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Research Article

Optimizing Cashew-Pineapple Juice with Lemongrass through Sensory Evaluation

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Abstract - *This study aimed to evaluate the sensory acceptability of Cashew-Pineapple Juice Enriched with Lemongrass formulated in varying proportions of cashew apple and pineapple juices. Specifically, it sought to determine the most acceptable blend in terms of sweetness, sourness, and aftertaste. Three formulations were prepared: Proportion A (75 g cashew apple juice and 25 g pineapple juice), Proportion B (50 g cashew apple juice and 50 g pineapple juice), and Proportion C (25 g cashew apple juice and 75 g pineapple juice). A panel of evaluators assessed the samples using a 9-point hedonic scale, and the data were analyzed through Analysis of Variance (ANOVA) and Scheffé's Post-Hoc Test at a 0.05 level of significance. Results revealed that Proportion C obtained the highest mean ratings across all sensory attributes sweetness ($\bar{x}$ = 8.33), sourness ($\bar{x}$ = 8.20), and aftertaste ($\bar{x}$ = 7.55) all described as "Liked Very Much." Statistical analyses confirmed significant differences among the three formulations ($p < 0.05$), with Proportion C being significantly more acceptable than Proportions A and B. Findings indicate that a higher pineapple content enhances the juice's sweetness, provides a balanced sourness, and contributes to a pleasant aftertaste. Furthermore, the addition of lemongrass imparted a refreshing citrus aroma that complemented the fruit blend, improving the overall flavor profile. The study concludes that the most desirable formulation is the mixture containing 25 grams of cashew apple juice and 75 grams of pineapple juice, as it achieved optimal sensory balance and consumer acceptability. This formulation may serve as a potential standard in developing a nutritious and palatable tropical fruit beverage.*

Keywords - *Cashew apple juice, Fruit juice acceptability, Lemongrass enrichment, Pineapple juice, Sensory evaluation*

I. INTRODUCTION

According to the United Nations (2023), the world's population is projected to reach 9.8 billion by 2050, a figure approximately 20% higher than it is today. This exponential increase, combined with continuous climate change, water shortages, and diminishing agricultural land, creates societal and global issues that pose a threat to future food production. With the exponentially growing human population, the global demand for food is increasing year after year. Auxiliary to this, in 2021, the Food and Agriculture Organization (FAO) reported that with the current global diet trends, several million tons of food are lost and wasted every year. Statistics reveal that 14 percent of food valued at an estimated $400 billion is lost globally in various stages of the food chain, including production, post-harvesting, processing, and distribution. These staggering figures indicate that food loss and waste currently represent a pressing issue in the design of sustainable food systems. This condition has a negative impact on food security and nutrition, contributes significantly to greenhouse gas emissions, environmental pollution, natural ecosystem degradation, and biodiversity loss, and represents a waste of resources utilized for food production (UN, 2021). In the agriculture field, post-harvesting, processing, distribution, and consumption could generate agricultural by-products that are wasted in huge amounts, which can contribute to the food waste problem. Fruits and vegetables are the most commonly consumed horticultural commodities because of their nutrients and health-promoting substances. To meet the rising demand for these horticulture crops, production and processing have expanded dramatically which resulting in significant losses and waste. In fact, statistics have shown that approximately 45% of fruits and vegetables are wasted worldwide, making it one of the categories with the highest wastage rate (FAO, 2021). According to the United Nations Environment Programme (UNEP, 2021), losses and waste in fruits and vegetables are estimated to be the highest

among all types of foods, and their processing operations produce significant waste by-products, which account for approximately 25% to 30% of the whole commodity group. These statistics clearly demonstrate that food concerns and sustainability are inseparable, and thus, immediate measures to minimize them should be taken. Hence, it will be imperative to develop strategies and ways for producing more food and better food with less waste. As a result, efficiently utilizing food wastes, such as vegetable and fruit by-products, could be a way to improve food sustainability while also aligning with the United Nations Sustainable Development Goal (SDG) to ensure sustainable consumption and production patterns.

Fruits are essential components of a healthy diet due to their content of vitamins and minerals, fiber, and beneficial non-nutrient substances as bioactive compounds. The World Health Organization (WHO) recommends ingestion of at least 400 g (about five portions) of fruits and vegetables per day. Fruits intake is among the pillars of a healthy lifestyle and it has been prescribed to the general population so that the risk of developing diseases that cause early mortality rate is reduced globally. The person consumes little fruit, in turn, is among the key risk factors in the development of cardiovascular disease and cancer, the two most frequent causes of mortality, which claim 27.5 million lives in 2020 World Health Organization (WHO). Thus, it is believed that the sufficient consumption of fruits is the necessary choice in terms of preventing illnesses and preserving good health. In addition, Agarwal (2019) indicated that an increased consumption of fruits is usually correlated with an improved nutritional value and the overall health. On the same note, an adequate intake of fruits has been correlated in epidemiological studies to decreased risk of many noncommunicable diseases. Philippines being a tropical archipelago has a climate so favorable to the production of various types of fruits with most of them being valuable sources of livelihood and export revenue to the nation. Its rich soil, heavy rainfall and conducive temperature ensures that fruits are produced throughout the year thus the Philippines is one of the most productive countries in the south east of Asia. Fruits in the country are not only a domestic product, but they are also a major contributor to the national economy with some of the export products being bananas, coconuts, pineapples, mangoes, and papayas. The fruits have earned international acclaim due to their quality, taste and nutritional value which are boosting the reputation of the Philippines in terms of large production of tropical fruits.

