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Product Development and Market Acceptability of Lemon Grass Bottled Tea (*Cymbopogon citratus*)

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Abstract. Lemongrass grows abundantly in Compostela, Davao de Oro, thriving with proper drainage and adequate sunlight. Traditionally used as an herbal tea, its pale light-yellow color may not be appealing, locally produced packaging is unavailable, and its commercialization in the province of Davao de Oro is limited. This study aimed to increase the market competitiveness of lemongrass bottled tea by adding calamansi and honey flavors from locally available agricultural produce and packaging them in polyethylene plastic bottles. The research determined the most acceptable honey and calamansi-flavored lemongrass bottled tea in terms of (a) sensory qualities and (b) formulation or percentage of honey and calamansi. Sensory evaluation involving two hundred consumer-type panelists assessed the sensory qualities and acceptability of the lemongrass bottled tea formulations. Modes and means were used to interpret the results of the sensory evaluation. ANOVA with repeated measures determined if significant differences existed among samples. The most acceptable product formulation was compared with similar products currently offered in the marketplace. Results showed no significant difference with similar products and revealed the potential marketability of honey and calamansi-flavored lemongrass bottled tea.

Keywords: Lemongrass drink; Market acceptability; Product development; Sensory evaluation; Value-added product.

1.0 Introduction

Beverages are liquid products that food processing companies manufacture for human consumption (Grumezescu, A. and Holban, 2019). Beverages account for a significant portion of the market because people drink them at all times of the day and in various settings. Beverages may be broken down into several categories, namely those that include alcohol, those that do not contain alcohol, and those that contain dairy products (Rocha et al., 2017). Non-alcoholic drinks are the results of the distillation process that are drunk without alcoholic ingredients. The production procedure for these beverages does not include fermentation (Nanasombat et al., 2015). The sale of packaged drinks that do not include alcohol substantially influences the global economy, as shown by the revenue of $1.038T and the typical consumption capacity per capita of 109.5 L in the year 2020. The volume of this market is forecasted to expand at a rate of 6.8% yearly, ultimately reaching 935.76B liters by 2025 (Statista, 2020).

Moreover, healthier beverage options such as non-alcoholic drinks are one of the most often eaten as part of contemporary diets since non-alcoholic beverages provide customers various benefits, including rehydration, pleasure, ease of consumption, and other advantages. When the whole category of beverages is considered, these items are also viable options (Piorkowski and McClements, 2014; Shachman, 2004). There has already been a movement in global consumer preferences toward foods that provide additional health advantages because of

socioeconomic developments, a rise in the average life duration, the rising number of elderly individuals, and a need for an enhanced quality of life with lower hospitalization expenditures.

Existing academic literature has several categories for packaged non-alcoholic drinks, and generally, these classifications are based on the manufacturing processes and their corresponding ingredients (Rocha et al., 2017). Two primary categories may be used to manufacture packaged non-alcoholic beverages: ready-to-drink (RTD) goods and diluted beverage products (Ashurst, 2016). Packaged ready-to-drink (PTD) non-alcoholic drinks may be further subdivided into juices, carbonated soft drinks (CSDs), bottled waters, and still drinks (Shachman, 2004). These subcategories may be categorized technologically by statistics on the top-selling products worldwide (Statista, 2020). Non-carbonated beverages, sometimes known as still drinks, do not include any added carbonation. This sector was challenging to compete in the past because customers favored handcrafted items over commercial ones, and the products needed better quality.

On the other hand, throughout the previous few decades, shifts in lifestyle preferences regarding eating habits and advancements in technology capabilities have been favorable to the growth of this product area (Ashurst, 2016). On the other hand, drinks, such as fruit and flavored drinks, ready-to-drink coffee and iced tea products, non-alcoholic beer, and flavored water may be categorized as industrially distinct categories, as presented in Figure 1. The category of juices includes the many kinds of packaged vegetable and fruit juices that include 100 percent vegetable and fruit liquid content. Bottled water may be generated from various sources, including healthy water, mineral, tap water, or spring water.

Recently, there has been an upsurge in demand among Filipino consumers for health drinks rather than carbonated beverages, which has led to an increase in both the production and consumption of non-carbonated drinking drinks in the Philippines. Several government agencies, such as the Department of Education (DepEd), enacted a regulation prohibiting the sale of sugar-based artificial, carbonated, and unhealthy juices within school premises. These drinks are "artificial" juices (Reeve et al., 2018). Ready-to-drink (RTD) drinks, which offer various health benefits, such as those derived from natural therapeutic origins or those with a high antioxidant concentration, are now attracting the attention of customers who are more inclined towards a healthier beverage alternative. RTD tea has been the beverage category with the most rapid growth in total percentage volume over the last several years, and this trend is projected to continue (Statista, 2020).

In Davao de Oro, indigenous plants are available, used, and innovated. Therefore, it is imperative to explore the potential of indigenous plants like lemongrass in developing or innovating existing products. Lemongrass (*Cymbopogan citratus*) is a naturally fragrant tall sedge belonging to the Poaceae family (Lawrence et al., 2015). It has a wide range of medical applications, including the treatment of convulsions, digestive system spasms, fever, cough, vomiting, and high blood pressure.

The lemongrass plant has the potential to reach a height of up to 6 inches and has bulblike stems made up of terete and glabrous linearly spaced wrapped leaves with a narrow base and sharp tip (Olorunnisola et al., 2014). The leaf is around 100 cm high, yet it is just 2 cm wide. Squeezing the leaves produces a fragrant essential oil that might be yellow or amber (Tajidin et al., 2012).

