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DEVELOPMENT AND ACCEPTABILITY OF CALAMANSI-GINGER CONCENTRATE

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ABSTRACT This study developed a calamansi-ginger concentrate and determined its acceptability in terms of taste, aroma, aftertaste, color, and general acceptability. This study used a Completely Randomized Design (CRD) with four treatments: 5%, 10%, and 15% ginger extract per kilogram of calamansi juice, and a control with no ginger extract. The treatments were replicated three times. Fifty respondents evaluated the developed formulations using a 9-point hedonic scale. Data were analyzed using mean and one-way analysis of variance (ANOVA), with a multiple range test used to determine differences among treatment means. Results showed significant differences among treatments in terms of taste, aftertaste, and general acceptability, while no significant differences were observed for aroma and color. The formulation containing 15% ginger extract obtained the highest mean ratings for taste (9.00), aftertaste (8.67), and general acceptability (9.00). In comparison, the 5% ginger formulation obtained the lowest ratings for taste (7.00) and general acceptability (7.00). The findings indicate that ginger extract concentration influenced the sensory acceptability of the calamansi-ginger concentrate, particularly taste, aftertaste, and overall acceptance. Among the formulations evaluated, the 15% ginger extract treatment demonstrated the highest sensory acceptability and may therefore serve as the preferred formulation for further product development and evaluation.

Keywords: *calamansi, concentrate, ginger extract, product development, sensory acceptability*

INTRODUCTION

Growing interest in food products made from natural, locally available ingredients has created opportunities to develop value-added beverages that combine sensory appeal with the benefits of plant-based raw materials. Fruits, herbs, and spices are increasingly incorporated into beverages because they contribute distinctive flavors, aromas, and naturally occurring bioactive compounds. Among locally available ingredients with potential for beverage development are calamansi (Citrus microcarpa) and ginger (Zingiber officinale), both widely used in food preparation and traditional beverages. Combining these ingredients into a concentrated beverage may offer an alternative way to use locally available agricultural products while meeting consumer preferences for flavorful, plant-based drinks.

Calamansi is a citrus fruit commonly cultivated and consumed in the Philippines. Its distinctive acidic taste and citrus aroma make it suitable for juices, concentrates, syrups, flavoring agents, and other processed food products. Beyond its culinary importance, calamansi contains sugars, organic acids, volatile compounds, and phenolic acids that contribute to its physicochemical and sensory characteristics. Cheong et al. (2012) characterized calamansi from the Philippines, Malaysia, and Vietnam and identified numerous volatile compounds and phenolic acids in the peel. Their investigation also showed geographical variation in calamansi composition, with Philippine calamansi peel showing comparatively high levels of total phenolic acids. These characteristics indicate calamansi's potential as a raw material for value-added food and beverage products.

The composition of calamansi juice also supports its potential use in beverage processing. Cheong et al. (2012) identified approximately 60 volatile compounds in calamansi juice and documented differences in its sugars, organic acids, phenolic acids, and other physicochemical characteristics. Such components contribute to the distinctive flavor and aroma associated with calamansi beverages. In addition, Siner et al. (2020) examined the blood glucose response to a calamansi drink among healthy adults and reported a calculated glycemic index of 37 for the particular beverage formulation evaluated. Although this finding should not be generalized to all calamansi products because formulations may differ, it provides additional evidence supporting scientific interest in calamansi-based beverages.

Ginger (Zingiber officinale), meanwhile, is widely utilized as a spice and food ingredient because of its characteristic pungent flavor and aroma. It contains several phytochemical constituents, particularly gingerols and shogaols, which have been investigated for their biological properties. Ghasemzadeh et al. (2010) reported antioxidant activity as well as phenolic and flavonoid contents in young ginger varieties, while Dugasani et al. (2010) demonstrated antioxidant and anti-inflammatory activities of major gingerols and shogaol under experimental conditions. Similarly, Min et al. (2017) examined phytochemical concentrations and antioxidant capacities in ginger rhizomes and leaves. Collectively, these findings establish ginger as a potentially useful ingredient in food product development because it contributes not only a distinctive sensory character but also naturally occurring bioactive compounds.