Among the provinces contributing to the nation's agricultural output, Palawan stands out as a region of great ecological and economic significance. Renowned as the "Last Ecological Frontier of the Philippines," Palawan is widely celebrated for its pristine natural landscapes, diverse ecosystems, and rich marine resources. However, beyond its tourism appeal, Palawan is also emerging as one of the country's most promising agricultural provinces. It has fertile lands with good climatic conditions to allow the cultivation of a wide variety of crops including rice, coconut, papaya, pineapple, and the specialty of the region cashew. Agriculture is still an important economic factor in the locality as it is one of the main revenue streams of most rural communities and it is part of the sustainable development objectives of the province. Cashew (Anacardium occidentale), also called locally as kasoy, is a perennial tropical tree, which is highly appreciated not only due to its nuts, but also its pseudo fruit, the cashew apple. This tree grows well in sandy beaches and forested regions proving to be very resilient in tough and dry spots. The cashew tree has ecological merits in addition to its economic worth which includes stability of the soil and prevention of erosion along the coastal regions. Cashew is a traditional cash crop extensively grown in the Philippines especially in the areas with dry tropical climate. According to the Philippine Statistics Authority (2019), the country is one of the largest producers of cashew in the world, and annually it produces more than 27,000 metric tons.

Palawan, in particular, has been recognized as the country's "Cashew Capital," a title earned through decades of consistent production and cultivation. Approximately 90% of the Philippines' total cashew yield is attributed to the province, making it the primary source of raw nuts and cashew apples for local processing and distribution. Cashew farming in Palawan is deeply embedded in local culture and livelihood practices, with many smallholder farmers engaging in both traditional and semi-modern production methods. In addition to its economic importance, the cashew industry contributes to the promotion of agri-tourism in the province, as visitors often associate Palawan not only with its scenic beaches and biodiversity but also with its distinctive cashew-based delicacies and products.

Despite being the country's leading producer of cashew, the problem of low income is still experienced by many of Palawan's cashew farmers. This was partly attributed to the underutilization of the cashew fruit since only the nuts were utilized. Presently, only the nut is given attention by cashew growers as it commands a good demand in the market among domestic consumers. The nuts are then processed by roasting, salting, or boiling before being consumed as a snack or used as an ingredient in a variety of cuisines, while the cashew apple flesh is rarely eaten fresh due to its severe astringency. As a result, when the nuts were extracted, the cashew apple, which accounts for 90% of the cashew fruit, was discarded. As a consequence, the cashew apple becomes waste material in the cashew nut processing industry. Nonetheless, although cashew apple is often overlooked as a food and commodity, it is a good source of protein, carbohydrates, crude fiber, minerals (calcium, magnesium, potassium, sodium, phosphorus, copper, zinc, and iron), vitamins (vitamin C and vitamin B complex), and bioactive components such as phenolic acids, flavonoids, tannins, and carotenoids (FAO, 2021). Given the nutritious benefits of cashew apples, cashew apple processing should be viewed as an agricultural waste management program that generates revenue for farmers.

Cashew apples have long been the subject of scientific research aimed at improving their microbiological, nutritional, and therapeutic properties. It provides nutritional value due to its high levels of vitamin C and magnesium. Furthermore, cashew apple juice contains 5 times more vitamin C than orange juice and 10 times more vitamin C than pineapple juice (Oliveira et al. (2012) . Moreover, the high concentration of essential vitamins and minerals present in cashew apples makes them a valuable resource for addressing micronutrient deficiencies (Agbangnan et al., 2015). However, despite its high nutritional potential, most of its production is abandoned at harvest sites. Also, because cashew apple is rich in astringency components, its consumption is limited, and it is a very perishable product with a short shelf-life after harvest. With these, cashew apple is often discarded after harvest or used as fertilizers, narrowing the economic value of the cashew industry and contributing to the accumulation of agricultural waste.

Moreover, Palawan is widely recognized for its abundance of tropical fruits, many of which are processed into flavorful and healthy juices. The province's tropical climate and fertile soil make it an ideal place for growing a wide range of fruit varieties used in juice production. One of these includes pineapple which is one of the major agricultural products in the southernmost part of Palawan. Pineapple (Ananas comosus) is a tropical fruit which is famous due to its characteristic odor and sweet taste. It is appreciated due to its high concentration of volatile compounds that make it taste impressive. Besides the fact that pineapple has got a very pleasant taste, the fruit is a powerful source of important vitamins and minerals that have numerous health benefits. It contains fiber, enzymes and other nutrients that aid in good digestion, maintain a healthy body weight and offer balanced nutrition, just like other fruits. Pineapple contains high amounts of Vitamin C, low fat, sodium and has no cholesterol. It is also a very good source of vitamins and minerals that have many health benefits (Mohd Ali et al., 2020). Studies have also suggested that it may help protect against cancer, prevent blood clots, and promote heart health.

During recent years, the demand for beverages prepared from fruit juices has increased substantially, which may be related to changes in dietary habits, increased health awareness, flavor preferences, and the style of life of today's consumers. However, despite having outstanding nutritious properties, the utilization of some fruits for consumption is limited due to their high acidity, astringency, bitterness, and other aspects. As a result, combining two or more fruit juices to make a ready-to-serve beverage may be a desirable and cost-effective way to use such fruits. Corollary to this, research studies have shown that blending fruit juices significantly improved the nutritional quality and palatability (Sobhana, et al, 2015; Das & Arora, 2017). In line with this, it captured the researcher's interest to blend cashew apple, which is usually discarded and regarded as waste material, with pineapple juice to form a beverage with high nutritional value and palatability. However, it is the researcher's belief that adding another salient ingredient to this blended cashew apple and pineapple juice will significantly boost its nutritional content. Lemongrass (Cymbopogon citratus) is a rhizomed, densely tufted, fibrous rooted perennial tall grass, which is aromatic. Lemongrass is a fortified source of fiber, carbohydrates, Vitamin A, B, C, as well as boosts the immune system, tissue damage repair, and cell division, magnesium, required in protein synthesis, glycolysis, and muscle activity, selenium, needed in cognitive functions and fertility, phosphorus,