Aside from its medicinal use, the aqueous extract of lemongrass is used as a natural flavoring for traditional foods (Ullah et al., 2020) and as an aromatic drink (Wifek et al., 2016) or herbal tea. Lemongrass herbal tea is usually prepared by boiling lemongrass and is naturally drunk without additional flavoring (Nambiar and Matela, 2012). The lemon grass tea infusion is light-colored with a mild lemongrass aroma (Mukherjee et al., 2024). In the study, lemongrass leaves extract, honey, and calamansi extract went through different processes to prevent undesirable changes in their sensorial and nutritional qualities, which are conveniently packed in polyethylene (PET) plastic bottles and ready to be sold.

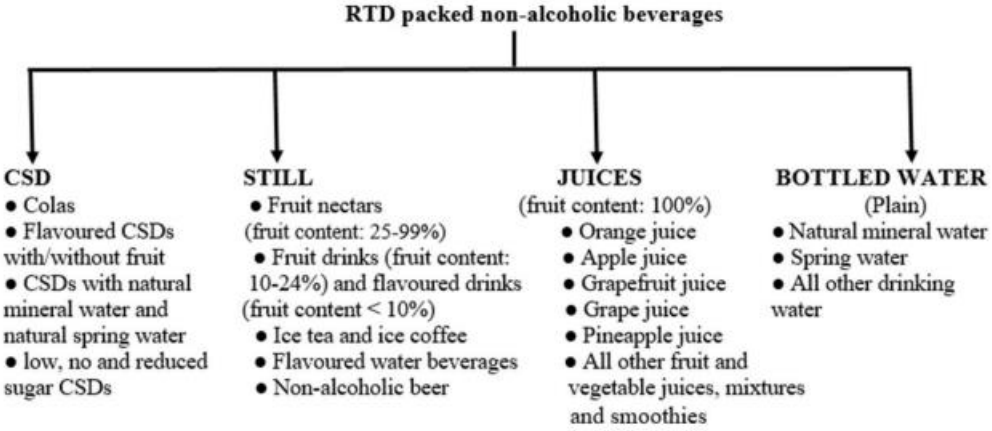

Figure 1. Industrial classification of ready-to-drink (RTD) packed non-alcoholic beverages (Tireki, 2021).

Tanglad is a kind of health drink that has been used for a long time because of its many health advantages. These benefits include acting as a cure for debility, hypertension, and overall bodily weakness, and debility. Lemongrass may treat stomach aches, flatulence, and indigestion (Ekpenyong et al., 2014). The decoction can also be used to treat indigestion. Research conducted by Asaolu et al. (2009) has shown that lemongrass has antioxidant properties. The essential oil component of *Cymbopogon citratus* includes citral, which has been shown to have antioxidant and anticancer characteristics (Sharma et al., 2021). In addition, Sambo et al. (2024) stipulate that lemongrass contains flavonoids, tannins, saponins, alkaloids, cardiac glycosides, and phenols. These are phytochemicals whose therapeutic effects have been established. Thus, the plant may serve as a source of these phytochemicals. In addition, lemongrass contains non-essential amino acids and all the essential amino acids, thus could serve as a source of these essential amino acids to life (Sambo et al., 2024). Hence, the lemongrass beverage has the potential to position itself as a nutritious alternative to carbonated beverages widely existing in the market, not just for children who go to school but also for members of the public.

According to a previous study by Nillos et al. (2017), tea made by decoction or infusion from fresh or dried lemongrass plants includes citral and many antioxidants. Research conducted by Muala et al. (2021) stipulates the conditions and preparations needed to attain a substantial quantity of antioxidants and citral on decoctions made from fresh lemongrass leaves. These studies were used as bases in the study by Nillos et al. (2017) of antioxidant activity, essential oil (citral) content determination, sensory evaluation, and market acceptability of various RTD lemongrass beverage formulations. The exact formulas for the Lemongrass beverage have already been determined, making it a candidate for the ready-to-drink category. In the study, lemongrass leaves extract, honey, and calamansi extract went through different processes to prevent undesirable changes in their sensorial and nutritional qualities, which are conveniently packed in polyethylene (PET) plastic bottles and ready to be sold.

The beverage market linked to healthier product composition will report for forty percent of the total consumer demand by 2025 (Nazir et al., 2019). This makes the market for functional beverages the category of functional foods with the highest compound annual growth rate (CAGR). Beverages may be made functional by including beneficial components such as vitamins, as well as by reducing or eliminating potentially harmful components such as sugar. Since the non-alcoholic beverage industry is mainly driven by its consumers, the trends that develop in terms of these components may be found internationally. More research needs to be conducted on the formulation and development of functional beverages. However, the market for packaged non-alcoholic beverages is large and is forecast to increase even more. Due to large consumption and demand volumes and health advantages, the creation of technically advanced beverages that include functional ingredients is expected to get more thought and interest from both the business world and academic institutions.

Using data from Statista (2020) that predicts volume, the global population prediction for 2025 was used to estimate the average per capita consumption in 2025. This estimate was 114.3 L, projected to have 24% forecasted demand for still beverages such as ready-to-drink bottled teas. Given this enormous trend on the forecasted

demand of still beverages in the market, it supports the notion that there is a vast market potential for the product development of non-carbonated beverages such as Lemon Grass Bottled Tea, which offers a healthier alternative beverage among consumers in the market.

