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Sensory acceptability of gnocchi pasta added with different levels of malunggay (*Moringa oleifera*) leaves and blue ternate (*Clitoria ternatea*) flowers

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ABSTRACT

The primary objective of this study is to evaluate the acceptability of gnocchi pasta added with malunggay and blue ternate. Specifically, the study aims to assess whether there are significant differences in sensory attributes among the different treatments and to analyze the cost description of producing these improved gnocchi pasta. Experimental design survey methods were employed to assess the sensory acceptability of four treatments. The study involved 30 selected respondents from BISU Calape Campus. A modified score sheet was used to gather data, allowing respondents to evaluate the sensory attributes of each treatment. A two-way analysis of variance (ANOVA) was utilized to determine the acceptability of the four treatments on its sensory attributes and to determine if there was a significant difference in acceptability among the four treatments. Based on the results, all four treatments were acceptable in terms of color, aroma, taste, texture, and general acceptability. In conclusion, the proposed product was acceptable and has the potential to be introduced in the market. Moreover, further research is still needed to address other gaps revealed by the research.

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INTRODUCTION

Pasta is traditionally considered an Italian dish. It may have been consumed by the Chinese as early as 5000 BC or even earlier by ancient Etruscan civilizations, with its earliest written record dating back to 1279 (Webb, 2019). It comes in various types and unique shapes. Some of the most common types of pasta are angel hair, spaghetti, bow tie pasta, ditalini, fettuccine, rotini, gnocchi, lasagna, linguine, macaroni, penne, rigatoni, and shells (Tietsort, 2023).

Gnocchi is pasta that has different variation, and originates in northeastern Italy. Gnocchi comes from the old Lombard word knohha, which means "knot" and was used to refer to any round ball of dough. it can be produced with a variety of base components, such as flour, maize meal, semolina, bread, chestnut flour, ricotta, or vegetables like pumpkin, spinach, or regular potatoes (Zullo, 2021). Furthermore, gnocchi are shaped by forming the dough into balls and then pressed with a pork to produce texture. The purpose of the ridges is to hold the sauce on every piece of the pasta (McNamee, 2022).

In the Philippines, spaghetti is the most popular type of pasta, which was introduced by the Americans in the late 19th century (Limos, 2020). A recent study by Gonzales and Nunez (2020) explored the use of pili nuts, a native Philippine fruit, in pasta recipes. The Philippine market offers a variety of pasta shapes, including spaghetti, elbow macaroni, lasagna, fettuccine, linguine, and fusilli (SMMarkets, 2024). Additionally, vegetable-enriched pastas are available online, such as Veggie Pasta Fusilli featuring squash, red bell pepper, and jute mallow (saluyot), Saluyot Spaghetti, and Malunggay Spaghetti (Filipina, 2024).

Malunggay (*Moringa oleifera*), on the other hand is a highly valued plant that is mostly cultivated in the tropics and subtropics. In fact, malunggay tree can be seen anywhere in the Philippines (Veloso, 2018). It is used for food, medication, and industrial purposes (Busani, *et al.*, 2011). Malunggay have been used to enrich in various food product namely: ice cream, biscuit stick, otap, cookies, and cupcakes (Hapinat, 2020), creamy malunggay pesto, fresh lumpia in malunggay crepe, malunggay pizza, malunggay ice cream, sushi rolls, cookies, miki and polvoron (Adriano, 2023).

On the other hand, blue ternate (*Clitoria ternatea*) flower also as known butterfly pea flower is a plant native to Southeast Asia that's commonly used to make herbal tea. It's sometimes also called butterfly pea tea or blue *Clitoria ternatea*. In the Philippines, a tea made from blue ternate flower is available in the market (Hapinat, 2020). A study by (Astillo *et al.*, 2023) utilized blue ternate flower to enrich into guso icecream. *Clitoria ternatea* is a good source of anthocyanin (Turnos, 2021) which is often used to add a beautiful blue hue to different food products. The phytochemicals present in blue ternate flower are anthocyanins, saponin, tannin, alkaloids, glycosides, and volatile organic compounds can mainly affect color, texture, flavor, and aroma when added into other products (Sahu, *et al.*, 2023).