which is needed in DNA/RNA and cell membrane synthesis, and zinc, which is needed in wound healing, normal growth, and development (Villalobos, et al., 2020). Lemongrass is said to be antibacterial, antifungal and has been used traditionally as a pain reliever and a fever reliever. Due to all positive features which lemongrass may offer, the researcher concludes that it may be a flexible ingredient which can be mixed with the cashew apple and pineapple juice to form tasty and healthy beverages. The proposed food innovation will be aligned with Sustainable Development Goal (SDG) goal 12.3 that seeks to promote sustainable production and consumption and minimize food losses through production and supply chains, including losses through post-harvest phases. Thinking along these lines, fruit beverages can be a valuable carrier for providing additional health benefits by being fortified with functional ingredients. Therefore, there is a good opportunity to use ingredients like cashew apple, pineapple, and lemon grass to improve its sensory characteristics and palatability. Hence, this becomes the impetus of this proposed study.

II. MATERIALS AND METHODS

A. Research Design

To address the questions raised in this study, a quantitative research design specifically a true-experimental design was employed. This method was used to evaluate the acceptability of cashew-pineapple juice enriched with lemongrass among the target consumers. Experimental research was used as the method whereby an experimental variable was manipulated with other variables being controlled. This design covered every study that had one or more experimentsally manipulated independent variables and one dependent or outcome variable. Similarly, the experimental design offered a framework of testing a hypothesis in a systematic manner.

Moreover, the application of this method demonstrated the effectiveness of food enrichment in improving the nutritional quality of food products and addressing nutrient deficiencies among populations. Experimental research in food science entailed the analytical study of properties and behavior of food, and the reactions and interactions that took place during food processing, storage and consumption. It also employed analytical methods, sensory tests and different physical and chemical measurements.

In the context of this study, experimental research was applied to develop and optimize innovative food enrichment strategies. As explained, food enrichment was the concept that involved improving food products in terms of nutritional value or functionality by adding nutrients or other useful ingredients. Thus, the research design was utilized to identify the effectiveness of food enriched and find out the acceptance of the enriched product by consumers with respect to sensory properties including aroma, appearance and color, taste, and texture. Further, this approach was vital for developing and refining food enrichment strategies that improved the nutritional and sensory qualities of food products while maintaining their overall acceptability and quality.

B. Respondents of the Study

In the context of this study, the researcher believed that it was essential to examine the trends and patterns of product acceptability from the perspectives of both teachers and students. Thus, the participants of the research were 50 full-time faculty members and full-time students of one state university in the Philippines. These were the taste panel who were selected using a simple random sampling method in order to provide a rational and equitable representation of the population. One of the probability sampling techniques is the simple random sampling, which is a statistical approach whereby a sampling of a population is done in a manner that the members of the population have equal probability of being sampled. The approach was considered suitable in the study as it reduced the selection bias as well as making each member of the population have an equal chance of being selected. It was also practical and effective, particularly when the population size made it difficult to include all potential respondents.

The fifty randomly selected respondents rated the cashew-pineapple juice that had lemongrass added to it based on the pre-established sensory characteristics, which were aroma, appearance, color, taste, texture, and acceptability. It was also practical and effective, particularly when the population size made it difficult to include all potential respondents.

C. Instrument

To gather the necessary data for this study, a written questionnaire was administered to the respondents to assess and evaluate the tropical juice enriched with cashew apple juice. The questionnaire incorporated a 9-point Hedonic Scale, which measured the respondents' level of acceptability toward the cashew-pineapple juice enriched with lemongrass based on specific sensory parameters such as appearance, aroma, color, and taste.

The hedonic scale is a well-established rating tool in sensory evaluation used to measure individuals' subjective responses to various stimuli, including food and beverages. It measures the extent of pleasure or liking otherwise known as the hedonic tone an individual will exhibit which he or she experiences when exposed to a given product. The hedonic scale normally uses a numerical scale to describe the degree of likes or dislikes with the two ends of the scale being a description of the extreme ends of preference. A 9-point scale was used in this study with a scale of 1 to 9, where 1 was extreme dislike, 5 was neither like nor dislike, and 9 was extreme liking. In the evaluation, the respondents rated the samples of the juice and were asked to select a number on the scale that best depicted their degree of liking each sensory attribute. The information gathered with the help of these ratings helped to state the general acceptability of the product and to recognize which of sensory properties was the most important in the tastes or repulsions of the respondents. Furthermore, each sensory attribute taste (sweetness, sourness, and aftertaste) was assigned a corresponding numerical value by the evaluators, which served as the basis for the statistical analysis of the product's acceptability.

D. Data Gathering Procedure

In this study, the researcher employed four main phases to ensure a systematic and organized research process. The first phase involved the preparation and extraction of cashew apple, pineapple, and lemongrass, during which the raw ingredients were carefully cleaned, processed, and extracted to obtain their respective juices and essences. The second phase was dedicated to the preparation of the experimental setup, i.e., the preparation of the cashew-pineapple juice with the addition of lemongrass according to the standard procedures to be consistent and accurate across all the samples. The third step involved the testing and reviewing of the product in terms of its acceptability through the 9 point Hedonic Scale.

In this phase, the respondents rated the cashew-pineapple juice enriched with lemongrass depending on the pre defined sensorial attributes like taste (sweetness, sourness and aftertaste). The sensory analysis presented quantitative data that gave the perceptions and preference of the respondents on the product. Finally, the fourth stage was the analysis of the acceptability ratings of the respondents based on the criteria given. The data gathered from the evaluation were statistically analyzed to determine the overall level of consumer acceptance and to identify which sensory attributes had the most significant influence on the product's appeal.

