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Assessment of sensory quality in mango (*Mangifera indica* L.) infused tapioca beverage via milk varietal formulation

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Abstract

In the Philippines, the demand for nutritious and appealing food and beverage options has led to the development of new products. Beverages are becoming popular in the market and are displayed in various flavors. Mango (*Mangifera indica* L.) holds global significance as a crucial fruit, primarily attributed to its nutritional richness. The increasing demand for alternative and innovative food and beverage options that not only provide essential nutrients but also cater to evolving consumer preferences. This study aimed to determine the level of acceptability of bottled mango tapioca beverage in terms of color, aroma, taste, flavor and general acceptability and to determine the significant differences among the different treatment. It was found out that among the four treatments, treatment 2 got the highest acceptability rating in terms of color, aroma, taste, flavor, and general acceptability. It was also found out that the higher the mango and milk the more acceptable is the bottled mango tapioca to the consumer. The positive feedback regarding the color, aroma, taste, flavor and general acceptability, suggesting its potential as a viable commercial product. In conclusion, this research highlights bottle mango tapioca as a promising alternative nutritious beverage that combines the goodness of mango and tapioca to provide a plethora of essential nutrients and health benefits. The results of this research add to the expanding body of knowledge on innovative trends in food and beverage alternatives and pave the way for further exploration and development in this exciting field.

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Introduction

Malnutrition poses a significant public health issue in the Philippines. High rates of under nutrition are observed in children, with one in three under the age of five experiencing stunted growth, and 7% showing signs of wasting. Micronutrient deficiency, particularly vitamin A deficiency, remains a significant public health issue (Capanzana *et al.*, 2018).

Beverages are becoming popular in the market and are displayed in various flavors. Most of the Filipinos enjoyed beverages especially in summer season. Leading international health organizations acknowledge that the exposure of children to marketing of unhealthy food is likely a causal factor contributing to unhealthy lifestyles and obesity (Bridget *et al.*, 2014).

Tapioca, originating from cassava tubers, is a starchy product rich in carbohydrates and calories. Additionally, it serves as a source of iron and calcium. In moderation, tapioca can be a beneficial component of a well-balanced eating plan (Sarfo, 2016).

Mangifera indica, commonly known as mango is a tropical fruit of India and Southeast Asia. Mango is deserving of its name as the "king of fruits" as it is not only delicious but also boast an impressive nutritional value. Mango contains a significant amount of macro and micro-nutrients. Macro-nutrients accounts for carbohydrate with 16-18%, protein, lipids, amino acids and dietary fibers. The pulp serves as a valuable reservoir of micronutrients, encompassing essential trace elements such as calcium, phosphorus, iron, and vitamins, specifically, vitamins C and A (Lemmens *et al.*, 2013).

Combining sweetened milk is more advantageous than using sugar alone, as the product not only offers sweetness but also provides essential components such as protein, fat, and bone-healthy minerals like calcium and phosphorus, naturally found in milk. Evaporated milk is nutritionally comparable to both fresh milk and powdered milk, making it a wholesome option as it supplies essential nutrients crucial for bone health, including protein, calcium, and vitamins A and D (Tseng *et al.*, 2005). All-purpose cream is a healthful soy-based alternative with zero grams of trans-fat and lactose, making it an excellent choice for savory applications.

Children in the Philippines generally exhibit low consumption of milk and dairy products, and this trend tends to decrease with age. Despite this, milk and dairy form a crucial component of the essential food group for preschool children, significantly contributing to their overall energy, protein, and calcium intake (Capanzana *et al.*, 2018). Thus, an innovation of a beverage can be developed, taste and flavors are improved. The production of bottled mango tapioca, a beverage made out from Mango. This beverage that is healthier as compared to sodas. Thus, the objective of this study was to assess the acceptability of mango tapioca beverage based on criteria such as color, aroma, taste, flavor, and overall acceptance. Additionally, the study aimed to identify any significant differences among the various treatments.