Despite these desirable characteristics, incorporating ginger into beverages requires careful formulation because its strong flavor may substantially influence consumer acceptance. Increasing the amount of ginger can intensify pungency, aroma, and lingering flavor, whereas insufficient amounts may not noticeably contribute to the product's sensory profile. Thus, determining an appropriate concentration is important when combining ginger with an acidic, strongly flavored ingredient such as calamansi. Sensory evaluation is particularly relevant because technical development does not necessarily ensure consumers will find the resulting product acceptable.

Consumer acceptability is essential in food product development because sensory attributes influence consumers' willingness to consume and potentially purchase a product. Taste, aroma, aftertaste, and color provide important information regarding how consumers perceive a newly developed beverage, while general acceptability reflects their overall response to the formulation. Variations in ingredient proportions can alter these attributes and, in turn, affect product preference. For calamansi-ginger concentrate, ginger concentration is particularly important because it can modify calamansi's naturally sour citrus character and create differences in taste, aroma, aftertaste, and overall sensory experience. Consequently, sensory evaluation of different formulations is necessary to identify a concentration that produces a desirable balance between the two ingredients.

Developing calamansi and ginger into a concentrate also provides an opportunity for value addition. Concentration allows fruit-based ingredients to be processed into a form that can subsequently be diluted or incorporated into beverages and other products. The combination of calamansi and ginger is particularly relevant because the acidity and citrus character of calamansi can be complemented by the warm and pungent sensory qualities of ginger. However, an effective formulation requires more than simply combining the two ingredients. The proportion of ginger extract must be considered carefully because concentration variations may produce different levels of sensory acceptability.

Although calamansi and ginger have been studied separately for their chemical composition and functional properties, comparatively little attention has been given to their combined use as a concentrated beverage and to how varying ginger concentrations affect the sensory acceptability of such a product. Existing literature provides evidence concerning the volatile and phenolic composition of calamansi (Cheong et al., 2012), the characteristics of calamansi beverages (Siner et al., 2020), and the antioxidant and anti-inflammatory properties associated with ginger constituents (Dugasani et al., 2010; Ghasemzadeh et al., 2010; Min et al., 2017). However, these studies do not establish the ginger extract level consumers may prefer when calamansi and ginger are formulated together as a concentrate. This represents an important product-development concern because a nutritionally promising formulation must also achieve satisfactory sensory acceptability.

Addressing this gap may provide useful information for developing a value-added beverage using ingredients readily available in local communities. It may also provide practical guidance on incorporating ginger into calamansi concentrate based on consumer sensory responses. Rather than assuming that increasing or decreasing ginger concentration automatically improves the product, empirical sensory evaluation can identify how different formulations are perceived and determine which formulation offers the most acceptable sensory characteristics.

Therefore, this study aimed to develop a calamansi-ginger concentrate and determine its acceptability in terms of taste, aroma, aftertaste, color, and general acceptability. Specifically, different concentrations of ginger extract were incorporated into calamansi juice and compared with a control formulation to determine how variations in ginger concentration affected the sensory characteristics and overall acceptability of the developed product. The findings were intended to provide an empirical basis for identifying a suitable calamansi-ginger formulation for further product development and potential utilization.

METHODOLOGY

Research Design

The study used an experimental research design with a Completely Randomized Design (CRD) to develop and assess the acceptability of calamansi-ginger concentrate. Researchers prepared four treatments, including the control, and replicated each three times, resulting in 12 experimental units. Treatment A consisted of 5% ginger extract per kilogram of calamansi juice; Treatment B contained 10% ginger extract; Treatment C contained 15% ginger extract; while Treatment D served as the control and consisted of pure calamansi juice without ginger extract. The developed formulations were evaluated for taste, aroma, aftertaste, color, and general acceptability.