E. Data Analysis Treatment

Consistent with the true-experimental research design to be adopted in this proposed study, the researcher employed both descriptive and inferential measures. Descriptive statistics such as measures of central tendency and variability were used to describe the respondents' acceptability of the cashew-pineapple juice enriched with lemongrass.

On the other hand, Analysis of Variance (ANOVA) will be used for inferential analysis. This statistical indicator will be employed to identify the high level of differences on overall acceptance and acceptance of appearance, aroma, color, taste, and texture of the enriched cashew-pineapple juice with lemongrass. ANOVA is a statistical test to determine the difference between two or more groups or treatments of a specific study. Scientific studies normally apply it to know whether there exist statistically significant differences among the means or averages of more than two samples. This is an effective statistical tool of comparing differences across groups or treatments in a research. It enables the researcher to test the hypothesis and draw inferences regarding the means of the population using sample data. Nevertheless, one has to be cautious about the assumptions of ANOVA, including the assumption of normality and the assumption of homography of variance, and should interpret the results carefully. Moreover, the Post-Hoc analysis, in particular, the Scheffé test was also used to test the differences further. Furthermore, all inferential analyses were analyzed using Statistical Package for Social Sciences, tested at 0.05 level of significance.

III. RESULTS AND DISCUSSION

This section discusses the mean ratings of the Cashew-Pineapple Juice Enriched with Lemongrass in different proportions in terms of taste, as to sweetness, sourness, and aftertaste, as evaluated by the respondents.

Table 1. Mean Rating of the Cashew-Pineapple Juice Enriched with Lemongrass in different Proportion in Terms of Taste (Sweetness)

Proportion	Mean Rating	Description	Sd
Proportion A – 75 grams cashew apple Juice & 25 grams pineapple Juice	6.55	Liked moderately	1.28
Proportion B - 50 grams cashew apple Juice & 50 grams pineapple Juice	7.13	Liked moderately	1.50
Proportion C - 25 grams cashew apple Juice & 75 grams pineapple Juice	8.33	Liked very much	0.82

Legend							
8.50 – 9.00	liked extremely		5.50 –6.49	liked slightly		2.50 –3.49	disliked moderately
7.50 – 8.49	liked very much		4.50 –5.49	neither liked nor disliked		1.50 –2.49	disliked very much
6.50 – 7.49	liked moderately		3.50 –4.49	disliked slightly		1.00 – 1.49	disliked extremely

The results of the sensory evaluation revealed notable variations in the acceptability levels of the different formulations of cashew-pineapple juice enriched with lemongrass. Among the three proportions tested, Proportion C ($\bar{x}$ = 8.33) obtained the highest mean score and was evaluated by the respondents as "Like Very Much." In contrast, Proportion B ($\bar{x}$ = 7.13) and Proportion A ($\bar{x}$ = 6.55) both received the descriptive rating of "Like Moderately." This indicates that while all formulations were generally acceptable to the evaluators, the beverage with a higher pineapple content (Proportion C) stood out as the most preferred in terms of overall sensory quality and taste balance.

The findings suggest that the pineapple component played a significant role in enhancing the overall palatability of the cashew-pineapple juice. The trend has shown that there is a direct correlation between pineapple juice percentage and the degree of consumer acceptability, especially with regard to sweetness of the drink. In the same way that the pineapple content was higher, the pleasantness of the flavor profile was also perceived to be higher. This means that the natural sugars and acidity of pineapple contributed to counteracting the harshness of the cashew apple that is sometimes too astringent and made the drink more refreshing and enjoyable to drink. The enhanced sweetness and improved aroma contributed to the product's higher acceptability, confirming that formulation adjustments involving pineapple concentration are essential for optimizing sensory appeal.

In the context of this study, the formulation prepared with 25 grams of cashew apple juice and 75 grams of pineapple juice emerged as the most acceptable formulation among the three variants. This particular blend offered a harmonious balance between the distinct fruity sweetness of pineapple and the mild, tangy character of cashew apple, complemented by the subtle citrus notes imparted by lemongrass. The respondents' preference for this proportion highlights their inclination toward beverages with a naturally sweet, smooth, and mildly acidic taste profile rather than overly tangy or bitter flavors. The findings of the present study are consistent with those of Dey et al. (2016), who highlighted that the balance of sweetness and acidity is an essential factor that can determine the quality of the senses and the overall acceptability of diluted fruit juices like cashew-pineapple juices. Equally, the outcomes are consistent with those by Krishna et al. (2017), who indicated that one of the most important sensory properties in the context of consumer preference and general liking of fruit-based beverages is sweetness. The current results thus support the significance of having an optimal proportion of the fruit ingredients to create a juice concoction that meets the taste and sensory demands. Furthermore, the positive response to Proportion C demonstrates consumers' appreciation for natural fruit combinations that

deliver both nutritional value and desirable flavor complexity. It also recommends the possibility of marketability of cashew-pineapple juice with added lemongrass which can be highly marketable especially to health conscious consumers who prefer sweeter and refreshing drinks which are natural. Thus, adjusting the pineapple concentration within the blend can serve as a key strategy for improving product formulation and developing value-added tropical fruit beverages suited to consumer preferences. To find out if there was a significant difference among Proportion A, B, and C as to Taste (Sweetness), ANOVA was employed using 0.05 level of significance.