Materials and methods

This study used an experiment and descriptive method to determine the acceptability level of mango tapioca as an alternative nutritious beverage in terms of color, aroma, viscosity, taste, flavor and overall acceptability of the four treatments. There are fifty (50) respondents of the study; six (6) food technology instructors, thirty (30) students, fourteen (14) different working individuals. A researcher's constructed rating sheet was used for data gathering. This tool was used to determine the acceptability level of mango tapioca as an alternative nutritious beverage in terms of color, aroma, viscosity, taste, flavor, and overall acceptability.

The researcher used four (4) point hedonic scales to determine the sensory preference of the products; (4) like very much, (3) like moderately, (2) dislike moderately and (1) dislike very much. The data gathered served as a basis for the

statistical analysis, evaluation and interpretation. The sensory acceptability data collected underwent One-way Analysis of Variance using a Completely Randomized Design (CRD). Statistical analysis of data was obtained using software-IBM SPSS. The descriptive sources of the sensory evaluation were analyzed using cross-tabulation and frequency (Fig. 1).
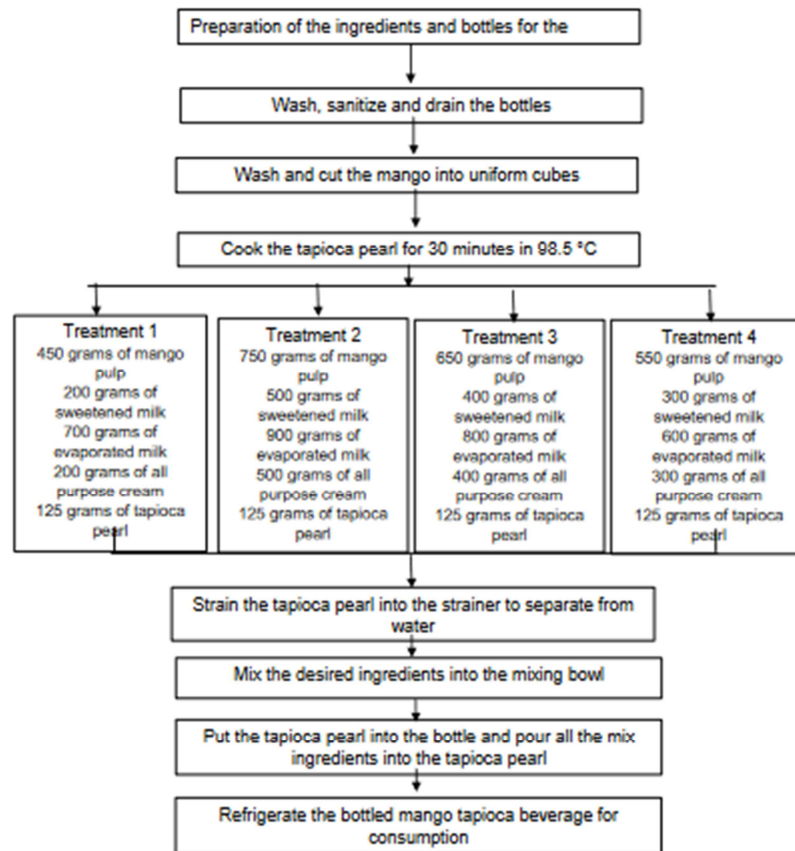
Fig. 1. Schematic diagram of producing bottled mango tapioca

Results and discussion

Color

Color is a key component in increasing beverages quality acceptability parameter which is used to measure consumers acceptance level. The products' color acceptability is greatly influenced by the presence of pigment carotenoids, a pigment characterize with yellow, orange coloration (Hernández-Estrada *et al.*, 2019) found in mango. The figure below illustrates that Treatment 2 received the highest mean scores for color acceptability, while Treatment 3 obtained the lowest mean scores for color acceptability. This is justifiable since treatment 2 compared with other treatment contains the highest amount of mango, the carotenoids being the prevalent color pigment influences the yellowish color appearance of the product. Result is in conformity to the study conducted by Sakhale, 2012, in which at higher amount of mango added produces a higher color acceptability scores. Nonetheless, when combined with lower amount of mango and higher or lower amount of milk added produces a lower color acceptability scores.

