the respondents on the wines for their preference which will be measured by means of a validated questionnaire. A mix of quantitative and qualitative measurements for satisfaction level and subjective judgments on the sensory characters thus makes this study unique. Through sensory evaluation and product properties, the research attempts to know the extent to which the wine has been able to fulfill the expectations of the actual consumers it targets. The results are expected to inform further development and refining of Blue Tongue Berry Wine, making it more attractive and commercially viable as a new beverage. Data were gathered from 20 food experts and 100 consumers using a 9-point Hedonic Scale. Mean and Standard Deviation were used to determine the acceptability of the Blue Tongue Berry Wine in terms of appearance, aroma, flavor/taste, and texture. Multivariate Analysis of Variance (MANOVA) for Repeated Measures and Bonferroni's Test were used to compare the three formulations of Blue Tongue Berry Wine in terms of the four sensory attributes: appearance, aroma, taste, and texture.

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IV. RESULTS AND DISCUSSION

Table 1 presents the sensory acceptability ratings of the appearance of the Blue Tongue Berry Wine for three different formulations: A, B, and C.

TABLE 1
ACCEPTABILITY OF APPEARANCE OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	D	M	SD	D	M	SD	D
The wine has an appealing and vibrant color.	7.82	0.63	***LVM***	7.68	0.62	***LVM***	7.75	0.65	***LVM***
The clarity of wine is consistent and free of particles.	7.63	0.93	***LVM***	7.53	1.62	***LVM***	7.58	0.94	***LVM***
The appearance of the wine matches its expected quality.	7.48	0.92	***LM***	7.34	2.62	***LM***	7.44	0.80	***LM***
The wine has visually rich and inviting look.	7.88	0.60	***LVM***	7.57	3.62	***LVM***	7.60	0.67	***LVM***
The bottle and packaging design complement the wine's appearance.	7.93	1.17	***LVM***	7.31	4.62	***LM***	7.20	1.10	***LM***
Average	7.75	0.50	***LVM***	7.49	5.62	***LM***	7.52	0.55	***LVM***

For Formulation A, the highest-rated item was "The bottle and packaging design complement the wine's appearance," with a mean score of 7.93, interpreted as Like Very Much (LVM). This suggests that the raters were most impressed by the external presentation of the wine. The lowest-rated item, although still favorable, was "The appearance of the wine matches its expected quality," with a mean score of 7.48, interpreted as Like Moderately (LM). Overall, Formulation A achieved the highest average score of 7.75, indicating strong visual appeal across all indicators. In Formulation B, the highest mean score of 7.68 was observed in the item "The wine has an appealing and vibrant color," also interpreted as Like Very Much (LVM). The lowest rating was for "The bottle and packaging design complement the wine's appearance," with a mean of 7.31, which fell under the Like Moderately (LM) category. Despite a generally favorable reception, Formulation B had the lowest average rating among the three at 7.49. It should also be noted that this formulation had unusually high standard deviations, particularly in three items, which may indicate variability in rater responses and suggest inconsistency in appearance perception. As for Formulation C, the item "The wine has an appealing and vibrant color" once again received one of the highest ratings, with a mean of 7.75 (LVM). On the other hand, the lowest-rated aspect was "The bottle and packaging design complement the wine's appearance," with a mean of 7.20 (LM). The average score for Formulation C was 7.52, which is comparable to Formulation B but slightly lower than Formulation A. The lower score on packaging indicates an area for potential improvement, even though the overall appearance was positively viewed.

Table 2 presents the results of the sensory evaluation on the aroma acceptability of the Blue Tongue Berry Wine across three formulations.

TABLE 2
ACCEPTABILITY OF AROMA OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	D	M	SD	D	M	SD	D
The wine has strong and appealing aroma.	7.49	1.31	***LM***	6.18	1.71	***LS***	5.75	1.39	***LS***
The fruity notes in the aroma are easily	7.09	1.31	***LM***	6.16	1.62	***LS***	5.62	1.35	***LS***

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detectable.