Clitoria ternatea is an herbal medicinal plant used for anxiolytic and memory enhancement. It contains tannins, resins, starch, and other active compounds. Traditional medicine uses it to treat various ailments, including jaundice, migraines, and skin diseases (Kumar *et al.*, 2010).

Clitoria ternatea is known as a medicinal plant and is known to treat various diseases. Almost all parts of this plant are reported to have medicinal properties (Turnos, 2021). The blue ternate flower is often used to add a beautiful blue hue to dishes and desserts. It is commonly found in drinks, rice dishes, and vibrant desserts like jelly (Tababa, 2023).

Statement of the problem

The main goal of this study was to determine the sensory acceptability of gnocchi pasta added with different levels of malunggay and blue ternate.

Specifically, this study sought to answer the following question:

1. What is the sensory description of the treatments of the gnocchi pasta added with different levels of malunggay and blue ternate in terms of:
   1.1. color;
   1.2. aroma;
   1.3. texture; and
   1.4. flavor?
2. Is there a significant difference in the sensory acceptability among all the treatments in terms of aroma, color, taste, texture, and general acceptability?
3. What is the cost description of malunggay and blue ternate pasta?
4. What can be proposed to promote the sensory acceptability of gnocchi pasta added with different levels of malunggay and blue ternate?

Statement of hypothesis

There is no significant difference in the sensory acceptability of pasta added with different levels of malunggay and blue ternate in terms of aroma, color, taste texture, and general acceptability.

MATERIALS AND METHODS

Design

The researchers used experimental survey method to determine the sensory acceptability of gnocchi pasta added with different levels of malunggay and blue ternate in terms of color, aroma, texture, taste, and general acceptability. The researchers also used modified score sheets to be given to the respondents. The data were collected, analyzed, and interpreted to get the main target of the study to determine the Sensory Acceptability of Gnocchi Pasta added with different levels of Malunggay (*Moringa oleifera*) and Blue Ternate (*Clitoria ternatea*).

Environments and participants

This study was conducted in the Bohol Island State University Calape Campus. There were 30 respondents selected to evaluate the product through sensory evaluation, broken down as follows: 5 Food Preparation Services and Technology instructors, 20 selected 2nd-year Food Preparation Services and Technology students, and 5 Food Preparation Services and Technology OJTs. The researchers chose the following participants for the reason that they have the capabilities needed to evaluate the malunggay and blue ternate pasta.

Research instrument

The researchers used modified score sheet to obtain the respondent's evaluation on the sensory attributes of the malunggay and blue ternate pasta. This includes the sensory attributes of the pasta specifically its color, aroma, taste, texture, flavor, and its general acceptability.The questionnaire was based on a 9-point Hedonic scale where 9 as extremely acceptable, 8 as very much acceptable, 7 as moderately acceptable, 6 as slightly acceptable, 5 as neither like or dislike, 4 as slightly inacceptable, 3 as moderately inacceptable, 2 as very much inacceptable,and 1 as extremely inacceptable. The highest descriptive made extremely acceptable and the lowest is extremely inacceptable. Rating scale allowed the researcher to measure the options and behavoiur of respondents in a quantitative manner.

Research procedure

Approval of the study and preparation of the questionnaire

The researchers asked for permission from the campus director and the dean of the College of Technology and Allied Sciences to conduct the study inside the school premises. The researchers prepared before developing the questionnaire to collect the study's data. First, the self-made rating sheet was given to the adviser for revisions.

Preparation of ingredients, tools, and equipment

In the preparation of making the pasta with malunggay and blue ternate, the treatments were: T1; 45 grams of Malunggay puree and 45 grams of Blue Ternate puree, T2; 45 grams of Malunggay puree and 90 grams of Blue Ternate puree, T3; 90 of Malunggay puree and 45 grams of Blue Ternate puree, and T4; 90 grams of Malunggay puree and 90 grams of Blue Ternate puree. All the ingredients were prepared by the researchers, who ensured that food safety and

sanitation were followed and applied before making the product.