Table 2. ANOVA Table for the Taste when Determine the Sweetness of the Cashew-Pineapple Juice Enriched with Lemongrass

Sources of Variation	SS	df	MS	F-value	p-value
Between Groups	99.21	2	49.6056	32.6259	0.000000**
Within groups	269.12	177	1.5204		
Total	368.33	179			

Legend: **p < 0.05

Table 2 presents the Analysis of Variance (ANOVA) for the taste (sweetness) of the cashew-pineapple juice enriched with lemongrass. The data clearly demonstrate that there is a statistically significant difference in the sweetness levels among the three formulated products, as indicated by the computed value $F(2,177) = 32.6259$, $p = 0.000000$. This highly significant result implies that the sweetness perception of the cashew-pineapple juice varied considerably depending on the proportion of fruit extracts used in the formulation. In other words, the variation in the amount of cashew apple and pineapple juice directly influenced the sweetness intensity perceived by the evaluators.

The statistical findings confirm that the beverage's sweetness was significantly enhanced as the proportion of pineapple juice increased. This outcome can be attributed to the naturally high sugar content and pleasant acidity of pineapple, which tend to mask the astringency and slightly tart flavor of the cashew apple juice. Therefore, the formulations that contained more pineapple in them had better balance of tastes and thus received high consumer acceptability ratings. This suggests that the intrinsic sweetness of the fruit with the higher ratio of it plays a major role in the overall palatability of the beverage, and hence the need to ensure the fruit mix proportion is maximized by ensuring the desired sensory profile is attained.

The findings also indicate that all the three formulations were acceptable but the individual difference in the intensity of sweetness was clear enough to affect consumer preference. It is stressed in the analysis that the ratio of cashew apple to pineapple extract is crucial in the perception of sweetness and general acceptability. Bevacours with greater concentration of pineapples were perceived to be sweeter and more palatable than beverages with greater amount of cashew apple. The result of this observation is that whereas cashew apple contributes to the body and aroma of the juicing mixture, pineapple is the primary contributor of the sweetness and taste appeal. The inclusion of lemongrass further enhanced the overall sensory experience by adding a refreshing citrus note that complemented the fruit base without overpowering it.

The findings of this study are in agreement with the observations of Stiletto and Trestini (2021), who reported that consumer acceptance is positively correlated with the sweetness level of a product. The other point that their study highlighted was the need to maintain balance because though consumers tend to like sweet tasting products, over-sweetness can cause sensory fatigue and decreased overall liking. This insight aligns with the present study's results, which suggest that the optimal sweetness of the cashew-pineapple juice lies in achieving a natural and balanced flavour neither too mild nor overwhelmingly sweet. Furthermore, outcomes resonate with the conclusions of Oliveira et al. (2012), who discovered that fruit juices that were moderately higher in terms of sweetness are more attractive and are popular with consumers because of their likeable mouthfeel and flavor balance. Equally, it is evident in the given study that sweetness is not only a sensory characteristic but an important determinant of customer satisfaction and buying desire. The fact that a higher proportion of

pineapples positively responded to the formulation is a testimony that naturally sourced sweetness can be good and beneficial in the creation of healthy and appealing drinks. On the whole, the findings of the ANOVA test support that the perception of the sweetness of the cashew-pineapple juice that is enriched with lemongrass is considerably influenced by the different ratios of the fruit elements in it. The results suggest that the strategic formulation especially the maximization of pineapple concentration can increase consumer acceptability without artificial sweeteners. This reinforces the value of blending tropical fruits to produce nutritionally beneficial and naturally flavorful beverages that align with modern consumer preferences for health-conscious yet enjoyable drink options. Since the F-test results indicate that the differences are statistically significant, there is a need to perform Scheffé's Post-Hoc Test to further test the difference in terms of sweetness.

Table 3. Scheffé Table for the Appearance (Color) of the Cashew-Pineapple Juice Enriched with Lemongrass

Sample 1	Sample 2	Mean Difference	p-value
A- Sweetness	B- Sweetness	-0.583	0.028
A- Sweetness	C- Sweetness	-1.78	0.0006**
B- Sweetness	C- Sweetness	-1.20	0.0003**

Legend: **p < 0.05

Table 3 presents the Scheffé post hoc analysis for the taste (sweetness) of the cashew-pineapple juice enriched with lemongrass. The results revealed that there were statistically significant variations in sweetness between Proportion A and Proportion C (Mean Diff. = -1.78, p = 0.0006) as well as between Proportion B and Proportion C (Mean Diff. = -1.20, p = 0.0003). These significant mean differences indicate that the sweetness intensity of the juice samples varied considerably depending on the fruit blend ratios. Specifically, formulations with higher pineapple content (Proportion C) were perceived as significantly sweeter and more palatable compared to those with higher proportions of cashew apple juice (Proportions A and B). This finding underscores the direct influence of the relative amounts of cashew apple and pineapple extracts on the beverage's perceived sweetness, demonstrating that the fruit with the greater concentration contributed most to the overall flavor profile and consumer appeal of the final product.

The results of the pairwise comparisons provide clear evidence that pineapple juice, known for its natural sweetness and acidity, plays a key role in enhancing the flavor balance of the beverage. Pineapple sweetness is a successful remedy to the low level of bitterness and astringency of cashew apple juice making the overall sensory experience to be more pleasant and enjoyable. This balanced incorporation does not only add palatability, but also adds to the positive consumer acceptability ratings. The results have therefore shown the need to attain the appropriate ratio of fruit content in developing multi-fruit drinks since this will have a direct bearing on the level of sweetness perceived and the total sensory experience. The results of this analysis corroborate the findings of Sukkwai et al. (2018), who reported that consumers often associate sweetness with nutritional quality and freshness, leading to higher food acceptability.

In their research, they stressed that naturally sweet products are likely to produce positive consumer reactions since the concept of sweetness is widely related to energy and satisfaction. Equally, Li, Jervis, and Drake (2015) concluded that sweetness has a significant positive influence on the palatability of food and drinks as it masks unwanted flavor notes thereby increasing the acceptability of a food or drink item. In the context of the present study, the cashew-pineapple blend enriched with lemongrass aligns with these conclusions, as the sweeter formulation (Proportion C) elicited the most favorable evaluation from respondents.