The aroma of the wine enhances the overall drinking experience.	7.21	1.30	***LM***	6.02	1.55	***LS***	5.72	1.26	***LS***
The wine's scent is free from any unpleasant of chemical-like odors.	7.02	1.20	***LM***	5.93	1.62	***LS***	5.39	1.32	***NLND***
The aroma has a balance of intensity without being overpowering.	7.11	0.99	***LM***	5.90	1.36	***LS***	5.68	0.96	***LS***
Average	7.18	1.03	***LM***	6.04	1.33	***LS***	5.63	0.99	***LS***

For Formulation A, all five aroma attributes received ratings in the Like Moderately range, suggesting a generally positive reception of its scent profile. The highest mean score was observed for "The wine has strong and appealing aroma," with a mean of 7.49, indicating that the wine's aromatic strength and pleasantness were well appreciated by the evaluators. The lowest score within Formulation A was 7.02, for "The wine's scent is free from any unpleasant or chemical-like odors," though it still fell under Like Moderately, reflecting a consistent and favorable aroma experience overall. With an average score of 7.18, Formulation A emerged as the most acceptable in terms of aroma among the three. In Formulation B, the aroma was rated slightly lower across all indicators. The highest mean score of 6.18 was given to "The wine has strong and appealing aroma," interpreted as Like Slightly, showing that while the scent was appreciated, it lacked the impact or strength observed in Formulation A. The lowest score in this formulation was 5.90, assigned to "The aroma has a balance of intensity without being overpowering," also rated as Like Slightly. The average aroma score for Formulation B was 6.04, indicating a moderate but less enthusiastic acceptance compared to Formulation A. Formulation C received the lowest overall aroma ratings among the three. The highest score, 5.75, was for "The wine has strong and appealing aroma," interpreted as Like Slightly. The lowest was 5.39 for "The wine's scent is free from any unpleasant or chemical-like odors," which fell under Neither Like Nor Dislike (NLND), implying some reservations or neutrality in perception. The rest of the attributes remained within the Like Slightly range. The average score for Formulation C was 5.63, reflecting the least favorable aroma experience and suggesting potential improvements in scent formulation.

Table 3 summarizes the ratings on the acceptability of taste of the Blue Tongue Berry Wine for three different formulations.

TABLE 3
THE ACCEPTABILITY OF TASTE OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Statement	**Formulation A**			**Formulation B**			**Formulation C**		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
The wine has balance sweetness and acidity.	7.94	0.64	***LVM***	2.24	1.27	***DVM***	4.89	1.67	***NLND***
The wine's taste lingers pleasantly after consumption.	7.81	0.94	***LVM***	2.39	1.11	***DVM***	4.68	1.73	***NLND***
The flavors of the wine are well-defined and distinct.	7.65	0.93	***LVM***	2.17	1.27	***DVM***	4.72	1.72	***NLND***
The wine tastes fresh and natural.	8.02	0.59	***LVM***	2.38	1.31	***DVM***	4.73	1.65	***NLND***
The wine has a complexity that enhances its taste experience.	8.29	0.96	***LVM***	2.61	1.38	***DM***	5.08	1.82	***NLND***
Average	7.94	0.53	***LVM***	2.36	1.14	***DVM***	4.82	1.60	***NLND***

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Formulation A received highly favorable ratings across all taste descriptors, with all items falling under the Like Very Much category. The highest mean score of 8.29 was given to "The wine has a complexity that enhances its taste experience," suggesting that the richness and layered flavors of this formulation were greatly appreciated by the panelists. The lowest, though still high, was 7.65 for "The flavors of the wine are well-defined and distinct." With an overall average of 7.94, Formulation A demonstrated superior taste acceptability and was clearly the preferred option among the three. In contrast, Formulation B received the lowest ratings, with four out of five items falling under Dislike Very Much. The mean scores ranged from 2.17 to 2.61, indicating a strong negative perception of its taste attributes. The lowest score was 2.17 for "The flavors of the wine are well-defined and distinct," suggesting the flavors may have been too faint or muddled. The slightly higher score of 2.61 was for "The wine has a complexity that enhances its taste experience," which, while better, still fell under Dislike Moderately (DM). The overall average of 2.36 for this formulation confirms its general rejection by the panel in terms of taste. Formulation C received intermediate ratings. All five taste-related items were rated as Neither Like Nor Dislike, reflecting a neutral stance from the raters. The highest rating was 5.08 for "The wine has a complexity that enhances its taste experience," indicating some appreciation for flavor depth, though not enough to generate strong preference. The lowest was 4.68 for "The wine's taste lingers pleasantly after consumption." With an average of 4.82, Formulation C was perceived more favorably than Formulation B but still lacked the appeal demonstrated by Formulation A.