The notion of customers' acceptance is grounded in the elements that influence the acceptability of food, which provides the theoretical concept for the study of consumer acceptance and market acceptability. The terms, such as preference, pleasure, selection, and consumption of a food product and its quality, are sometimes used interchangeably to refer to food acceptability. "Food acceptability" refers to various attitudes and behaviors toward food products. The selection and choice of food a person makes are affected by elements that arise from both the product and the individual (Martinez-Velasco et al., 2023). A model proposed by Wierenga (1983) that shows characteristics that impact the acceptance of food products was used in this research study, as shown in Figure 2. The framework illustrates that in the process of choosing a particular item from a class of food products, different product attributes may play a role. The overall product performance is the result of (1) the relevant perceptual dimensions and beliefs of the consumer concerning the product's performance on the relevant dimensions, as well as (2) how the consumer trades off these product dimensions against each other.

A fast-paced introduction of highly innovative product development initiatives is made available for purchase on the market. Developing new items and innovative ideas is fraught with danger since so many new products have yet to succeed after being introduced to the market. The product could initially only be available in a restricted quantity from the firm on the market. This practice is also known as "test marketing," its primary objective is to gauge the responses of potential customers regarding the demand for and acceptance of the product. This research offered an assessment of the lemongrass sensorial properties to assess the viability of the proposed product development in mass commercialization and market acceptability, which has the potential to become a healthier alternative drink for the public.

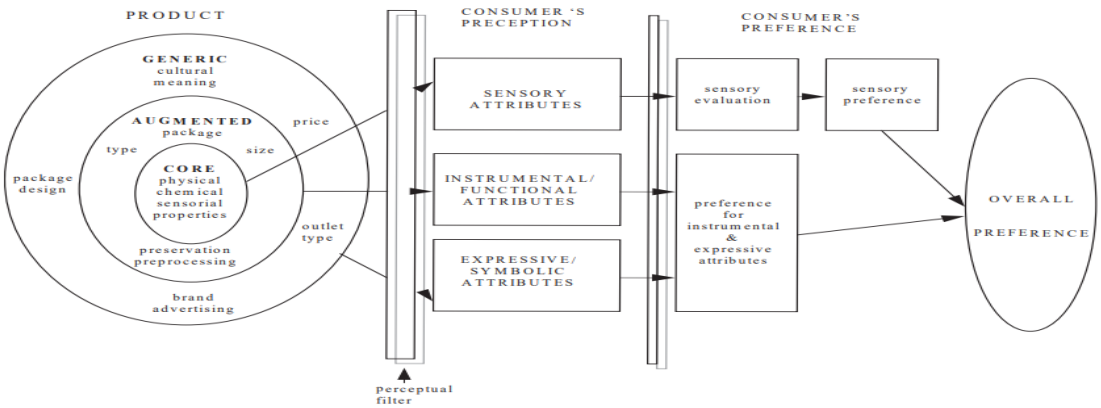

Figure 2. The formation of perceptions and preferences depends on the type of stimuli (Wierenga, 1983).

2.0 Methodology

2.1 Materials

The lemongrass (*Cymbopogon citratus*), honey, and calamansi extract were used in the study. The agricultural materials grow abundantly in Compostela, Davao de Oro, and are readily available in the public markets of Poblacion and nearby municipalities. Other materials used in the product prototyping process were sugar, distilled water, sodium benzoate (used as a food preservative), PET bottles, and product labels. On the other hand, the following equipment will be used to prototype the proposed product development: scissors, knives, chopping boards, pasteurizers, strainers, homogenizers, and bottle-capping machines.

2.2 Product Prototyping

The production of LGB Tea will undergo several processes, namely: the acquisition of raw materials, sorting, washing, slicing, the addition of other ingredients, which are calamansi concentrate and sugar, cooking/pasteurization and sterilization of the product, stirring, straining, bottling/labeling, cooling, and product

storage. Acquiring raw materials involves attaining the primary raw material, lemon grass. The lemon grass will then undergo a sorting process, removing discarded discolored parts. The remaining parts will be washed with water from a deep well. The water from the deep well source will be analyzed microbiologically through third-party analysis to prevent contamination and affirm its safety. The lemon grass will be manually sliced. The process will be done to extract more juices from the lemongrass. Then, boiled water will be prepared in the boiler at a temperature of 100°C, which will be used for tea extraction. The remaining ingredients, namely calamansi concentrate and sugar, will be added to the production of LGB Tea.

The following process flow was utilized during the proposed product development's prototype stage, namely the Lemon Grass Bottled Tea (LGB Tea), as presented in Figure 3.