Table 1. Experimental treatments of the calamansi-ginger concentrate

Treatment	Formulation
Treatment A	5% ginger extract per kilogram of calamansi juice
Treatment B	10% ginger extract per kilogram of calamansi juice
Treatment C	15% ginger extract per kilogram of calamansi juice
Treatment D	Control – pure calamansi juice without ginger extract

Selection of Calamansi and Ginger

The study used mature calamansi fruits with dark green skin to prepare the concentrate. The researchers collected the fruits locally in Guimaras. The study also used mature ginger, approximately nine to ten months old. The researchers obtained the ginger either from the local market or directly from local ginger farmers.

Extraction of Calamansi Juice

The researchers thoroughly washed the calamansi fruits with tap water and sanitized them by soaking them for 30 minutes in a brine solution containing 15% salt per liter of water. After sanitization, the fruits were sliced while submerged in the brine solution and squeezed to extract the juice. The extracted juice was strained to remove pulp and other solids. The strained calamansi juice was covered and set aside to prevent contamination before further processing.

Extraction of Ginger Juice

The mature ginger was peeled, washed thoroughly, and sliced into smaller pieces. Small portions of the sliced ginger were placed in a juice extractor to obtain the juice. The extracted ginger juice was collected in a clean container and strained to remove solid particles. It was then covered until further use in preparing the different formulations.

Preparation of the Calamansi-Ginger Concentrate

The strained calamansi juice and ginger extract were combined according to the specified treatment formulations. In a separate container, mix water, sugar, and salt thoroughly until the sugar fully dissolves. The mixture was then strained to remove unwanted particles.

The calamansi-ginger juice and the water-sugar-salt mixture were combined in a casserole and stirred thoroughly. The mixture was heated over high heat until it reached boiling point. The heat was then reduced to medium, and the mixture was stirred occasionally to prevent burning. Cooking was continued for 45 minutes. After cooking, the concentrate was allowed to cool to approximately 40°C before being transferred into plastic bottles. The prepared formulations were subsequently subjected to acceptability evaluation.

Acceptability Evaluation

The acceptability of the developed calamansi-ginger concentrate was evaluated by 50 respondents using a 9-point hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). Respondents evaluated each formulation for taste, aroma, aftertaste, color, and general acceptability. The 9-point hedonic scale is commonly used to measure the degree of liking and acceptability of food products (Lim, 2011).

Data Analysis

The acceptability evaluation data were analyzed using the mean and one-way Analysis of Variance (ANOVA) for the Completely Randomized Design. The mean was used to determine the acceptability of the different calamansi-ginger concentrate formulations in terms of taste, aroma, aftertaste, color, and general acceptability. When significant differences among treatment means were identified, a Multiple Range Test was used to determine the differences among the treatments.

RESULTS AND DISCUSSIONS

Development of Calamansi-Ginger Concentrate

Four formulations were prepared to determine an appropriate combination of calamansi juice and ginger extract. Treatment A contained 5% ginger extract per kilogram of calamansi juice, Treatment B contained 10%, Treatment C contained 15%, while Treatment D served as the control with no ginger extract.

The development process involved separately extracting calamansi and ginger juices, formulating them with water, sugar, and salt, and then heating them as described in the methodology. Using different concentrations of ginger extract allowed the developed formulations to be compared systematically in terms of sensory acceptability. Thus, all four formulations were subjected to sensory evaluation, and their relative suitability was determined based on respondents' ratings.

The formulation approach is comparable with previous product-development research involving calamansi and ginger. Albiso et al. (2018), in developing kalamansi nip with ginger extract, similarly evaluated a control and formulations containing 5%, 10%, and 15% ginger extract through sensory evaluation. Their study demonstrates the relevance of varying ginger concentration when developing calamansi-based products because formulation changes can affect consumer preference. However, the most acceptable formulation identified in their study differed from that obtained in the present investigation, emphasizing that acceptability should be determined empirically for the specific product being developed.