Furthermore, the Scheffé test results showed that when Proportion C was compared with both Proportion A and Proportion B, the respondents consistently rated it higher, primarily due to its increased pineapple content. The higher level of pineapple contributed not only to sweetness but also to the beverage's desirable fruity aroma and tangy undertone, which enhanced its overall sensory appeal. Conversely, the comparison between

Proportion A and Proportion B (Mean Diff. = -0.583, $p > 0.05$) revealed no statistically significant difference in sweetness ratings. This indicates that although Proportion B was slightly more preferred than Proportion A, the difference in their mean evaluations was too small to be considered significant at the 0.05 level of confidence. In essence, both proportions shared relatively similar sweetness intensities, suggesting that moderate adjustments in fruit ratio between these two formulations did not substantially alter sweetness perception.

The results collectively imply that the sweetness perception of blended fruit beverages is sensitive to variations in fruit proportion, especially when the difference involves a high-sugar component such as pineapple. Increasing the pineapple content in the blend dramatically raises the level of sweetness and consumer preference, whereas reduced proportions provide weaker less desirable sweetness profiles. The result also supports the hypothesis that the sweetness is a key factor influencing consumer preference in beverages based on fruits, which has already been supported by research highlighting the importance of sugar equilibrium in the process of taste maximization. Moreover, the lemongrass extract present in all formulations also added a faint citrus taste and freshness to the overall experience without reducing the level of sweetness. This implies that lemongrass may be employed as a natural flavor addition which blends with fruit based drinks in line with current consumer trends that focus on products with natural ingredients and those with reduced artificial additives.

Table 4. Mean rating of the Cashew-Pineapple Juice Enriched with Lemongrass in different proportion in terms of taste (sourness)

Proportion	Mean Rating	Description	Sd
Proportion A – 75 grams cashew apple Juice & 25 grams pineapple Juice	6.50	Liked moderately	1.28
Proportion B - 50 grams cashew apple Juice & 50 grams pineapple Juice	7.32	Liked moderately	1.08
Proportion C - 25 grams cashew apple Juice & 75 grams pineapple Juice	8.20	Liked very much	0.86

Legend							
8.50 – 9.00	liked extremely		5.50 –6.49	liked slightly		2.50 –3.49	disliked moderately
7.50 – 8.49	liked very much		4.50 –5.49	neither liked nor disliked		1.50 –2.49	disliked very much
6.50 – 7.49	liked moderately		3.50 –4.49	disliked slightly		1.00 – 1.49	disliked extremely

Table 4 presents the mean rating of Cashew-Pineapple Juice Enriched with Lemongrass in different proportion in terms of Taste (Sourness). The table depicted that the sourness of Proportion C ($\bar{x}$ = 8.20) was evaluated by the respondents as "Like Very Much" while Proportion B ($\bar{x}$ = 7.32) was rated as "Like Moderately". were evaluated by the evaluators as "Like Very Much" respectively. While Proportion A ($\bar{x}$ = 7.35) was evaluated by the evaluators as "Like Moderately". Considering the three proportions of cashew-pineapple juice, Proportion C ($\bar{x}$ = 8.20) was highly accepted due to its high content of pineapple Juice. The results revealed that beverage with 25 grams cashew apple juice & 75 grams of pineapple juice has the most acceptable sourness than the other products with different proportions of cashew and pineapple.

This indicates that adding more pineapple extract to the cashew apple juice will result in a noticeable improvement in the sourness of the beverage. This implies that the respondents preferred the formulation of a proportion that has a minimal sourness, primarily from the natural acidity of the pineapple juice. The results of this study support the findings of Alves et al. (2017), who reported that consumers favored fruit juices with a balanced taste profile that is, where the natural sweetness and sourness are in harmony with each other. The findings further underscore that the right balance between sweet and sour tastes is crucial for formulating a pleasant and well-rounded flavor. This reflects that there is a need to consider the desired level of sourness, as this will significantly improve the acceptability of fruit juices. Furthermore, ANOVA was utilized to determine the differences in the taste (sourness) among Proportions A, B, and C. This was tested at a 0.05 level of significance.

Table 5. ANOVA Table for the Taste when Determine the Sourness of the Cashew-Pineapple Juice Enriched with Lemongrass

Sources of Variation	SS	df	MS	F-value	p-value
Between Groups	86.74	2	43.3722	36.6293	0.000000**
Within groups	209.58	177	1.1841		
Total	296.33	179			

Legend: **p < 0.05

Table 5 presents the Analysis of Variance (ANOVA) results for the sourness attribute of the Cashew-Pineapple Juice Enriched with Lemongrass. The data revealed a statistically significant difference among the three formulated products with respect to their level of sourness, as indicated by the computed value $F(2,177) = 36.6293$, $p = 0.000000$. This finding demonstrates that the varying proportions of cashew apple and pineapple extracts led to a significant variation in the perceived sourness of the beverages. The high level of significance ($p < 0.05$) confirms that the evaluators were able to distinguish clear differences in sourness intensity among the three formulations.

The observed variability in sourness can be attributed primarily to the natural acidity and astringency of the two fruit components used. Cashew apple juice is known for its distinct astringent flavor, which is caused by the presence of tannins and organic acids, while pineapple juice possesses a mild but pleasant acidity derived from citric and malic acids. These inherent flavor compounds react when mixed in different proportions, to give different levels of sourness and tartness to the end product. The analysis therefore shows clearly that the sourness of the juice mostly reduces with the level of cashew apple extracts and pineapple extracts incorporated in each formulation.