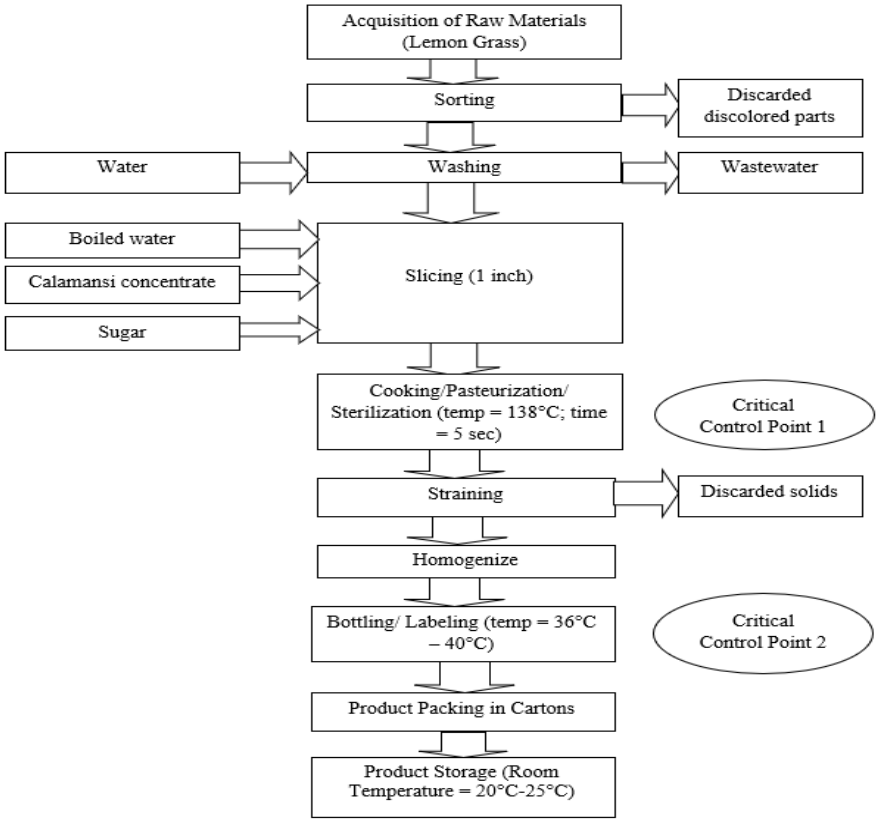

Figure 3. The process flow of Lemon Grass Bottled Tea (LGB Tea)

Cooking, pasteurization, and sterilization of the product will be done next. In this process, the product will be adequately cooked to attain the desired product. Simultaneously, the product will undergo pasteurization and sterilization at 138°C for 5 seconds to eradicate pathogenic microorganisms and to ensure the desired and longer shelf-life viability for the proposed beverage (Naz, 2018). The process will be identified as Critical Control Point 1 (CCP1) in the production since the process should be carefully conducted to safeguard the flavor and nutrients in the beverage product. After this procedure, no additional processes will be conducted to eradicate survivor microorganisms or product contamination. Due to the acidic nature of the product, only yeasts and molds can thrive in this environment. However, these fungi can be eliminated at elevated temperatures. It is, therefore, imperative to conduct this process cautiously.

The lemon grass utilized will be strained through a clean fine-mesh sieve and glass funnel to remove all solids and leave the tea in the boiler. The following process will be homogenizing the product to ensure that it will have a smooth texture. The product's homogeneity is vital since it will dictate the texture of the finished product. The product will be bottled using the ice tea processing machine, which is used for bottling, washing, ice tea filling, and capping the product. The packaging material will be labeled using the adhesive sticker bottle labeling

machine. The process was chosen as Critical Control Point 2 (CCP2) since proper bottling should be conducted to ensure product uniformity, especially in terms of volume or product content. The process is done at 36°C-40°C since the temperature range of yeasts and molds, the only possible contaminants, is between 10°C-35°C (Hutzler et al., 2012). The product will be packed in cartons serving as secondary packaging and ready for distribution. The undistributed products will be kept in the inventory and storage room for two weeks at room temperature. Solid waste and wastewater were also produced in the process.

2.3 Sensory Evaluation

Level 1 Sensory Evaluation – Establishing the Most Preferred Standard Formulation

To establish the most suitable product formulation for the proposed product development study, the following treatments and standard formulations will be utilized. As summarized in Table 1, these will undergo a sensory evaluation analysis to establish the most acceptable product formulation.

Table 1. Modified standard formulation of the proposed product development study

Raw Materials	Formulation 1		Formulation 2		Formulation 3		Formulation 4		Formulation 5	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Lemongrass Extract	20 ml	13.8	15 ml	10.8	20 ml	14.3	20 ml	13.3	20 ml	13.3
Calamansi Concentrate	10 ml	6.9	10 ml	7.1	5 ml	3.6	15 ml	10.0	10 ml	6.7
Sugar	10 g	6.9	10 g	7.1	10 g	7.1	10 g	6.7	10 g	6.7
Water	100 ml	69.0	100 ml	71.4	100 ml	71.4	100 ml	66.7	100 ml	66.6
Honey	5 g	3.4	5 g	3.6	5 g	3.6	5 g	3.3	10 g	6.7
TOTAL	145 ml	100	140 ml	100	140 ml	100	150 ml	100	150 ml	100

The revised standard product formulations for the proposed product development study are shown in Table 1. Two hundred panelists who are untrained in sensory evaluation will evaluate the samples. These panelists will represent diverse localities in the Davao de Oro province. The researchers will use a preference ranking test to evaluate each standard formulation's appearance, color, aroma, taste, and mouth feel. Then, they will determine which of the five treatments is the most preferable product formulation (1 will be the most preferred standard product formulation, and five will be the least preferred standard product formulation). The study's results will be analyzed using Analysis of Variance (ANOVA). If there is a significant difference, the Duncan Multiple Range Test (DMRT) will be carried out with a significance level of $p<.05$, and the means of the preference ranking test with the lowest rank regarding general acceptability will be utilized for the succeeding steps.

Level 2 Sensory Evaluation – Determining the General Acceptability of the Most Preferred Standard Formulation

Once the most preferred product formulation was determined during the level one sensory evaluation analysis, the level 2 sensory evaluation analysis. The most accepted product formulation will be tested for general product acceptability in this product development phase. In this test, an additional two hundred untrained panelists will be requested to determine the overall product acceptability of the most accepted product formulation by using the 9-point hedonic scale to evaluate the appearance, color, aroma, taste, mouth feel, and general product acceptability of the proposed product formulation of Lemon Grass Bottled Tea. This test will determine which product formulation has the highest level of general product acceptability. Once the recommended product formulation's general acceptability is determined and widely acceptable, the researchers will proceed to level three sensory evaluation.