Steps in making gnocchi pasta

a. Preparation of malunggay

1. Gather malunggay from its tree.
2. Remove the leaves from its stalk.
3. Weigh the needed malunggay leaves.
4. Wash the leaves thoroughly.
5. Blanch the leaves for 20 seconds.
6. After blanching, rinse the leaves with cold water.
7. Squeeze the leaves to remove excess water, then set aside.

b. Preparation of blue ternate

1. Gather blue ternate flowers.
2. Wash the flower thoroughly, then squeeze the flower to remove excess water.

c. Pureeing the malunggay and blue ternate

1. Load the weighed malunggay and blue ternate into the blender and add the egg then blend until smooth.
2. Set aside for the next process.

d. Process of making the pasta

1. Measure all the ingredients accordingly for every treatment.
2. Pour the flour in a clean work surface and form a mound then make a well in the center.
3. Add 5 grams of salt and 15 ml oil.
4. Add the pureed mixture of malunggay, blue ternate and egg at the center.
5. Incorporate the flour into the mixture using a fork. Continue mixing until a dough starts to form.
6. Once the dough starts to form, used your hand to knead the dough. Keep kneading until the dough becomes smooth and elastic.
7. Wrap the dough in a plastic wrap and let it rest for 1-2 hours at room temperature.
8. After resting the dough, roll the dough into logs with a half-inch diameter and cut them into quarters of an inch.
9. Put the portioned dough one at a time in the pasta board then scrape it using a scraper or an edge of a knife to put texture in each piece of the pasta.

Statistical treatment

To be able to attain scientific evidence and answers to the research problems, the following statistical tools were used.

Frequency (*f*) and percent (%) will be used to determine the sensory description of the malunggay and blue ternate gnocchi pasta such as color, aroma, texture, and flavor. Mean (*M*) was be used to ascertain the sensory acceptability of gnocchi pasta added with different levels of malunggay and blue ternate in terms of aroma, color, taste, texture, and general acceptability.

Two-way analysis of variance applying bootstrapping with 95% Bias corrected accelerated was used to test if there is a significant difference in the acceptability of the four treatments of Gnocchi pasta added with different levels of malunggay and blue ternate in terms of aroma, color, taste, texture, and general acceptability Bootstrapping is robust estimation method for reducing bias associated with normality, homogeneity of variance, and sampling. Explicitly, the *F*-statistic with corresponding between and within group degrees of freedom was determined which is defined as the ratio of the between-group variability to the within-group variability. The IBM SPSS Statistics Base Authorized User V 29 was used in data analysis (Bower, 2013; Field, 2020; Tabachnick and Fidell, 2018).

RESULTS AND DISCUSSION

Table 1 show the sensory description of the four treatments of gnocchi pasta with different amounts of malunggay and blue ternate evaluated in terms of color, aroma, taste, and flavor.

In color, the mixtures of malunggay leaves and blue ternate pasta can be attributed to the pH-sensitive anthocyanin pigments present in blue ternate flowers and the chlorophyll in malunggay leaves. Malunggay leaves contain chlorophyll, which typically imparts a

green color to plant tissues through photosynthesis (Tanaka *et al.*, 2011). When 45 grams of malunggay leaves and 45 grams of blue ternate flowers are mixed, the pH of the mixture favors a dark blue-green color due to the balance of anthocyanin concentration and chlorophyll influence. With 45 grams of malunggay leaves and 90 grams of blue ternate pasta, the higher ratio of blue ternate flower increases the concentration of anthocyanins, leading to a blue color. Conversely, with 90 grams of malunggay leaves and 45 grams of blue ternate pasta, the higher chlorophyll content from malunggay leaves dominates, resulting in a green color. Finally, when both components are increased to 90 grams each, the combined effect produces a lighter blue-green shade due to a balanced interaction of chlorophyll and anthocyanins. These color variations can thus be explained through the principles of pH-dependent anthocyanin coloration and chlorophyll presence in the respective plant materials (Khoo *et al.*, 2017).