However, results of the statistical analysis depicted in Table 1 showed that the mango and the milk doesn't affect statistically on the color acceptability of the product. Given that the computed p-value (0.326) exceeds the critical value (0.05), the null hypothesis is accepted. This indicates that there is no significant difference in respondents' acceptability regarding the color of the four treatments of Mango Tapioca. The four treatments got similar acceptability rating from the respondents in terms of color.

Table 1. Color description, acceptability and post-hoc of mango tapioca beverage

Treatment	Mean acceptability	Post-Hoc		Inferences
		Areas/ treatment	Sig. values	
1	6.93	2	.550	ns
		3	.971	ns
		4	1.0	ns
2	7.46	1	.550	ns
		3	.296	ns
		4	.550	ns
3	6.75	1	.971	ns
		2	.296	ns
		4	.971	ns
4	6.93	1	1.0	ns
		2	.550	ns
		3	.971	ns

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)

Aroma

The sense of smell serves a crucial role as the primary sensory system in detecting food aromas and volatile flavors, ultimately acting as the ultimate discriminator of food aroma and flavor quality. Aroma is the second attribute that can be noticed in a food which greatly affects the acceptability of a product, thus making aroma as an important sensory attribute of any food.

The aroma of the Fig. 2 below shows that treatment 2 got the highest aroma acceptability mean scores whereas treatment 3 got the lowest aroma acceptability mean scores. This is acceptable since treatment 2 compared with other treatment contains the highest amount of mango, in which the main source of fruity aroma with one of the key contributors that is the ethyl butanoate (Brunning, 2017). Results show that at higher amount of mango add the higher its acceptability. The sweet aromatic compounds in mango contributed to this high aroma acceptability is due to the volatile constituents specifically 4-hdroxy-2,5-dimethyl-3(2H)-furanone (Munafo *et al.*, 2018).

Conversely, results of the statistical analysis depicted in Table 2 showed that the mango and the milk doesn't affect statistically on the aroma acceptability of the product. Given that the computed p-value (0.248) exceeds the critical value (0.05), the null hypothesis is accepted. This indicates that there is no significant difference in respondents' acceptability regarding the aroma of the four treatments of Mango Tapioca. The four treatments got similar acceptability rating from the respondents in terms of aroma.

Table 2. Aroma description, acceptability and post-hoc of mango tapioca beverage

Treatment	Mean acceptability	Post-Hoc		Inferences
		Areas/ treatment	Sig. values	
1	7.11	2	.406	ns
		3	.987	ns
		4	.909	ns
2	7.61	1	.406	ns
		3	.237	ns
		4	.810	ns
3	7.00	1	.987	ns
		2	.237	ns
		4	.748	ns
4	7.32	1	.909	ns
		2	.810	ns
		3	.748	ns

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)

Viscosity

Understanding viscosity is crucial in any industrial sector dealing with liquid media, as the demand for high-quality food continues to grow, becoming increasingly significant to consumers (PCE Instruments, 2016). Viscosity testing is an integral tool employed in the production processes of virtually all types of food and beverages. Liquids exhibiting higher viscosity pour more slowly and appear thicker compared to liquids with lower viscosity, as viscosity characterizes a fluid's internal resistance to flow. The modification of material properties, such as molecular weight and density, influences the flow of the liquid and the resulting changes in viscosity, ultimately affecting its quality (Vessel, 2019).