Level 3 Sensory Evaluation – Preference Ranking of the most preferred Standard Formulation in comparison with Identified Competitors

The last part of the sensory evaluation analysis will be the preference ranking of the most preferred standard formulation compared to the identified competitors of the proposed product development. In this sensory evaluation, the researchers will utilize a preference ranking test requesting another two hundred untrained panelists to evaluate the appearance, color, aroma, taste, and mouth feel of each product sample (1 – the most preferred standard product formulation and 4 – product sample of identified competitors) and determine which among the five samples is the most preferable product by the respondents. The Analysis of Variance (ANOVA) will be used to analyze the result statistically. In the occurrence of a significant difference, the Duncan Multiple Range Test (DMRT) at $p<0.05$ will be used. The result of the ANOVA analysis will determine the position of the proposed product development concerning the existing competitors who offer the same product line in the market. Through this, the researchers can effectively identify and position the proposed product development to

identify the necessary interventions and potential marketing strategies for the product to become highly competitive once it is launched in the marketplace.

2.4 Interview and Survey Questionnaire

In this study, a structured questionnaire that was split into two sections was used. In the first phase of this analysis, the different product formulations of lemongrass bottled tea will be compared in terms of their color, scent, taste, intensity, and general acceptability as a product. This will be done using the five test samples. The 5-hedonic scales are used to conduct this analysis. A rating of one on the lower scale for the feature denotes a very light color, a too-light scent, a very light bitter aftertaste, and a very moderate strength. The top end of the scale of 5 represents the contrary: a very dark color, an overly aromatic and distinct perfume, an overly bitter aftertaste, and extreme intensity. The point on each scale where the qualities are "just right" corresponds to the center point of 3, regardless of the scale.

After evaluating the sensory qualities of the coded product samples, respondents were asked to rate the overall acceptability of the products. A fondness for this was assessed using a five-point Likert scale. On a scale of 1 to 2, "extremely disliked" and "disliked" are respectively represented, while on a scale of 4 to 5, "liked" and "extremely liked" are respectively represented. The midway point on the scale indicates that something is "neither liked nor disliked."

The second section of the questionnaire comprises demographics such as age, gender, education level, employment, annual income, and place of living. In addition, the respondents were questioned about the quantity of liquid they consumed, the location of their most recent purchase, and their top choice when purchasing bottled tea. Questions about health and general attitudes regarding bottled tea and lemongrass, as well as participants' readiness to purchase the goods if they were commercialized and made accessible on the market, were included in the remaining survey items.

2.5 Survey Implementation

The project leader will accompany the research assistant during the study. The research assistant will be expected to speak in the native tongues of the area and have a solid understanding of sensory evaluation procedures and interviewing techniques. Before the survey execution and the pre-testing phase, the enumerators will go through the appropriate training to perform the interviews that the research team has planned. The procedure is going to be looked at by the college's research ethics committee. Following the review and acceptance of the research, a preliminary version of the questionnaire will be used with a select group of respondents. Once the pilot testing is completed, the enumerators will report their experiences in the pilot implementation of the questionnaire, such as identifying unclear or poorly stated items and making ideas for changes. This will take place once the pilot testing has been completed.

2.6 Research Respondents

In the study, 200 untrained panelists from various Davao de Oro municipalities were asked to participate as research respondents. During the proper survey, the researcher/ enumerator thoroughly explains the question and conducts it one-on-one with the respondent. Respondents regardless of age, gender, or economic strata, who are willing to share their perceptions and acceptability of the proposed product development can participate in the survey. Moreover, respondents will not be forced if they do not want to be surveyed. Their engagement and participation in the study are voluntary, and the researchers will not push them to participate. Moreover, participants can withdraw their participation anytime without giving a reason or incurring any costs. A trained enumerator who could communicate with the respondents in their native language and collect data under research supervision.

The researcher will try to fully retain records of this study as the law allows. Any personally identifiable information gathered during this research will be kept strictly confidential unless it becomes essential to safeguard the respondent's rights or well-being. If the respondents give their approval, the researcher can prevent any identifying information about the respondents from being published or discussed at conferences since they will have the respondents' permission to do so.

Apart from this, the information obtained through the survey questionnaire will also be given due consideration during the study to establish the market acceptability of the proposed product development before technology adoption and mass commercialization. This research aims to contribute to the existing academic literature in the food product development discipline. The investigation never influenced any secondary interest, such as economic or academic interest or recognition. Hence, the confidentiality of the respondents will be maintained.

2.7 Data and Statistical Analysis

The information elicited from the survey will be analyzed and interpreted using percent descriptive statistics. The results of the sensory evaluation were tabulated. The model was used to determine lemongrass's color, flavor, and aftertaste, considering varied descriptors in different product formulations. The degree of acceptance of product attributes and the overall acceptability of the lemon grass bottled tea were determined using the mean of the ratings. To assess whether there are significant changes in the degree of acceptability of the traits detected between the samples being tested, an analysis of variance (ANOVA) was performed with repeated measurements using the Statistical Program for the Social Sciences (SPSS). These quantitative approaches emphasize objective measures and the statistical, mathematical, or numerical analysis of data obtained via polls, questionnaires, and surveys or by modifying already collected statistical data using computer techniques.

2.8 Ethical Consideration

As evidenced by the Davao de Oro State College Research Ethics Committee with certification number 386 – 07 - 2023, this study satisfied the requirements of all applicable ethical standards in research. Such certification covers the manner of gathering data from participants, which had extended to voluntary participation, compliance with the data privacy law, obtaining written informed consent from the respondents, and allowing respondents who would have wished to withdraw involvement in the study anytime with proper communication executed.

3.0 Results and Discussion

3.1 Respondents Characteristics

The characteristics of the respondents are summarized in Table 2.