Table 1. Sensory description of gnocchi pasta with different amount of malunggay and blue ternate (n = 30)

Attributes	Descriptions	Treatments							
		45 grams of malunggay + 45 grams of blue ternate		45 grams of Malunggay + 90 grams of blue ternate		90 grams of Malunggay + 45 grams of blue ternate		90 grams of Malunggay + 90 grams of blue ternate	
		f	%	f	%	f	%	f	%
Color	Light blue-Green	11	36.7	4	13.3	5	16.7	17	56.7*
	Dark blue-Green	17	56.7*	12	40.0	2	6.7	5	16.7
	Blue	1	3.3	13	43.3*			1	3.3
	Green	1	3.3	1	3.3	23	76.7*	7	23.3
Aroma	Malunggay's aroma is more perceptible than blue ternate's aroma	10	33.3	10	33.3	16	53.3*	7	23.3
	Blue ternate's aroma is more perceptible than malunggay's aroma	15	50.0*	15	50.0*	5	16.7	10	33.3
	Aroma of malunggay and blue ternate have equal perceptibility	5	16.7	5	16.7	9	30.0	13	43.3*
Texture	Firm and chewy	7	23.3	13	43.3*	11	36.7*	10	33.3
	Elastic and squishy	14	46.7*	9	30.0	10	33.3	12	40.0*
	Smooth	9	30.0	8	26.7	9	30.0	8	26.7
Flavor	Malunggay's flavor is more perceptible than blue ternate's flavor	10	33.3	10	33.3	17	56.7*	12	40.0*
	Blue ternate's flavor is more perceptible than malunggay's flavor	12	40.0*	16	53.3*	7	23.3	8	26.7
	Flavor of malunggay and blue ternate have equal perceptibility	8	26.7	4	13.3	6	20.0	10	33.3

Description with the highest *f* and % is used as descriptor for the treatment.

In aroma, considering the proportions of malunggay leaves and blue ternate flower in a mixture, such as 45 grams of each, the aroma of blue ternate pasta is more perceptible due to its lighter, more volatile compounds that readily evaporate and are perceived by the olfactory system compared to the heavier and less volatile compounds of malunggay leaves. Increasing the amount of blue ternate pasta to 90 grams while keeping malunggay leaves at 45 grams further enhances the perceptibility of blue ternate's aroma, as more of its volatile compounds are present in the mixture. In contrast, increasing malunggay leaves to 90 grams and keeping blue ternate pasta at 45 grams shifts the balance towards malunggay's aroma due to its increased presence and concentration of volatile compounds. When both are equal at 90 grams each, the perceptibility of their aromas may balance out, assuming their aroma intensities are comparable in strength and volatility.

In texture of pasta incorporating different proportions of malunggay leaves (*Moringa oleifera*) and blue ternate flower (*Clitoria ternatea*) can be attributed to the interaction between phytochemical compounds and the structural components of the pasta. Both malunggay leaves and blue ternate

flowers are rich in phenolic compounds, which play a significant role in determining the texture by interacting with the gluten network and starch molecules in the pasta. When 45 grams of malunggay leaves and 45 grams of blue ternate flowers are used, the moderate concentration of phenolic compounds and anthocyanins from both ingredients likely leads to a balanced interaction with gluten, resulting in an elastic and squishy texture. Increasing either the malunggay leaves or blue ternate flower concentration to 90 grams (while the other remains at 45 grams) enhances the firmness and chewiness. This is because the higher phenolic content strengthens the gluten network and increases the binding interactions within the pasta dough. However, when both malunggay leaves and blue ternate concentrations are increased to 90 grams each, the phenolic and anthocyanin content could damage the gluten network more significantly, leading to a softer, elastic, and squishy texture similar to the 45 grams of malunggay and 45 grams of blue ternate combination but with a different sensory profile due to the higher phytochemical content. This phenomenon aligns with findings from Shiau *et al.* (2023) where the inclusion of blue ternate extracts altered the texture and sensory attributes of noodles.