Acceptability of the Calamansi-Ginger Concentrate

The second objective determined the acceptability of the developed calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability. Table 2 presents the sensory evaluation results for the four formulations.

Table 1. Acceptability of the calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability

Treatment	Taste	Aroma	Aftertaste	Color	General Acceptability
A – 5% ginger extract	7.00^{c}	7.33	7.33^{b}	7.33	7.00^{b}
B – 10% ginger extract	8.33^{ab}	7.33	8.33^{ab}	7.67	8.00^{ab}
C – 15% ginger extract	9.00^{a}	8.33	8.67^{a}	8.00	9.00^{a}
D – Control	7.67^{bc}	7.67	7.33^{b}	7.33	7.67^{b}
F-test	*	ns	*	ns	*
CV (%)	8.1	7.5	7.3	9.3	7.3

Note. Means within a column bearing different superscript letters are significantly different based on the multiple range test reported in the study. * = significant; ns = not significant.

Taste

Taste differed significantly among the four formulations. Treatment C, containing 15% ginger extract, obtained the highest mean rating of 9.00, followed by Treatment B at 8.33, the control at 7.67, and Treatment A at 7.00. The significant F-test indicates that varying the ginger extract concentration affected respondents' taste evaluation of the calamansi-ginger concentrate.

The mean pattern indicates that the formulation with the highest ginger concentration was the most acceptable in terms of taste. Based on the superscript groupings, Treatment C differed significantly from Treatment A and the control, whereas Treatment B shared statistical groupings with the higher- and lower-rated treatments. Thus, the results support the preference for the 15% formulation within the concentrations tested but should not be interpreted as evidence that concentrations beyond 15% would produce further improvement.

The result reinforces the importance of ingredient proportion in sensory product development. A Philippine study by Albiso et al. (2018) likewise reported differences in the acceptability of kalamansi products formulated with different concentrations of ginger extract. Interestingly, their study found the 5% formulation to be more acceptable, whereas the present study obtained the highest taste rating at 15%. This difference suggests that the sensory effect of ginger concentration may depend on the particular formulation, processing method, accompanying ingredients, and characteristics of the finished product. Therefore, establish an optimal ginger concentration for the product under development rather than generalizing across different calamansi-based beverages.

Aroma

Mean aroma ratings ranged from 7.33 to 8.33. Treatment C had the highest mean (8.33), followed by the control (7.67), while Treatments A and B both had 7.33. Despite these numerical differences, the F-test was not significant. The result indicates that varying the ginger extract concentration from 5% to 15% did not produce statistically significant differences in the respondents' acceptance of the aroma. Consequently, although Treatment C recorded the highest numerical mean, it cannot be concluded statistically that its aroma was preferred over those of the other formulations. The appropriate interpretation is that the four formulations were comparable in terms of aroma acceptability.

A similar pattern has been observed in other beverage-development research, where changes in ingredient levels influenced some sensory characteristics but not aroma. For example, research involving different levels of calamansi and stevia in a ready-to-drink beverage reported significant effects on flavor, taste, and general acceptability but not on aroma and color. This supports the broader observation that formulation changes do not necessarily affect all sensory attributes in the same manner.

Aftertaste

Significant differences were also observed in aftertaste. Treatment C obtained the highest mean rating of 8.67, followed by Treatment B at 8.33, while Treatment A and the control both obtained 7.33. The significant F-test demonstrates that ginger extract concentration affected the acceptability of the product's aftertaste.

Based on the multiple range groupings, Treatment C differed significantly from Treatment A and the control, whereas Treatment B occupied an intermediate statistical grouping. The findings therefore indicate that the 15% ginger formulation produced the most acceptable aftertaste among the treatments evaluated.