Table 2. Descriptive characteristics of the research respondents

Variables (N=200)	Frequency	Percentage (%)
Sex		
Male	86	43
Female	114	57
Age		
18-20	32	16
21-25	72	36
26-30	58	29
31-35	24	12
36 above	14	7
Educational Attainment		
Elementary Undergraduate	2	1
Elementary Graduate	6	3
High School Undergraduate	12	6
High School Graduate	26	13
College Undergraduate	112	56
College Graduate	42	21
Income Level		
No Income	138	69
<P10,000.00	14	7
P10,001 – P20,000	8	4
P20,001 – P30,000	12	6
> P 30,000	28	14
Occupation		
Student	112	56
Teacher	42	21
Private Worker	30	15
Business Owner	12	6
Office Employee	4	2
Health Conscious		
Yes	174	87
No	26	13

Out of the 200 research respondents, 43% of the study participants are male, while 57% are female. There, 16% of the respondents fell into the age bracket for people aged 18–20 years old, 36% fell into the age bracket for people aged 21–25 years old, 29% fell into the age bracket for people aged 26–30 years old, 12% fell into the age bracket for people aged 31–35 years old, and 7% fell into the age bracket for people aged 35 years old and beyond. Regarding the respondents' places of employment, those who identify as students make up the most significant majority at 56%. This is to be expected mainly because the target market for the product will consist of individuals currently enrolled in primary, secondary, and higher levels of education. The occupations of the other respondents were as follows: 21% are teachers, 15% are workers from the private sector, 6% are company owners, and 2% are office employees.

Regarding the level of education attained by the respondents, 56% were either high school graduates or college undergraduates, 21% were college graduates, 13% were high school graduates, 6% were high school students, and 3% and 1% respectively were elementary school graduates and students. 14% of respondents reported a monthly personal income of more than P30,000.00, 6% reported an income between P20,001 and P30,000, 4% reported an income between P10,001 and P20,000, 7% reported an income of less than P10,000, and 69% reported having no income. 59% of those who participated in the survey said that they get their bottled tea from supermarkets, 23.5% from convenience shops (sari-sari stores), 11.5% from public markets, and 6% either prepare their teas or receive teas from friends and family.

3.2 Sensory Evaluation of the Lemongrass Bottled Tea

Table 3. Analysis of Variance for the overall product acceptability of the 5 different product sample treatments.

Source of Variation	Sum of Squares (SSE)	Degrees of Freedom (df)	Mean Square (MSE)	F-value	P-value
Treatments	102.7	4	25.69		
Error	955.2	995	0.960	26.65	<.0001
Total	1057	999			

Table 3 presents the findings of an analysis of variance performed to determine the acceptability of the lemongrass bottled tea from a sensory perspective, considering factors such as color, scent, taste, and level of potency or intensity. Respondents reported the predominant lemongrass sample formulation as having a light-yellow color. In contrast, lemongrass tea with varying quantities of honey and calamansi extract was described as having a color range from light yellow to golden yellow. Aroma ranged from "like very slightly" to "like very much," depending on the different product compositions. The flavor was bitter, with an intensity between moderate and vigorous. Regarding the general acceptability of the product, most respondents selected either "like moderately" or "like very much" as their rating. The analysis of variance (ANOVA) produced an F-value of 26.65 and a $p<.0001$, which indicated a significant difference in how the respondents viewed the five different product formulations or treatments.

3.3 Best Product Formulation

Due to the ANOVA result, which indicated a significant difference among the five product formulations of the lemongrass bottled tea, it is imperative to determine the most widely acceptable product treatments among the five samples. A preference ranking test through the Duncan Multiple Range Test (DMRT) was conducted to determine which among the five different product formulations is the most widely accepted product sample, as DMRT was commonly used in agricultural research and food product development studies (Midway et al., 2020). Results showed that treatment 5 was the most preferred product sample of the respondents. Table 4 shows the summary of the statistical analysis of the sensory evaluation.

Table 4. Duncan Multiple Range Test (DMRT) value of the 5 different product sample treatments.

Treatment	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
Rank Sum	500	696	856	508	440
Average Rank Sum	2.50	3.48	4.28	2.54	2.20
Rank Sum Difference with T5*	60	196	356	8	N/A
Relationship with T5*	NSD	SD	SD	NSD	N/A

*Treatment 5 was used as the benchmark for indicating significant difference as the most preferred product sample

The results summary of the preference ranking test among the five different product sample treatments is now presented in Table 4. Results showed that Treatment 5 got the lowest average rank sum at 2.2, indicating that this is the most preferred product formulation of the 200 sensory panelists. Furthermore, the relationship between treatment in comparison with other product treatments is also presented. Before establishing the relationship between treatments, the least significant difference (LSD) was computed first and was calculated at 81.17. Thus, any difference lower than LSD signifies no significant difference with the most preferred product treatment, while the difference higher than LSD signifies a significant difference with the most preferred product formulation.

Results showed that Treatment 5 is significantly preferred over Treatments 2 and 3, but shows no significant difference with Treatments 1 and 4, respectively. This implies that Treatments 2 and 3 possess moderate lemongrass flavor, although a varied consumer panel acceptability was observed. This result may be due to the obscured effect of the color of the product sample, as it was established that a darker color is associated with a more robust lemongrass flavor (Spence & Levita, 2022). Thus, Treatments 2 and 3 were liked slightly in terms of the strength of the lemongrass flavor, which is perceived as having a darker color and a moderately strong lemongrass flavor.