Table 2. Sensory acceptability and test of hypothesis of gnocchi pasta with different amounts of malunggay (n = 60)

Attributes	Treatments	Mean	Interpretation	F	*p*	Result
Color	45 grams of malunggay	7.600	Very much acceptable	.000	1.000	ns
	90 grams of malunggay	7.600	Very much acceptable			
Aroma	45 grams of malunggay	7.567	Very much acceptable	.251	.617	ns
	90 grams of malunggay	7.467	Very much acceptable			
Texture	45 grams of malunggay	7.633	Very much acceptable	.060	.806	ns
	90 grams of malunggay	7.683	Very much acceptable			
Flavor	45 grams of malunggay	7.700	Very much acceptable	.254	.615	ns
	90 grams of malunggay	7.600	Very much acceptable			
General acceptability	45 grams of malunggay	7.850	Very much acceptable	.538	.465	ns
	90 grams of malunggay	7.700	Very much acceptable			

Note: *F* values were determined with 1 degree of freedom between groups and 116 degrees of freedom within groups. *F* values are based on bias-corrected and accelerated (BCa) bootstrap 95% confidence intervals, unless otherwise noted. Bootstrap results are based on 1,000 resamples. ns indicates a non-significant result ($p > .05$); * indicates significance ($p \leq .05$); ** indicates high significance ($p \leq .01$).

Table 3. Sensory acceptability and test of hypothesis of gnocchi pasta with different amounts of blue ternate (n = 60)

Attributes	Treatments	Mean	Interpretation	F	*p*	Result
Color	45 grams of blue ternate	7.450	Very much acceptable	2.490	.117	ns
	90 grams of blue ternate	7.750	Very much acceptable			
Aroma	45 grams of blue ternate	7.400	Very much acceptable	1.369	.244	ns
	90 grams of blue ternate	7.633	Very much acceptable			
Texture	45 grams of blue ternate	7.583	Very much acceptable	.543	.463	ns
	90 grams of blue ternate	7.733	Very much acceptable			
Flavor	45 grams of blue ternate	7.467	Very much acceptable	3.417	.867	ns
	90 grams of blue ternate	7.833	Very much acceptable			
General acceptability	45 grams of blue ternate	7.633	Very much acceptable	1.918	.169	ns
	90 grams of blue ternate	7.917	Very much acceptable			

Note: *F* values were determined with 1 degree of freedom between groups and 116 degrees of freedom within groups. *F* values are based on bias-corrected and accelerated (BCa) bootstrap 95% confidence intervals, unless otherwise noted. Bootstrap results are based on 1,000 bootstrap samples. ns indicates a non-significant result ($p > .05$); * indicates a significant result ($p \leq .05$); ** indicates a highly significant result ($p \leq .01$).

In flavor, the case of malunggay leaves and blue ternate flower, malunggay leaves are known for their characteristic bitter and slightly peppery flavor, caused by compounds such as glucosinolates and isothiocyanates (Singh *et al.*, 2020). On the other hand, blue ternate flowers are knwon for their vivid

blue color due to anthocyanin pigments, which also contribute to their slightly sweet and flavor profile (Azima *et al.*, 2017).

When comparing different ratios of these malunggay leaves and blue ternate flower in a mixture, such as 45 grams of malunggay leaves and 45 grams of blue ternate flowers versus 90 grams malunggay leaves and 90 grams blue ternate flowers, the perceptibility of flavor shifts due to the different concentration of each ingredient alters the overall sensory experience. Higher concentrations of blue ternate flower (90 grams) would enhance its perceptibility due to the higher levels of its characteristic volatile compounds compared to malunggay leaves, thus making its flavor more perceptible. In contrast, higher concentrations of malunggay leaves (90 grams) would enhance their bitter and peppery taste, making malunggay's flavor more perceptible than the blue ternate flower. Therefore, the varying proportions of malunggay leaves and blue ternate flower directly influence the dominance of their respective flavors based on their concentration of volatile compounds.

Table 4. Sensory acceptability and test of hypothesis of gnocchi pasta with interaction of the different amounts of malunggay and blue ternate (n = 30)