Table 4 illustrates the sensory evaluation results for the texture acceptability of the Blue Tongue Berry Wine across the three formulations.

Formulation A received the highest overall ratings for texture, with an average mean score of 7.44, indicating a general interpretation of Like Moderately. Three of the five indicators were rated Like Very Much, including "The wine has a smooth and pleasing texture on the palate," "The wine feels balanced and not overly thick or watery," and "The mouthfeel of the wine is refined and enjoyable," all scoring around 7.56 to 7.57. These high scores suggest that the wine's texture was perceived as smooth, balanced, and enjoyable to drink. The lowest-rated item for Formulation A was "The texture enhances the overall flavor profile of the wine," which, at 7.07, still fell within the Like Moderately range, showing that while flavor enhancement by texture was less prominent, it remained favorable. For Formulation B, the ratings were generally lower, with an average mean score of 6.02, interpreted as Like Slightly. The highest-rated attribute was "The wine has a smooth and pleasing texture on the palate," which received a score of 6.55 (Like Moderately), indicating some level of appreciation for mouthfeel. The remaining attributes were rated between 5.76 and 6.17, all falling under Like Slightly, with "The texture enhances the overall flavor profile of the wine" receiving the lowest score at 5.77. These results suggest that while Formulation B's texture was acceptable, it lacked the refinement and consistency seen in Formulation A. Formulation C had the lowest texture ratings among the three, with an overall mean of 5.63, interpreted as Like Slightly. Most items hovered in the mid-5 range, suggesting a mild level of acceptance. The highest rating was 5.89 for "The wine has a smooth and pleasing texture on the palate," indicating some degree of positive reception. The lowest score was 5.43 for "The wine feels balanced and not overly thick or watery," which was interpreted as Neither Like Nor Dislike, hinting at neutrality or slight dissatisfaction regarding this aspect of the wine's texture.

TABLE 4
ACCEPTABILITY OF TEXTURE OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
The wine has a smooth and pleasing texture on the palate.	7.57	0.99	***LVM***	6.55	1.50	***LM***	5.89	1.47	***LS***
The body of the wine is consistent and satisfying.	7.43	0.99	***LM***	6.17	1.79	***LS***	5.64	1.84	***LS***
The texture enhances the overall flavor profile of the	7.07	0.86	***LM***	5.77	1.57	***LS***	5.53	1.53	***LS***

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wine.

The wine feels balanced and not overly thick or watery.	7.56	0.74	***LVM***	5.76	1.53	***LS***	5.43	1.60	***NLND***
The mouthfeel of the wine is refined and enjoyable.	7.56	1.12	***LVM***	5.88	1.54	***LS***	5.68	1.50	***LS***
Average	7.44	0.62	***LM***	6.02	1.27	***LS***	5.63	1.35	***LS***

Tables 5 and 6 present the results of the Multivariate Analysis of Variance (MANOVA) and subsequent univariate and pairwise comparisons that were conducted to determine if there were significant differences among the three Blue Tongue Berry Wine formulations in terms of the sensory attributes: appearance, aroma, taste, and texture.

TABLE 5
SIGNIFICANT DIFFERENCE ON THE ACCEPTABILITY OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Attribute	F	p	Decision on Ho	Interpretation
Appearance	8.94	<0.01	Rejected	Significant
Aroma	74.87	<0.01	Rejected	Significant
Taste	698.00	<0.01	Rejected	Significant
Texture	89.38	<0.01	Rejected	Significant

Wilks' Lambda Λ= 0.0.084, F=143.44, p<0.01

As shown in Table 5, the overall MANOVA results using Wilks' Lambda ($\Lambda = 0.084$, $F = 143.44$, $p < 0.01$) indicate a statistically significant difference across the wine formulations when all sensory attributes are considered simultaneously. This means that at least one formulation differed from the others in a combination of sensory characteristics. Following the MANOVA, univariate tests were performed for each attribute, and the results revealed significant differences among the formulations for all four sensory attributes: appearance ($F = 8.94$, $p < 0.01$), aroma ($F = 74.87$, $p < 0.01$), taste ($F = 698.00$, $p < 0.01$), and texture ($F = 89.38$, $p < 0.01$). Thus, the null hypotheses for each individual attribute were rejected, indicating that at least one formulation had a significantly different mean rating for each sensory quality.