Meanwhile, other treatment samples were liked very much, indicating the significant difference between Treatments 1, 4, and 5 towards Treatments 2 and 3, respectively. The results also suggest that the calamansi concentrate effect on the product formulation is vital in masking off the odor and flavor of the lemongrass on the most preferred product treatment. Whereas, those product treatments that established a significant difference with Treatment 5 had a lower concentration of calamansi concentrate, thereby exposing the profound odor and flavor of the lemongrass due to the presence of aromatic oil such as citral aroma as the principal constituent (Aragon & Jao-jao, 2023). The citral component is composed of geranial and neral. Geranial has a strong lemon odor, while the neral has a weaker but sweeter odor than the geranial; both are insoluble in water (Tajidin et al., 2012).

3.4 Overall Product Acceptability of the Most Preferred Product Treatment

Table 5. The overall product acceptability of the most preferred product treatment.

N = 200	Yes (n = 195)		No (n=5)		Statistical Analysis
Sex					
Male	83	96.51%	3	3.49%	$\chi2$ =0.605, df=1
Female	112	98.25%	2	1.75%	
Age					
18-20	32	100.00%	0	0.00%	$\chi2$ =14.138**, df=4, p<.05
21-25	72	100.00%	0	0.00%	
26-30	57	98.28%	1	1.72%	
31-35	22	91.67%	2	8.33%	
36 above	12	85.71%	2	14.29%	
Educational Status					
Elementary Undergraduate	2	100.00%	0	0.00%	$\chi2$ =10.867, df=5
Elementary Graduate	6	100.00%	0	0.00%	
High School Undergraduate	12	100.00%	0	0.00%	
High School Graduate	26	100.00%	0	0.00%	
College Undergraduate	111	99.11%	1	0.89%	
College Graduate	38	90.48%	4	9.52%	
Income Level					
No Income	138	100.00%	0	0.00%	
<P10,000.00	14	100.00%	0	0.00%	$\chi2$ =21.734**, df=4, p<.05
P10,001-P20,000	8	100.00%	0	0.00%	
P20,001-P30,000	11	91.67%	1	8.33%	
>P30,000.00	24	85.71%	4	14.29%	
Occupation					
Student	112	100.00%	0	0.00%	
Teacher	38	90.48%	4	9.52%	$\chi2$ =11.868**, df=4, p<.05
Private Worker	29	96.67%	1	3.33%	
Business Owner	12	100.00%	0	0.00%	
Office Employee	4	100.00%	0	0.00%	
Health-conscious					
Yes	169	97.13%	5	2.87%	$\chi2$ =0.766, df=1
No	26	100.00%	0	0.00%	

The most acceptable product formulation (Treatment 5) from the various product treatments tested for the preference ranking test was then subjected to an overall product acceptability test. The same 200 panelists who conducted the preference ranking test were asked about the overall general product acceptability of the most preferred product treatment. Table 5 below summarizes the results.

A total of 195 respondents signified that the most preferred product treatment is generally acceptable (Table 5). Most of the respondents have positive acceptance of the product sample from age 18-30 years old (161), females (112), students (112), and health-conscious (169). The overall product acceptance was significantly associated with age ($\chi2 = 14.138$, $p<.05$), income level ($\chi2 = 21.734$, $p<.05$), and occupation ($\chi2=11.868$, $p<.05$) but not with sex, educational status, and health-consciousness. The results indicate that among the demographic factors that show significant differences in terms of the overall product acceptability, age, income level, and occupation status can be considered determinants of the overall market acceptability of the product. Based on the given results, the potential target market of the proposed product offering is the students or the younger population trying to consume products considered a healthier alternative.

3.6 Sensory Evaluation of the Lemongrass Bottled Tea with Competitors

Table 6. Analysis of Variance for the overall product acceptability of lemongrass bottled tea and 3 other competitors.

Source of Variation	Sum of Squares (SSE)	Degrees of Freedom (df)	Mean Square (MSE)	F-value	P-value
Treatments	4.102	3	1.034		
Error	358.2	796	0.450	2.297	.065
Total	362.302	799			

The results of the sensory evaluation of the lemongrass bottled tea considering color, aroma, taste, strength or intensity, and overall product acceptability using ANOVA in comparison with identified competitors are given in Table 6. The ANOVA resulted in an F-value of 2.297 and p=.065, which resulted in no significant difference between how the respondents perceived the most preferred product formulation of lemongrass bottled tea and existing competitors in the marketplace. The ANOVA table summary is presented in Table 6.

Table 6 shows no significant differences between the most preferred product formulation of lemongrass bottled tea and three other existing competitors. The main contributor to this result can be attributed to the presence of calamansi concentrate in the product formulation of LGB Tea. Existing competitors offer calamansi based bottled tea. Since the calamansi concentrate in the LGB Tea masks the odor and flavor of the lemon grass, the respondents no longer perceived the presence of such a component in the product sample, leading to no significant difference in result. Furthermore, the distinctive aromatic and essential oils in LGB Tea make it more preferred than its identified competitors since the main ingredient of those products is the calamansi concentrate.

3.7 Market Acceptability

Results showed that 190 respondents were willing to buy the lemongrass bottled tea product (Table 7). Most of the respondents willing to buy were aged 21 to 30 (160), females (110), students (112), and health-conscious (170). The willingness to buy the product was significantly associated with age ($\chi2 = 29.021$, $p<.05$), income level ($\chi2 = 44.612$, $p<.05$), and occupation ($\chi2 =20.351$, $p<.05$) and health-conscious individuals ($\chi2 =20.559$, $p<.05$), but not with age and educational status. The results suggest that the proposed lemon grass-bottled tea will be widely accepted among students and young professionals who are health enthusiasts looking for an alternative ready-to-drink bottled tea that leans towards healthier RTD beverage options.