Attributes	Treatments	Mean	Interpretation	F	*p*	Result
Color	45 grams of malunggay + 45 grams of blue ternate	7.400	Very much acceptable	.277	.600	ns
	45 grams of malunggay + 90 grams of blue ternate	7.800	Very much acceptable			
	90 grams of malunggay + 45 grams of blue ternate	7.500	Very much acceptable			
	90 grams of malunggay + 90 grams of blue ternate	7.700	Very much acceptable			
Aroma	45 grams of malunggay + 45 grams of blue ternate	7.567	Very much acceptable	1.369	.244	ns
	45 grams of malunggay + 90 grams of blue ternate	7.567	Very much acceptable			
	90 grams of malunggay + 45 grams of blue ternate	7.233	Very much acceptable			
	90 grams of malunggay + 90 grams of blue ternate	7.700	Very much acceptable			
Texture	45 grams of malunggay + 45 grams of blue ternate	7.567	Very much acceptable	.007	.935	ns
	45 grams of malunggay + 90 grams of blue ternate	7.700	Very much acceptable			
	90 grams of malunggay + 45 grams of blue ternate	7.600	Very much acceptable			
	90 grams of malunggay + 90 grams of blue ternate	7.767	Very much acceptable			
Flavor	45 grams of malunggay + 45 grams of blue ternate	7.500	Very much acceptable	.028	.876	ns
	45 grams of malunggay + 90 grams of blue ternate	7.900	Very much acceptable			
	90 grams of malunggay + 45 grams of blue ternate	7.433	Very much acceptable			
	90 grams of malunggay + 90 grams of blue ternate	7.767	Very much acceptable			
General acceptability	45 grams of malunggay + 45 grams of blue ternate	7.667	Very much acceptable	.166	.684	ns
	45 grams of malunggay + 90 grams of blue ternate	8.003	Very much acceptable			
	90 grams of malunggay + 45 grams of blue ternate	7.600	Very much acceptable			
	90 grams of malunggay + 90 grams of blue ternate	7.800	Very much acceptable			

Table 2 shows that both treatment with 45 or 90 grams of malunggay leaves, were rated as "Very Much Acceptable" by the respondents, regardless of how much blue ternate flower were added. This means that the products were well-liked by the respondents across all the different formulations. The findings suggest that the amount of Blue Ternate flower or Malunggay leaves didn't significantly affect how much people liked the treatments. These results align with the study of Valera and Ancheta (2017), where adding malunggay leaves to different products such as ice cream, cookies, biscuits, crackers, and cupcakes was found to be acceptable in terms of appearance, texture, aroma, and taste.

Table 3 shows that both treatment with 45 or 90 grams of Blue Ternate flower, were rated as "Very Much Acceptable" by the respondents, regardless of how much Malunggay leaves were added. This means that the products were well-liked by the respondents across all the different formulations. The findings suggest that the amount of Blue Ternate flower or Malunggay leaves didn't significantly affect how much people liked the treatments. The result aligns with the study of Soliman (2024), where incorporating blue ternate flowers into a potato-based product is very acceptable for the respondents in terms of color, aroma, and overall acceptability.

Table 4 shows the sensory acceptability and test of hypothesis of the four treatments of gnocchi pasta with different amounts of blue ternate evaluated in terms of color, aroma, taste, flavor, and general acceptability. The table shows that the four different combinations of blue ternate and malunggay (45/45; 45/90; 90/45; 90/90) in grams were rated "very much acceptable" by the respondents. The data indicate that all combinations were rated "Very Much Acceptable" by the respondents. The results of the ANOVA test further revealed that there were no statistically significant differences among the combinations in terms of color, aroma, texture, flavor, or overall acceptability. This suggests that varying the proportions of malunggay and blue ternate did not notably impact the sensory qualities perceived by the respondents. This result aligns with the study of Peñaflorida and Masbaño (2015), where adding malunggay leaves extract to a mango puree doesn't significantly affect the its taste, appearance, aroma, and general acceptability. Additionally, incorporating blue ternate flower extract into jelly significantly affect taste, texture, colour, smell, and appearance and the product are well-liked by the consumers (Madukokila *et al.*, 2021).

CONCLUSION

Based on the findings, the researchers concluded that the four treatments were acceptable in terms of aroma, color, taste, texture, and general acceptability. Moreover, since all four treatments were acceptable, the main ingredients used in this study can be utilized to innovate products. Extension program could be implemented to inform of its viability for home consumption as well as additional source of income.

RECOMMENDATIONS

Based on the conclusions drawn from the study, the researchers recommend the following:

1. Any of all of the treatments can be used in making Maluternate pasta since all of it were rated acceptable.
2. Use treatment 4 in making Maluternate pasta since the recipe can yield more than the other treatments.
3. Utilize other methods of drying to lessen the cost production of the product.
4. Future researchers may conduct an extension activity to introduce to the community the featured product.

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