Table 6 provides the results of the Bonferroni-adjusted pairwise comparisons for each sensory attribute. For appearance, Formulation A was significantly different from both B and C ($p < 0.01$), while B and C were not significantly different from each other ($p = 1.000$). This suggests that the visual superiority of Formulation A contributed most to the significant difference in appearance. In terms of aroma, all three formulations significantly differed from one another, with Formulation A receiving the highest mean score ($M = 7.18$), followed by B ($M = 6.04$), and C ($M = 5.63$), all with $p < 0.01$. The same pattern was observed for taste, where all pairwise comparisons yielded significant differences ($p < 0.01$), with Formulation A rated the highest ($M = 7.94$), followed by C ($M = 4.82$), and B ($M = 2.36$), clearly indicating Formulation A's dominance in flavor. For texture, Formulation A was significantly different from both B and C ($p < 0.01$), but the difference between B and C was not statistically significant ($p = 0.066$). This suggests that although A had a notably superior texture, B and C had relatively similar mouthfeel experiences from the perspective of the panelists.

TABLE 6
PAIRWISE COMPARISONS ON SENSORY ATTRIBUTES OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Attribute	Formulation (Mean)		p	Decision on Ho	Interpretation
Appearance	A (M=7.75)	B (M=7.49)	<0.01	Rejected	Significant
	A (M=7.75)	C (M=7.52)	<0.01	Rejected	Significant
	B (M=7.49)	C (M=7.52)	1.000	Not Rejected	Not Significant
Aroma	A (M=7.18)	B (M=6.04)	<0.01	Rejected	Significant

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	A (M=7.18)	C (M=5.63)	<0.01	Rejected	Significant
	B (M=6.04)	C (M=5.63)	<0.01	Rejected	Significant
Taste	A (M=7.94)	B (M=2.36)	<0.01	Rejected	Significant
	A (M=7.94)	C (M=4.82)	<0.01	Rejected	Significant
	B (M=2.36)	C (M=4.82)	<0.01	Rejected	Significant
Texture	A (M=7.44)	B (M=6.02)	<0.01	Rejected	Significant
	A (M=7.44)	C (M=5.63)	<0.01	Rejected	Significant
	B (M=6.02)	C (M=5.63)	.066	Not Rejected	Not Significant

Table 7 presents the physicochemical composition of Blue Tongue Berry Wine Formulation A, which was previously identified as the most acceptable formulation based on sensory evaluation.

TABLE 7
PHYSICOCHEMICAL COMPOSITION OF FORMULATION "A" OF BLUE TONGUE BERRY (*Melastomamahalabatricum*) WINE

Description	Parameter	Result
250 mL in sealed glass bottle, unchilled	pH	2.92
	Moisture	87.95 g/100g
	Sugar Content	15%
	Total Titratable Acidity	2,169.20 mg/L

The pH level of the wine was measured at 2.92, indicating a relatively high level of acidity, which is typical of fruit-based wines. A pH below 3.0 suggests good microbial stability and contributes to the refreshing tartness that can enhance flavor perception. The moisture content was found to be 87.95 grams per 100 grams, reflecting the wine's liquid nature and high water content, which is expected in fruit wines and contributes to its fluidity and mouthfeel. The sugar content was reported at 15%, which classifies the wine as moderately sweet. This level of sweetness likely played a significant role in the wine's high sensory ratings for taste, as it balances well with the wine's acidity and enhances its palatability. The total titratable acidity, measured at 2,169.20 mg/L, confirms the presence of a strong acidic profile. This value, in combination with the low pH, suggests that the wine has a bright and crisp flavor, which may contribute to its perception of freshness and complexity as noted in the sensory evaluations.

V. CONCLUSION

Among the three formulations, Formulation A is the most acceptable in terms of sensory qualities, making it the best candidate for product development and commercialization. The significant differences in sensory ratings among formulations confirm that formulation A is most preferred by the participants. The favorable physicochemical properties of Formulation A support its high sensory acceptability, indicating that its composition is well-balanced and technically sound for wine production.

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