In particular, formulations with higher cashew apple content exhibited greater sourness and astringency, which, while characteristic of the fruit, may have contributed to lower acceptability among the respondents.Conversely, recipes that contained a larger content of pineapples had a more balanced taste, which was signified by a light and sweet sourness that did not interfere with the natural sweetness of the mix. The combination of sweet and sour ingredients further contributed to the increased palatability of the drink and made it more attractive to the testers. As a result, the percentage with higher content of pineapple extract was found to be more acceptable in terms of sourness with respect to higher content on cashew apple.

The findings of this study are consistent with those of Stiletto and Trestini (2021), who reported that consumer acceptance tends to be negatively correlated with high levels of sourness. Their study proposed that a moderate level of acidity can be beneficial to the complexity of taste to beverages, but that too much sourness can reduce the satisfaction of consumers. They also made comprehensive points regarding the fact that when developing a successful product, one should not only maintain a pleasant sourness but also acidity that gives food a freshness and strength of flavor without going into excesses of acidity, which would make it too bitter. This is consistent with the findings of the present study which indicate that the most acceptable formulation (that contained more pineapple) had this optimal balance where it provided a mild and refreshing sourness that enhanced the overall sensory impact.

In addition, the results also support the findings of Akinwale (2020), who observed that blending pineapple juice with cashew apple juice not only improved the nutritional profile of the resulting beverage but also significantly increased its overall sensory acceptability. According to Akinwale found that pineapple natural sweetness and acidity help to balance the potent astringency and excessive tartness of cashew apple juice to a better liking. The same principle may be noted in the current paper, as pineapple was used as an ingredient that balanced the bitter flavor of cashew apple and made the drink a lot smoother and more drinkable.These findings are important because it has been realized that consumer perception of sourness is important in the formulation of beverages. Sourness, although it is essential to impart the freshness and depth of flavor, should be maintained

to avoid excessive sourness that will result in rejection. The ANOVA results make it clear that the correct balance of the sweet and sour elements that was mostly dependent on the ratio between the fruits is the key to the highest acceptability. A higher proportion of pineapple, with its moderate acidity and distinct tropical sweetness, contributed to the beverage's well-rounded sensory profile, which aligns with consumer preferences for lightly tart but refreshing fruit drinks.

Furthermore, the inclusion of lemongrass extract may have also influenced the perception of sourness. Lemongrass imparts a subtle citrusy note and aromatic freshness that can enhance the perception of acidity without increasing it chemically. This implies that lemongrass does not only enhance an overall flavor of the drink but also assist in compensating the opposite tastes of cashew apple and pineapple. These three ingredients combined therefore led to the production of a drink that is refreshing and tasting, and this portrays a perfect combination of tropical flavors. A Scheffé's Post-Hoc Test analysis was employed to highlight the differences in the sourness among Proportions A, B, and C.

Table 6. Scheffé's Post-Hoc Test on the Taste when determine the Sourness of the Cashew-Pineapple Juice Enriched with Lemongrass

Sample 1	Sample 2	Mean Difference	p-value
A- Sourness	B- Sourness	-0.817	0.0009**
A- Sourness	C- Sourness	-1.700	0.0001**
B- Sourness	C- Sourness	-0.883	0.0072**

Legend: **p < 0.05

The results of the analysis showed that Proportion A and B (Mean Diff. = -0.817, p = 0.0009), Proportion A and C (Mean Diff. = -1.700, p = 0.0001), and Proportion B and C (Mean Diff. = -0.883, p = 0.0072) all varied significantly from one another. This clearly depicts that the sourness of cashew-pineapple juice with different proportion was different from each other because the amount of cashew apple and pineapple extracts added to the beverage mixture affects its taste (sourness). This implies that the sourness of the fruit juice influenced the sourness of the beverage especially if the amount is greater than the others, making the product acceptable to the respondents. The aforementioned results corroborate those of Pagliarini et al. (2021), who showed a direct correlation between consumer acceptance and food product consumption and their sourness and bitterness response. They also discovered a strong inverse relationship between acceptability and sense of sour taste.

Table 7. Mean rating of the Cashew-Pineapple Juice Enriched with Lemongrass in different Proportion in Terms of Taste (Aftertaste)

Proportion	Mean Rating	Description	Sd
Proportion A – 75 grams cashew apple Juice & 25 grams pineapple Juice	6.37	Liked slightly	1.27
Proportion B - 50 grams cashew apple Juice & 50 grams pineapple Juice	6.73	Liked moderately	1.47
Proportion C - 25 grams cashew apple Juice & 75 grams pineapple Juice	7.55	Liked very much	1.19

Legend							
8.50 – 9.00	liked extremely		5.50 –6.49	liked slightly		2.50 –3.49	disliked moderately
7.50 – 8.49	liked very much		4.50 –5.49	neither liked nor disliked		1.50 –2.49	disliked very much
6.50 – 7.49	liked moderately		3.50 –4.49	disliked slightly		1.00 – 1.49	disliked extremely

The result showed that the respondents evaluated Proportion C ($\bar{x}$ = 7.55) as "Like Very Much" whereas Proportion B ($\bar{x}$ = 6.73) as "Like Moderately". Likewise, Proportion A ($\bar{x}$ = 6.37) was rated by the evaluators as "Like Slightly". Comparing the aftertaste of the three proportions of cashew-pineapple juice, Proportion C ($\bar{x}$ = 7.55), containing 25 grams cashew apple Juice & 75 grams pineapple Juice, was the most acceptable among the respondents. This means that a high pineapple content resulted to a pleasant aftertaste whereas a high content of cashew apple extract yielded a mild tangy aftertaste.