The aftertaste findings complement the taste results because both sensory attributes showed significant treatment effects and their highest means occurred in Treatment C. This suggests that the amount of ginger incorporated into the formulation influenced not only the concentrate's immediate taste but also the sensory impression remaining after consumption. Nevertheless, the finding pertains specifically to sensory acceptability and should not be interpreted as evidence of nutritional or therapeutic superiority of the 15% formulation.

Color

For color, Treatment C had the highest mean score of 8.00, followed by Treatment B at 7.67, while Treatment A and the control both scored 7.33. However, the F-test showed no significant difference among the treatments.

This indicates that the different concentrations of ginger extract did not significantly affect the respondents' acceptance of the product's color. Although the mean ratings showed slight numerical variation, these differences were insufficient to establish statistical differences among formulations. Accordingly, all four treatments may be regarded as comparable in color acceptability.

This finding is consistent with sensory product-development research showing that varying ingredient concentrations may not produce perceptible differences in beverage color. In the previously reported calamansi-containing beverage study, color and aroma similarly did not differ significantly among formulations even when other sensory characteristics were affected.

General Acceptability

General acceptability differed significantly among the formulations. Treatment C obtained the highest mean rating of 9.00, followed by Treatment B at 8.00, the control at 7.67, and Treatment A at 7.00. The significant F-test demonstrates that ginger extract concentration influenced the overall acceptability of the calamansi-ginger concentrate.

Based on the multiple range test, Treatment C differed significantly from Treatment A and the control, while Treatment B fell into an intermediate group. The results indicate that the formulation containing 15% ginger extract was the most acceptable overall among the concentrations evaluated. This finding is consistent with its performance for taste and aftertaste, for which Treatment C likewise obtained the highest mean ratings.

The results further demonstrate that overall sensory acceptance was not determined equally by every sensory characteristic. Treatment differences were significant for taste, aftertaste, and general acceptability, whereas aroma and

color did not differ significantly. Thus, the sensory advantage of the 15% formulation was primarily associated with flavor perception rather than aroma or visual appearance.

Comparable beverage-development studies demonstrate the importance of evaluating individual sensory attributes rather than relying solely on general acceptability. Sensory evaluation identifies differences among formulations and provides an empirical basis for selecting a formulation for subsequent product development. Philippine research on kalamansi nip with ginger extract similarly employed sensory evaluation to distinguish the acceptability of formulations with different ginger concentrations, although its preferred concentration differed from the present study.

The study successfully developed four calamansi-ginger concentrate formulations: three ginger extract concentrations and a control. Sensory evaluation showed that ginger concentration significantly affected taste, aftertaste, and general acceptability, but did not significantly affect aroma and color. Among the formulations evaluated, Treatment C (15% ginger extract) received the highest mean ratings for taste, aftertaste, color, and general acceptability, and also the highest reported aroma means in Table 1. However, because aroma and color did not differ significantly among treatments, the preference for Treatment C is statistically supported primarily by its taste, aftertaste, and general acceptability results.

These findings identify the 15% ginger extract formulation as the most acceptable formulation within the concentrations evaluated in this study. The present data do not support conclusions about nutritional composition, antioxidant activity, microbial safety, shelf life, profitability, or marketability because these variables were not measured.

CONCLUSIONS

The study demonstrated the feasibility of developing a calamansi-ginger concentrate using varying levels of ginger extract. The sensory evaluation showed that ginger concentration influenced the acceptability of the product, particularly in terms of taste, aftertaste, and general acceptability, while aroma and color remained comparable across the formulations. Among the treatments evaluated, the formulation containing 15% ginger extract showed the highest acceptability, indicating that this level provided the most preferred sensory characteristics under the conditions of the study. These findings highlight the importance of ingredient proportion in developing an acceptable calamansi-ginger concentrate and provide a basis for further refinement and evaluation of the product.

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