Fig. 2 below shows that treatment 2 got the highest viscosity acceptability mean scores whereas treatment 3 got the lowest viscosity acceptability mean scores. This may be due to the highest amount of dairy and mango that can be found in treatment 2. The desired viscosity of the product is considerably affected by the

fat globules found in milk (Velez-Ruiz and Barbosa-Canovas, 2007) which will produce a thicker product consistency. Nevertheless, when combined with lower amount of mango and lower amount of milk added produces a lower viscosity acceptability scores.

On the other hand, results of the statistical analysis depicted in Table 2 showed that the mango and the milk doesn't affect statistically on the aroma acceptability of the product. Since the computed p-value (0.189) is greater than critical-value (0.05), the null hypothesis is accepted. This means that there was no significant difference on respondents' acceptability in the viscosity of the four treatments of Mango Tapioca. The four treatments got similar acceptability rating from the respondents in terms of viscosity (Table 3).

Table 3. Viscosity description, acceptability and post-hoc of mango tapioca beverage

Treatment	Mean acceptability	Post-Hoc Areas/ treatment	Sig. values	Inferences
1	6.57	2	.256	ns
		3	1.0	ns
		4	.889	ns
2	7.21	1	.256	ns
		3	.213	ns
		4	.672	ns
3	6.54	1	1.0	ns
		2	.213	ns
		4	.884	ns
4	6.82	1	.889	ns
		2	.672	ns
		3	.844	ns

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)

Taste

The gustatory system, or the sense of taste, is the sensory system that plays a role in the perception of taste or flavor. The taste sensation is initiated when nutrients or specific chemical compounds activate specialized receptor cells within the oral cavity. Taste plays a crucial role in guiding food choices and influencing the efficiency of the digestion process (Breslin, 2013). Fig. 2 below shows that treatment 2 got the highest acceptability mean scores in terms of taste whereas treatment 3 got the lowest mean score acceptability in taste. Moreover, since the computed p-value (0.009) is

less than critical-value (0.05), the null hypothesis is rejected. This means that there was a significant difference on respondents' acceptability in the taste of the four treatments of Mango Tapioca. Specifically, it was found that treatments 2 and 3 got different ratings from the respondents in terms of taste. Treatment 2 was found more acceptable than Treatment 3 in terms of taste. Results are influenced to the natural sugar content and other phytochemicals found in ripe mangoes. According to the study of Medicott and Thompson (1985) increased total solids and organic acids are associated with fruit ripeness producing a desirable sweet taste; hence a product is more acceptable with added high amount of mango (Table 4).

Table 4. Taste description, acceptability and post-hoc of mango tapioca beverage

Treatment	Mean acceptability	Post-Hoc Areas/ treatment	Sig. values	Inferences
1	6.86	2	.498	ns
		3	.170	ns
		4	1.0	ns
2	7.46	1	.498	ns
		3	.004	**
		4	.447	ns
3	5.96	1	.170	ns
		2	.004	**
		4	.199	ns
4	6.82	1	1.0	ns
		2	.447	ns
		3	.199	ns

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)

Flavor

Flavor is an important attribute of food which contributes to its palatability and acceptance. The main purpose of flavors is to impart taste to foods, devoid of any nutritional properties. Flavors are available in both natural and artificial forms (Flood, 2016). In this study, mango is the source of flavor aside from dairy milk.

Table 5 below shows that treatment 2 got the highest acceptability mean scores in terms of flavor while treatment 3 got the lowest mean score acceptability. Moreover, as the computed p-value (0.001) is lower than the critical value (0.05), the null hypothesis is rejected.

This means that there was a significant difference on respondents' acceptability in the flavor of the four treatments of Mango Tapioca. Specifically, it was found that treatments 2 and 3 got different ratings from the respondents in terms of flavor. Treatment 2 got higher rating than Treatment 3. Indeed, having more mango pulp made the respondents savor most the flavor of mango in treatment 2 and least in treatment 3 since there was only a small amount of mango pulp added. The favorable widespread acceptance of mango's intense flavor in larger quantities can be ascribed to the presence of 15% soluble sugars, which significantly contribute to its sweet taste (Yahia *et al.*, 2023). The addition of high-sweetened milk on the product increases the products acceptability.