This implies that the respondents preferred a cashew-pineapple juice with rich tropical fruitiness and citrusy aftertaste due to high pineapple content. The result of the above findings is parallel with the study conducted by Santos et al. (2021) which stressed that consumers preferred bright and deeper yellow fruit juice. The results of this study are in accordance with the study of Akinwale (2000) that when cashew apple juice was blended with pineapple juice, its aftertaste significantly improved, which resulted to a high acceptability. This study further emphasizes that a pleasant aftertaste is desirable in fruit juices as it leaves a positive impression on the consumer. Hence, there is a need to have a right proportion of cashew apple and pineapple extracts that will yield a pleasant aftertaste.

Table 8. ANOVA Table for the Taste when Determine the Aftertaste of the Cashew-Pineapple Juice Enriched with Lemongrass

Sources of Variation	SS	df	MS	F-value	p-value
Between Groups	44.03	2	22.0167	13.0544	0.000000**
Within groups	298.52	177	1.6865		
Total	342.55	179			

Legend: **p < 0.05

The analysis revealed that there was a significant difference existed on the level of acceptability of the Cashew-Pineapple Juice Enriched with Lemongrass (F [2,177] = 13.0544. p = 0.00000) as to taste (aftertaste) of the three products. This means that the three proportions (Proportion A, B, and C) have different aftertaste. This indicates that the respondents described the aftertaste of the three proportions differently due to the varying amounts of cashew apple and pineapple extracts used in the finished beverage. This implies that that a higher concentration of fruit juice extract has a substantial impact on the aftertaste of the beverage, leading to a high level of acceptance.

The study also highlights how much the cashew-pineapple juice's flavor was enhanced by the addition of lemongrass. According to the findings, the lemongrass adds a delightful twist and a vibrant lemon flavor that counterbalances the cashew apple and pineapple's sweetness. This is in line with the findings of Rahman et al. (2016), who emphasized that the unique and refreshing flavor of lemongrass can contribute to high acceptability when added to fruit beverages. Since the F-test results indicate that the differences are statistically significant, there is a need to perform Scheffé's Post-Hoc Test to further test the difference.

Table 9. Scheffé's Post-Hoc Test on the Taste when determine the Aftertaste of the Cashew-Pineapple Juice Enriched with Lemongrass

Sample 1	Sample 2	Mean Difference	p-value
A- Aftertaste	B- Aftertaste	-0.367	0.272
A- Aftertaste	C- Aftertaste	-1.183	0.0098**
B- Aftertaste	C- Aftertaste	-0.817	0.002**

Legend: **p < 0.05

The results of the study showed that the aftertaste of Proportion A and C differ significantly from one another (Mean-Diff. = -1.183, p = 0.0098). Additionally, the comparison of the two proportions shows that the aftertaste of C is preferable to that of A. Likewise, a noteworthy distinction was found between the aftertaste of B and C (Mean-Diff. = -0.817, p = 0.002), suggesting that the participants favored the aftertaste of C over B. This implies that increasing the pineapple content in cashew-pineapple juice will produce a pleasing aftertaste and, consequently, achieve a high acceptability.

This validates the study of Nascimento et al. (2020), who have shed light that mixed fruit juices that obtained high acceptability are beverages with a pleasant and refreshing aftertaste. In contrast, Proportion A and B did not differ significantly (Mean-Diff. = -0.367, p = 0.272). This indicates that the aftertaste of a mixture containing 25 grams of cashew apple and 75 grams of pineapple juice is comparable to the aftertaste of a mixture containing an equal amount of cashew apple and pineapple juice. The differences were statistically not significant even though the mean difference of -0.367 suggests that B is preferred over A.

IV. CONCLUSION

Based on the findings of the study, it can be concluded that the proportion of cashew apple and pineapple juices significantly influences the sensory acceptability of the Cashew-Pineapple Juice Enriched with Lemongrass in terms of sweetness, sourness, and aftertaste. Among the three formulations, Proportion C (25 grams cashew apple juice and 75 grams pineapple juice) consistently obtained the highest mean ratings across all sensory attributes, described as “Liked Very Much.” This indicates that a higher concentration of pineapple juice leads to improved sweetness, balanced sourness, and a more pleasant aftertaste. The results reveal a clear pattern: as the pineapple content increases, the overall acceptability of the beverage also increases. The Analysis of Variance (ANOVA) outcomes also support the point of view that the sweetness, sourness, and aftertaste difference between the three proportions of the fruit extracts were significant at the level of 0.05, which implies that the difference in evaluating the fruit extracts by changing the ratio has a direct impact on the level of perception of the taste by the consumers. The Post-Hoc Test of Scheffé’s indicated that there were significant differences between Proportion C and the other two formulations (A and B) in all the features of taste since the natural sweetness of pineapple and its acidity played a significant role in improving the flavor profile of the beverage. These results support the previous research (ex: Dey et al., 2016; Alves et al., 2017; Li et al., 2015) that emphasizes that the balance between sweetness and acidity significantly helps to achieve consumer preference and acceptability in fruit beverages. Moreover, the incorporation of lemongrass was found to complement the overall flavor by adding a refreshing and aromatic note that improved the drink’s aftertaste, consistent with the findings of Rahman et al. (2016). The added tropical fruitiness and optimization of the flavor by the pineapple extract coupled with the citrus smell of lemongrass gave a more desirable sensory experience. Hence, it is possible to conclude that the best and most acceptable version of the Cashew-Pineapple Juice Enriched with Lemongrass is the combination of 25 grams of cashew apple juice and 75 grams of pineapple juice since it was the one that offered the optimal balance of sweetness, mild sourness and pleasant aftertaste that consumers desired. This suggests that the formulation could serve as a potential standard for producing a refreshing, nutritious, and well-balanced fruit beverage.

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