Possible marketing strategies of Lemon Grass Bottled Tea include promotion of the product during Research and development events such as Techno Exhibits; including the product at catering services during college-wide special events and office meetings; participating in trade fairs such as in Department of Trade and Industry (DTI); serving the product daily in kiosks at school canteens, and advertising the product at the DDOSC website through the Production Services Division. This entails a united effort among crucial offices of the College, e.g., Research and Development Division (RDD) and Production Services Division (PSD).

It is vital to stress the benefits of Lemon Grass Bottled Tea to ensure that the advantages of the proposed RTD product outweigh the cost. This product is distinguished from similar beverages on the market by the presence of

various phytochemicals, or plant compounds, given by three different components. These phytochemicals offer more health advantages than those offered by competing beverages. Phytochemicals extracted from lemongrass tea have been shown to contain anticancer (Dolghi et al., 2021; Trang et al., 2020), anti-inflammatory (Kiani et al., 2022; Sousa et al., 2021), and antioxidant effects (Pan et al., 2022). Additionally, calamansi has Vitamin C and polyphenols that act as antioxidants (Xin et al., 2022).

Table 7. The willingness to buy of LGB Tea's most preferred product treatment.

N = 200	Yes (n = 190)		No (n=10)		Statistical Analysis
Sex					
Male	80	93.02%	6	6.98%	$\chi2$ =1.241, df=1
Female	110	96.49%	4	3.51%	
Age					
18-20	32	100.00%	0	0.00%	$\chi2$ =29.021*, df=4
21-25	72	100.00%	0	0.00%	
26-30	56	96.55%	2	3.45%	
31-35	20	83.33%	4	16.67%	
36 above	10	71.43%	4	28.57%	
Educational Status					
Elementary Undergraduate	2	100.00%	0	0.00%	$\chi2$=6.704, df=5
Elementary Graduate	6	100.00%	0	0.00%	
High School Undergraduate	12	100.00%	0	0.00%	
High School Graduate	26	100.00%	0	0.00%	
College Undergraduate	107	95.54%	5	4.46%	
College Graduate	37	88.10%	5	11.90%	
Income Level					
No Income	138	100.00%	0	0.00%	
<P10,000.00	14	100.00%	0	0.00%	$\chi2$ =44.612*, df=4
P10,001-P20,000	8	100.00%	0	0.00%	
P20,001-P30,000	8	66.67%	4	33.33%	
>P30,000.00	22	78.57%	6	21.43%	
Occupation					
Student	112	100.00%	0	0.00%	
Teacher	35	83.33%	7	16.67%	$\chi2$ =20.351**, df=4
Private Worker	27	90.00%	3	10.00%	
Business Owner	12	100.00%	0	0.00%	
Office Employee	4	100.00%	0	0.00%	
Health-conscious					
Yes	170	97.70%	4	2.30%	$\chi2$ =20.559**, df=1
No	20	76.92%	6	23.08%	

*p<.05

4.0 Conclusion

Based on the results, it is now concluded that honey and calamansi-flavored lemongrass bottled tea consisting of 66.67% water, 13.33% lemongrass extract, 6.67% honey extract, 6.67% sugar, 6.67% calamansi extract, and 0.1% sodium benzoate is the most preferred product treatment. A total of 195 out of 200, or 97.5% of the respondents, signified that the most preferred product treatment is generally acceptable regarding overall product attributes. Most of the respondents have positive acceptance of the product sample from age 18-30 years old (161), females (112), students (112), and health-conscious (169). The overall product acceptance was significantly associated with age ($\chi2$ = 14.138, p<.05), income level ($\chi2$ = 21.734, p<.05), and occupation ($\chi2$=11.868, p<.05) but not with sex, educational status, and health-consciousness. Meanwhile, there were no significant differences between the most preferred product formulation of lemongrass bottled tea and three other existing competitors. Furthermore, results showed that 190 out of 200 or 95% of the respondents signified that they would buy the lemongrass bottled tea product. Most of the respondents willing to buy were aged 21 to 30 (160), females (110), students (112), and health-conscious (170). The willingness to buy the product was significantly associated with age ($\chi2$ = 29.021, p<.05), income level ($\chi2$ = 44.612, p<.05), and occupation ($\chi2$ =20.351, p<.05) and health-conscious individuals ($\chi2$ =20.559, p<.05), but not with age and educational status. Lastly, with intensive marketing campaigns and initiatives for the proposed product offering, lemon grass bottled tea can compete with the existing brands that are currently offering ready-to-drink drinks in the beverage industry.

This research study contributes to the existing body of knowledge in food processing and agribusiness. The development of value-added products, such as Lemon Grass Bottled Tea, creates new market opportunities and economic benefits for farmers and producers. Furthermore, understanding consumer demand and market trends for the development of lemongrass bottled tea can guide tanglad farmers and producers in developing strategies to expand market reach and profitability.

The result of this study focuses on the product development and market potential of Lemon Grass Bottled Tea. However, this study recommends areas for future study. First, the nutritional content of the most accepted product formulation is not yet established. The nutritional content of the product is essential as it is one of the requirements needed by the Food and Drug Administration for product labels. In addition, the conduct of the shelf life study of the proposed product is essential to determine the product's viability for human consumption to ensure consumer safety. Further studies such as microbiological assays and chemical analysis are also recommended for future research.

5.0 Contributions of Authors

The following are the contributions of each author, presented as follows:
Jade Mark C. Salubre - Research design, participant selection, data gathering, drafting of manuscript, and data analysis.
Jennifer T. Pelegrino - Data gathering and drafting of the manuscript
Juma P. Wabinga - Data gathering and statistical analysis
Juanita C. Leopoldo - Data gathering and ensuring compliance with research ethics protocols

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7.0 Conflict of Interests

The authors declared that there is no potential conflict of interest in any form about this study, authorship, and publication of the same.

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