Table 5. Flavor description, acceptability and post-hoc of mango tapioca beverag

Treatment	Mean acceptability	Post-Hoc		Inferences
		Areas/ treatment	Sig. values	
1	6.89	2	.159	ns
		3	.159	ns
		4	.992	ns
2	7.68	1	.159	ns
		3	.000	**
		4	.272	ns
3	6.11	1	.159	ns
		2	.000	**
		4	.086	ns
4	7.0	1	.992	ns
		2	.272	ns
		3	.086	ns

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)
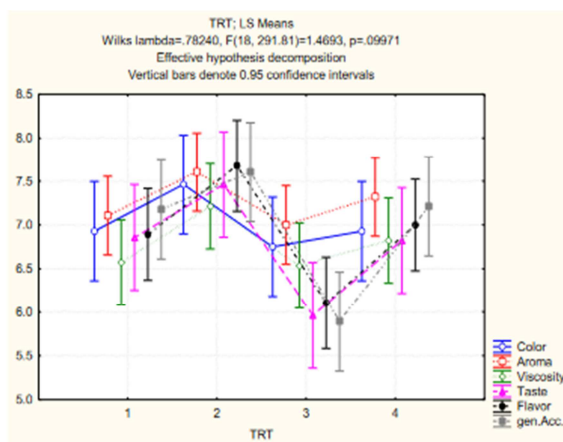
Fig. 2. Superimposed graphical presentation of sensory acceptability of mango tapioca beverage

Table 6. General acceptability and post-hoc of mango tapioca

Treatment	Mean acceptability	Post-Hoc		Inferences
		Areas/ treatment	Sig. values	
1	7.18	2	.716	ns
		3	.010	**
		4	1.00	ns
2	7.61	1	.716	ns
		3	.000	**
		4	.767	ns
3	5.89	1	.010	**
		2	.000	**
		4	.008	**
4	7.21	1	1.00	ns
		2	.767	ns
		3	.008	**

ns= not significant (p>0.05), *= significant (p≤ 0.05), **= highly significant (p≤0.01)

General acceptability

The general acceptability of the formulations, as rated by respondents, ranged from 5.89 to 7.18 on the 9-point Hedonic scale, which corresponds to "like slightly" to "like moderately." Among the four treatments, Treatment 2 received the highest acceptability score of 7.61, indicating that this formulation was the most favored. The findings suggest that reducing the amounts of all-purpose cream, evaporated milk, and sweetened milk lowers the overall acceptability of the beverage. This may be due to these ingredients contributing to the beverage's creamy texture and balanced sweetness, both of which are critical to consumer satisfaction.

The statistical analysis further supports these findings. The computed p-value (0.000) is significantly lower than the critical value of 0.05, leading to the rejection of the null hypothesis. This indicates a statistically significant difference in flavor acceptability among the four treatments. The variation in ingredient levels, particularly the amount of cream and milk, had a notable impact on the respondents' perceptions of flavor. These results demonstrate that small adjustments in the formulation can lead to significant changes in consumer preference, emphasizing the importance of precise ingredient calibration in product development (Table 6).

Conclusion

In conclusion, the analysis showed that while changes in the levels of mango and milk did not have a significant effect on the acceptability of color, aroma, or viscosity, taste and flavor were notably influenced by the amount of mango used. Treatment 2, which contained a higher proportion of mango, consistently emerged as the preferred option among respondents. This suggests that the flavor of mango plays a key role in driving consumer preferences.

The results emphasize the importance of finding the right balance of ingredients, especially the mango content, to enhance the sensory qualities that matter most to consumers, such as taste and flavor. A well-balanced formulation not only improves the product's appeal but also ensures its success in the market, as it aligns with what consumers find most enjoyable. These findings provide valuable insights for future product development, where ingredient ratios must be carefully considered to create a product that is both nutritious and enjoyable.

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